IMPACT OF GENERATIVE LEARNING MODEL ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN CHEMISTRY IN ONITSHA EDUCATION ZONE OF ANAMBRA STATE, NIGERIA

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ABSTRACT
The study investigated the impact of generative learning model on academic achievement of secondary school students in chemistry in Onitsha education zone. The study adopted a quasi-experimental, design specifically; a non-equivalent control group. A sample of Ninety eight (98) Senior Secondary One (SS1) students was used for the study. 50 students were used in experimental group and 48 students in control group. A total of 98 students (67 males and 31 females) constituted the sample for the study. The instrument used was Chemistry Achievement Test (CAT) which was validated by two experts. The reliability coefficient using Kudder-Richardson formula 20 (KR-20) was 0.81. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypothesis at 0.05 level of significance. The study revealed that students taught chemistry using Generative Learning Model (GLM) instructional strategy had higher mean academic achievement score than students taught using conventional method. There is a significant difference between the mean academic achievement scores of experimental group (GLM) and control group (conventional method) in favour of experimental group with higher mean academic achievement score. The high academic achievement shown by the experimental group may have been the impact of the exploration and elaboration phases of the generative learning model. These phases are interesting on their own, in the sense that, this phase encourages individual students to explore ideas and apply what they have learnt. The findings of this study reveal that male and female students taught chemistry with generative learning model instructional strategy have almost equal mean academic achievement scores. The findings also show that there is no significant difference due to gender on chemistry students' mean academic achievement scores of students taught with GLM. Based on these findings, it was recommended among others that Chemistry teachers should incorporate generative learning model as one of the instructional strategy used in teaching concepts in chemistry.
Keywords: Generative learning model, academic achievement, chemistry

Introduction

Science has penetrated every branch of modern life. It brings about the noise of machines, cars, mills and factories which wakes us up every day in the morning. The food we eat, the clothes we wear, the book and paper we read, all have one thing or

the other to do with the application of science. It was in recognition of the importance of science that Nigerian Government has continued to make serious effort towards providing her citizens with qualitative and quantitative science education programmes. In addition, looking at the modernization that takes place every day, the world work force requires people who could have acquired the necessary attitude and skill of science and technology. That is why Nzewi (2011) stated that, science and technological education are regarded as a vehicle for economic and social development in a country and the acceleration and sustainable development depend on the quality of scientists produced from science education. This implies that our nation's advancement in science depends to a large extent on its strong science education programmes.

Science education is the field of study which is concerned with sharing science contents and processes with individuals not traditionally considered part of the scientific community, thereby producing a scientific literate society (Offiah &Igboekwu, 2010). Science education can be seen as a process of teaching and training especially in school to improve one's knowledge about one's environment and develop one's skill for systematic inquiry. It is important to note that science education and its application in technology are one of the most powerful instruments which can enable all members of the society to face the dynamic nature of science and modernization of today. Science education has many branches which include chemistry education.

Chemistry is a branch of science that studies the properties, composition, and structures of matter together with the associated changes as well as how such changes impact on the welfare of man and the society (Ojokuku, 2010). Chemistry has made tremendous contributions in the world. It has helped man to understand the complexity of his body, the environment, benefit and hazard of this world. It has been increasingly used in providing solutions to problems such as health, agriculture, food, shelter, and manufacturing. There is scarcely a single area of our daily lives that is not affected by chemistry. However, it is disheartening to note that chemistry students' academic achievement in the subject in senior secondary school certificate examination has remained consistently poor. The poor achievement of students in chemistry has been attributed to some students' factor such as; student sex role stereotyping, lack of interest and negative attitude towards chemistry and teacher-related factors such as poor teacher preparedness and application of inefficient teaching methods (Chukwu, 2013). In Nigeria, efforts are being made by researchers, government and non-governmental organizations to diagnose the problems associated with teaching and learning of chemistry in order to proffer solutions that lead to better achievement. However, the WAEC Chief examiner's report (2014) indicated that achievement in chemistry at secondary school remained poor. Could it be that teachers' method of teaching is not effective to improve students' achievement?

Effective teaching involves classroom teaching behavior/interaction between the teacher, the student, the subject matter and combination of these three dimensions (Akuezilo, 2009). To achieve effectiveness in teaching and learning of science in general and chemistry in particular, teachers need to adopt some teaching model in the classroom. One of such models could be Generative Learning Model (GLM) instructional strategy.

Generative Learning Model (GLM) is a cognitive model of human learning with understanding that was developed by Wittrock, in 1974. It is a constructivist teaching strategy and instructional model that focuses on cognitive processes that the students used to comprehend concept. GLM focuses on considering the students previous learning experience and understanding so that the learner can actively generate meaningful relationships between the prior knowledge and new information (Grabowski, 2002). The model provides students' opportunity for active participation in the learning process, allows for group and individualized form of learning and empowers learners with ability to express their personal views through its phases. This is unlike the conventional methods, which have no direction or phases, and the teacher talks, writes, and in fact do everything in the classroom. The GLM phases direct both teacher and students in learning environment. There are several versions of generative learning model as proposed by many researchers such as Baker (2001), and Bybee, Buchwald, Crissman, Heel Kuerbis, Matsumoto and Nerney (1990). This study focuses on Bybee et al model. It is a teaching strategy with five instructional phases namely; engagement, exploration, explanation, elaboration and evaluation.

Teaching strategies are the techniques, methods and styles that a teacher can adopt to meet the various learning objectives. Teaching strategies include manner of presentation, the way of arranging conditions, grouping students, guiding activities and providing information to aid learning. Teaching strategies are central to the teacher's goal and strive to enrich the learning environment in which the learner is engaged. The learning environment is the total physical and mental world to which the students are exposed at a particular time, and the enrichment of the environment implies making the learning experience of the physical and mental world more conducive for the students. In addition, looking at today's age (computer age), students need to be taught with innovative teaching strategies. This is to enable them think critically, explore their environment, acquired the necessary attitude and skill to become future scientists. Therefore teachers of today need innovative teaching strategy in order to improve the academic achievement of secondary school students in chemistry, since it is the starting point of students for future carrier in the field of science.

Achievement in Chemistry can be regarded as a course accomplished with special ability, effort and great courage through chemistry scientific process. Those things

that are accomplished can be in physical learning process or moral learning process but are all learning achievement which must pass through scientific process that will bring about those things that came into being through chemistry and chemistry products for example, clothing materials, building materials (Obikezie, 2017). Chemistry and chemistry products like clothing materials, building materials are of great importance to the society.

Irrespective of the great importance of chemistry to a developing country like Nigeria, it is disheartening to note that the students' achievement in the subject in senior secondary school certificate examination has remained consistently poor. The reported record by West Africa Examination Council (WACE) chief examiner 2014 mentioned earlier, stated that students' weaknesses among others are poor knowledge of the concept of "chemical bonding" (electronic configuration, oxidation state, IUPAC nomenclature). Also, it seems there is disparity in the academic achievement of male and female students in these areas of chemistry. This poor achievement has generated concern for the researchers to carry out this study.

Generative learning theory was developed by Wittrock (1999). It states that as we make connection between our existing schema and new information, our knowledge base changes and new information is formed. The generative theory of learning by Wittrock is based on the idea that learners can actively integrate new ideas into their memory to enhance their educational experience. In essence, it involves linking new with old ideas in order to gain a better understanding of the instructed concepts. The concept behind the generative learning theory lies on 'schemata', that is learning process is based on the memory that is already stored in our brains, According to Wittrock (1999), human brain does not just passively observe its environment or the events it experiences, but that it constructs its own perception about problems, scenarios and experience. Wittrock further stated that the learner must be an active participant in the learning process. Emphasizing on the importance of what the student does in order to learn is of greatest importance. The theory involves four key concepts that instructional designers can involve. To involve all four of them or just one depends on the needs of the learner and the learning materials involved. They are: recall, integration, organizer and elaboration.

Recall occurs when the learner accesses information stored in his long term memory. Integration; involves the learner integrating new information with knowledge already collected and stored. Organization involves learners linking knowledge they have already collected to new concepts in an effective way. Elaboration involves the encouragement of the learners to connect and add new concepts to information that they have already collected by analyzing the ideas. Teacher's role is to know how and when to facilitate the learners' construction of relationship; making the learner and teacher or instructor partners in the learning process their priorities. Teacher has the collaborative task of guiding and facilitating the students' activity. The teacher

identifies the students by gathering the students conceptual preconceptions about their learning a topic, identify preconceptions about their role as learners, prior knowledge relating to the topic and Meta cognitive abilities. The teacher encourages learners to become fully immersed in learning, so that they can develop new strategies on how to solve problems or scenarios. It involves teacher allowing the struggling students to interact with more capable ones who continue to mediate transactions for the benefit of all.

Since GLM of Bybee et al emphasizes on engagement and exploration through which students' identified prior knowledge are linked to concept to be learned, the theory of generative learning has been one of the bases on which GLM is built upon. Therefore it is necessary to investigate the impact of generative learning model of Bybee et al on students' academic achievement in chemistry. One will also want to know if GLM will improve academic achievement of male and female students in chemistry.

Purpose of the Study

The purpose of the study was to investigate the effect of Generative Learning Model (GLM) instructional strategy on students' academic achievement in chemistry. Specifically, the study sought to investigate the:

1. Differences that exist between the mean achievement scores of students taught chemistry with GLM instructional strategy and those taught with conventional method.
2. Differences that exist between the mean achievement scores of male and female students taught chemistry with GLM.

Research Questions

The study provided answers to the under stated questions

1. What are the differences in the pretest and posttest mean achievement scores of students taught chemistry with GLM and those taught with conventional method?
2. What are the differences in the pretest and posttest mean achievement scores of male and female students taught chemistry with GLM instructional strategy?

Hypotheses

The following null hypotheses were tested in the study at 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught chemistry with GLM instructional strategy and those taught with conventional method.
2. There is no significant difference in the mean achievement scores of male and female students taught chemistry with GLM.

Methodology

The study adopted a quasi-experimental, design specifically; a non-equivalent control group. It used a quasi-experimental research design because the subjects cannot be randomized (Nworgu, 2008). Two intact classes were randomly assigned to experimental control groups. It is the study of effect of the systematic manipulation of one independent variable (GLM instructional strategy).

The study was carried out in Onitsha Education Zone of Anambra State. The zone has three Local Government Areas (LGAs) which consist of Onitsha North, Onitsha South and Ogbaru. The study was conducted in secondary school at Onitsha North and Onitsha South LGAs which have 16 and 9 schools respectively. The choice of these LGAs is that they have large number of student communities and completely urban. The towns around these LGA are; Inland town, G.R.A., Nkpor, Fegge, and Woliwo.

The population consists of 2,194 chemistry students in Senior Secondary year one (SSI) in Onitsha North and South L.G.As of Anambra State. There are 21 public secondary schools, 16 single sex and 5 co-educational schools located in the area. The students' age range is between 14 and 16 years. SS I students were used because their academic self-concept in chemistry needs to be considered, built and improved in chemistry in the sense that after SS1, students make choice of subjects whether to continue in science or move to arts class. In addition, they are not in external examination class and consequently are more agreeable and free to be involved in the study.

Ninety- eight (98) SS1 students were used for the study. To obtain this sample, purposive sampling technique was employed to pick all the government-owned co-educational secondary schools in the two LGAs used for the study. Then two schools, one from each LGA, were selected through simple random sampling. By tossing of the coin, one school became the experimental school while the other became the control. Using simple random sampling, two intact classes, one each from the two selected schools, were selected. The experimental group had 50 students while the control group had 48 students making a total of 98 students (67 males and 31 females).

The instrument used for data collection was a Chemistry Achievement Test (CAT) which comprised of 25 multiple choice items developed by the researchers based on Chemical combination, electrovalent, covalent, co-ordinate covalent, metallic bond and intermolecular force. The questions were selected from past West African Senior School Certificate Examination (WASSCE) questions between 1990-2013 in line with SS 1 scheme of work. CAT was validated by two experts, one from educational psychology and one from department of Science education, all from Nnamdi Azikiwe University, Awka. To ensure the reliability of the instrument, the

25 objective questions were administered to a trial testing group of 15 students who were not part of the main study. A coefficient of 0.81 was obtained using Cronbach Alpha indicating that the instrument was reliable.

Experimental Procedure

The chemistry teachers in the sampled schools who served as research assistants were properly briefed. The one in the experimental group received briefing on how to use GLM and expose the students to its five phases of engagement, exploration, explanation, collaboration and evaluation. The chemistry teacher for the control group was also briefed on how to use the conventional lesson plan prepared by the researchers to teach the concept of chemical bonding.

The experiment lasted for six weeks. The first week was used for pre-test using CAT for both groups. The next four weeks was used for the treatment proper. The lessons were delivered for a period of 80 minutes (double period) in each week. At the end of the teaching period, reshuffled CAT was given to the students as Post-test in the 6^{th} week.

Scores obtained from pretest and post-test were analyzed and used to answer the research questions and test the hypotheses. Mean and standard deviation were used to answer the research questions while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA).

Results

The result and statistical analysis of the data obtained are represented

Research Question 1: What are the mean differences in the pretest and posttest mean achievement scores of students exposed to GLM in chemistry and those taught with conventional method?

Table 1: Difference in Mean and standard Deviations of Pretest and Posttest Achievement Scores of Students in experimental and Control Groups

		Pretest		Post-test		
Group	N	Mean	SD	Mean	SD	Mean difference
Experimental	50	21.00	7.51	36.04	6.72	15.04
Control	48	22.13	7.74	22.63	7.38	0.50

Table 1 shows that students taught with GLM (experimental group) have a mean posttest achievement score of 36.04 with standard deviation of 6.72 while the control group has a mean posttest achievement score of 22.26 with standard deviation of 7.38. It is observed from the table that difference in mean achievement score of the experimental group (15.04) is higher than the difference in mean achievement score

of the control group (0.50). As such, GLM enhanced achievement in chemistry more than conventional method.

Research Question 2: What are the mean differences in the pretest and posttest mean achievement score of male and female students exposed to GLM instructional strategy?

Table 2: Difference in Mean and Standard Deviations of Pretest and Posttest Achievement Scores of Male and Female Students in experimental Group

		Pretest		Post-test		
Gender	N	Mean	SD	Mean	SD	Mean difference
Male	32	22.37	8.21	35.81	7.32	13.44
Female	18	18.56	5.47	36.44	5.67	17.88

In Table 3, the male students have a mean achievement score of 35.81 with standard deviation of 7.32 in their posttest, while the female students have a mean achievement score of 36.04 with SD of 5.67 in their posttest. It was also observed that the mean difference of female students (17.88) is higher than the mean difference of male students (13.44). This implies that GLM improves female students' achievement in chemistry more than in the male.

Hypothesis 1: There is no significant differences in the mean achievement scores of students taught chemistry with GLM instructional strategy and those taught with conventional method.

Table 3: Analysis of Covariance (ANCOVA) of Chemistry Students' Mean Achievement Scores by Teaching Method and Gender

Chemistry achievement posttest					
Source of variation	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected model	7349.396[a]	4	1837.349	93.220	.000
Intercept	1987.796	1	1987.796	100.853	.000
Precat	2792.158	1	2792.158	141.663	.000
Group	4566.349	1	4566.349	231.679	.000
Gender	42.500	1	42.500	2.156	.145
Group* gender	78.946	1	78.946	4.005	.048
Error	1833.012	93	19.710		
Total	94290.000	98			
Corrected Total	9182.408	97			

a. R Squared =.800 (Adjusted R Squared =.792)

The result in Table 5 indicates a significant mean effect of method with respect to achievement in chemistry, since the probability of obtained F- value (231.679) is 0.00, which is less than the 0.05 level of significance that is P=0.00< 0.05. The null hypothesis therefore is not accepted, which means that there is a significant difference between the scores of students' taught chemistry with GLM instructional strategy and those taught with conventional method in favour of the former.

Hypothesis 2
There is no significant difference in the mean achievement scores of male and female students exposed to GLM instructional strategy in chemistry.

Table 3 shows that the probability of obtaining the F- value of 2.156 is 0.145, which is higher than the 0.05 level of significance (P = 0.145 > 0.05). The null hypothesis therefore is accepted, which means there is no significance difference between the mean achievement scores of male and female students taught chemistry using GLM.

Discussion
The findings of this study show that students taught chemistry using generative learning model performed better than students taught using conventional method. The result indicates a significant difference between the mean achievement score of experimental group (generative learning model) and control group (conventional method) in favour of the experimental group with high mean score. This appears to be consistent with the findings of Ofiiah and Igboegwu (2010), Chukwu (2013) that students taught conceptual change using GLM performs better than those taught with conventional method.

The possible explanation to the significant difference can be that GLM phases serve as a guard which the teacher follows to direct instruction to the students. The experimental group is able to undergo learning following the five phases of GLM which allow the students to make connection between their previous knowledge and the chemistry concept to be learned. Also the phases may have helped them to explore ideas among themselves, ask questions and formulate scientific explanation in chemistry concept that are otherwise difficult for them before.

Conclusion
This study has provided empirical data as it concerns the impact of GLM in teaching and learning of chemistry. The generative learning model (GLM) instructional strategy has significant impact on students' academic achievement in chemistry. The experimental group taught chemistry GLM has higher mean achievement score than the control group taught with conventional method.

Recommendations
Based on the findings of this study, the following recommendations were made;

1. Educators of pre-service teachers should ensure that in their teacher education programmes more emphases are laid on the usage of constructivist or innovative instructional strategy such as GLM so that student teachers can learn the model and use it in teaching of science.
2. Generative Learning Model instructional strategy should also be used by chemistry teachers to enhance gender equity in academic achievement of all students in science.
3. Government and Professional Bodies like Science Teachers Association of Nigeria (STAN) and Chemical Society of Nigeria (CSN) can organize seminars, workshop and conferences chemistry teachers and other science teachers can be trained on the use of GLM in teaching and learning.
4. Curriculum planners should include GLM as a teaching model in their curriculum for the teachers to adopt in the classroom.

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