Improving Chemistry Students' Achievement and Retention in Chemical Kinetics Using Blended Learning Strategy in Jos -Plateau State, Nigeria

Ephraim Joel Gongden PhD
Department of Science and Technology Education
Faculty of Education
University of Jos
PMB 2084
Jos – Plateau State
Nigeria
gongdenej@yahoo.com , gondenej@unijos.edu.ng

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ABSTRACT
This study investigated the effect of rotation blended learning in improving chemistry students' achievement and retention in chemical kinetics in secondary schools in Jos - Plateau state, Nigeria. The study adopted a quasi-experimental design and five research questions and three null hypotheses were formulated to guide the study. A sample of 32 students were purposively selected for the study from two co-educational schools within the study area and randomly assigned into control and experimental groups. The instrument for data collection was a 30 multiple choice test called Chemical Kinetics Achievement Test, CKAT (r = 0.83). The CKAT was administered to students as pretest, posttest and retention test. The data obtained were analyzed using t-test statistical tool of analysis. The results indicated that blended learning increased the students' achievement in chemical kinetics. There was a significant difference between the posttest achievement scores of students taught with lecture and those taught with rotation blended learning strategy. The study also revealed that blended learning strategy increased the retention of chemistry by the students in the experiment group than those in the lecture group. The study recommended among others that students should be exposed to computer–based blended learning strategy in order to improve their achievement and aid their retention of chemistry concepts. Students should be exposed early to the use and operation of the computer especially for online learning purposes

***Keywords**: blended learning, chemical kinetics, achievement, retention*

INTRODUCTION

Chemistry is one of the physical sciences that deals with the composition, structure, properties of substances and the changes or transformations that the substances undergo (Gongden, 2015). It occupies a unique position in science education such that students offering courses such as medicine, biology, pharmacy, physics, biochemistry, microbiology and home economics among

others, are required to offer the subject. Various chemical processes such as respiration and digestion are performed in all living things for their proper function and survival. The knowledge of chemistry is brought to play in the manufacture of products that improves man's luxury such as herbicides, insecticides, plastic products, foams, drugs and clothing materials, just to mention a few (Ababio, 2017). Most industries rely on physical chemistry principles for their operations. Chemistry is needed for the advancement of technology hence the importance of chemistry in everyday life cannot be over emphasized.

However, reports and researches in the past have indicated that chemistry students often demonstrate weakness in chemistry examinations, especially in the West African Senior School Certificate Examination (WASSCE). Nja, Cornelius-Ukpepi and Ihejiamaizu (2019, and Nja, Cornelius-Ukpepi & Orim (2019) all noted that students' achievements in chemistry over the years have not been so encouraging. The West African Chief Examiners' reports (2017-2020) give a number of concepts that students found difficult or performed poorly to include: chemical equilibrium, particulate nature of matter, chemical bonding, periodicity of elements, energy changes, chemical kinetics, stoichiometry, classification, functional groups and nomenclature of organic compounds, kinetic theory of matter, etc among others. In chemical kinetics for example, students show inability to describe experiments to illustrate the effect of catalyst on the rate of decomposition of hydrogen peroxide when exposed to air. They also show inability to compare the rates of forward and backward reactions for a reversible reaction at time zero.

This poor achievement has been attributed to a number of factors ranging from poor attitude of teachers and learners towards the teaching and learning, the broad chemistry curriculum, poor teaching methods, inadequate instructional material, mathematical deficiencies in students and teachers amongst other factors. Chikendu (2018) observed that chemistry students do not learn chemistry concepts meaningfully therefore they perform poorly in at both internal and external examinations, and cannot apply their knowledge to solve everyday problems in the society in which they live. Instructional strategy is an important component that can affect the effectiveness and efficiency of teaching and learning process in chemistry (Gongden & Gongden, 2019).

With the development of Information and Communication Technology (ICT), teachers are required to use a variety of methods that provide more opportunities for learning by utilizing various technologies to change the paradigm of learning from teacher centered learning into student centered learning (Ceylan & Kesici, 2017). However, learning is not only based on technology but also it is a process of interaction between teachers, students and learning resources as in the case of the traditional (lecture) method. This is to say that not all learning can be done by online environment. However, the use of the lecture method for teaching all topics in chemistry has been found to be counter-productive and resulting in poor achievement in chemistry in external examination, (WAEC, 2015-18; Oloruntegbe & Odutuyi, 2015). In a lecture which is a teacher centered, students are forced to assume more passive roles - believing that they are expected to just copy notes and receive the knowledge dispensed by the teacher. However, the lecture method can enable teachers to present materials not otherwise available to students. It can also be used to present large amounts of information to a large audience. Despite these benefits, lecture method emphasizes only on superficial learning instead of in-depth knowledge of the facts, and when used alone, proves inadequate to improve achievement. Yet most chemistry teachers prefer using it to other conventional methods of instruction. The Chemistry teachers need to consider alternative and innovative teaching strategies to enable the chemistry students understand the relevant concepts thereby achieving better in tasks involving

the concepts. Gongden and Gongden, (2019) observed that some methods of teaching, like the use of computer animations, blended learning, and concept maps and analogies in teaching are more effective than others in a given circumstance. These innovative strategies are student-centred and help students to further explore the world of science.

Blended learning, also known as hybrid learning, is an approach to education that combines online educational materials and opportunities for interaction online with traditional lecture method Quigley (2019). It combines online and face-to-face learning spaces and experiences. Hence It is the integration of face-to-face and online instruction (Graham, 2013). This strategy aims at combining the strengths of both traditional and online learning methods in order to give learners a more engaging learning experience. Blended learning works well for covering a large amount of course material with learners who are independent and engaged (ELM Learning, 2022). Generally, research has found that blended learning results in improvement in students' success and satisfaction (Dziuban, Graham, Moskal, 2018). It can help teachers to provide several formats of learning material (Husamah, 2014). It can increase students' motivation and they can get new experience on learning process (Buran, 2015). The landscape of blended learning tools and technologies is not only vast but also still evolving. According to Teach Thought Staff (2022), There are different types of blended learning among which are: face-to-face, rotation, flex, gamification, online lab, self-blend, flipped classroom, self-directed, project-based, inside-out, remote, outside-out, etc. In rotation, students go from one learning activity to another learning activity, either in a structured learning session directed by a teacher, or online in a self-directed manner. Students rotate through stations on a fixed schedule, where at least one of the stations is an online learning station.

Retention is the ability to retain and recall information or knowledge gained after learning. One of the factors for the low achievement in science is lack of retention (Obinna, Abumchukwu & George, 2021). Aminu (2011) defined several variables that affect retention to include; the content or tasks to be performed, learners past experiences, the interval between lesson and evaluation and instructional strategies employed. Atadoga and Onaolapo (2008) however, noted that the critical factor influencing retention of students is the level of learning experience provided in the lesson which is also dependent on the instructional strategy used. When the learning process engages more senses, rich learning environment and experience is created. To engage the students meaningfully in the learning process, the teacher must have to adopt innovative teaching methods such as blended learning strategy. Therefore, the researcher used rotation blended learning strategy to ascertain its effectiveness on chemistry students' achievement and retention in chemistry in senior secondary schools – and especially in chemical kinetics.

STATEMENT OF THE PROBLEM

The teaching and learning of chemistry in secondary schools still remain a serious problem to chemistry teachers due to its abstract nature of the subject. The high rate of failure in senior secondary Certificate Examination (SSCE) has become a subject of constant worry and comments. Several strategies have been devised and employed to improve student's achievement in schools and colleges in Nigeria. Most of these strategies are enhanced by Information and Communication Technology. One of the strategies is the blended learning strategy. However, the researcher is not sure if the strategy would improve chemistry students' achievement and retention in chemical kinetics.

OBJECTIVES OF THE STUDY

The study aimed at using rotation blended learning with a view to improving chemistry students' achievement and retention in chemical kinetics. The specific objectives include:

1. To find out the difference between the pretest achievement mean score of students in the lecture (control) group and those in the blended learning (experimental) group
2. To ascertain the difference in the pretest and posttest achievement mean scores of students in control group
3. To determine the difference in the pretest and posttest achievement mean scores of students in the experimental group?
4. To find out how the posttest achievement mean scores of students in the control group differ from those in the experimental group
5. To determine the difference in the retention-test mean scores of students in the control and experimental groups

RESEARCH QUESTIONS

The following research questions guided the conduct of the study:

1. What is the difference between the pretest achievement mean score of students in the lecture (control) group and those in the blended learning (experimental) group?
2. Is there a significant difference in the pretest and posttest achievement mean scores of students in control group?
3. What is the difference in the pretest and posttest achievement mean scores of students in the experimental group?
4. How does the posttest achievement mean scores of students in the control group differ from those in the experimental group?
5. What is the difference in the retention-test mean scores of students in the control and experimental groups?

RESEARCH HYPOTHESES

1. There is no significant difference between the pretest achievement mean score of students in the control group and those in the experimental group
2. There is no significant difference between the posttest achievement mean score of students in the control group and those in the experimental group
3. There is no significant difference between the retention achievement mean score of students in the control group and those in the experimental group

METHODOLOGY

The researcher employed the quasi-experimental design for the study. The randomized pretest-posttest control group design was used. The sample consisted of seventy-three senior secondary two chemistry students made up of thirty-five females and thirty-eight male students. These were randomly assigned into experimental group and control group. The experimental group was treated using rotation blended learning model while in control group traditional learning model was used.

The research instrument was the chemical kinetics achievement test (CKAT) composed of thirty multiple choice objective questions drawn from past SSCE question papers on the topic: rates of

chemical reactions. The CKAT was constructed to measure both the pre-test and post-test students' achievement and retention in the tests on chemical kinetics. The validity of the test instruments was confirmed with the help of three experts in the relevant fields. The reliability of each instrument was determined by using the Pearson Product Moment Correlation formula and corrected using Spearman-Brown formula where CKAT = 0.83. This indicated that the research tool was reliable and within statistical limits. Two coeducational Secondary Schools in the study area were purposively sampled. The selection ensured that both schools had the same proprietor, offer computer study as a subject in the senior classes, have functional computers, have source of energy to power the computers, operate under similar if not same conditions and that the chemistry teachers were of same qualifications.

The two schools were randomly assigned into experimental and control groups respectively. A pretest using the CKAT was administered to the two groups prior to treatment to determine their prior knowledge of chemical kinetics (rate of chemical reactions). Thereafter, the experimental group was taught the topic – rates of chemical reactions using the rotation blended model. In the experimental group, students were informed about blended learning and they were introduced how to use online learning. The students rotate through stations, but on individual schedules set by a teacher to the activities scheduled on their playlists. They also interact with the teacher on a face-to-face basis. The control group was taught using the traditional mode of instruction (lecture). The scripts were scored and the pretest scores recorded. After three weeks of treatment, students were administered the same CKAT as posttest but with the questions reshuffled. Students' scripts were scored and the pretest and posttest scores compared. After four weeks of the posttest, the same students were given the same CKAT to test their retention. As in the posttest, the questions were also reshuffled and students' scores preserved for analyses.

RESULTS

Research Question One: What is the difference between the pretest achievement mean score of students in the lecture (control) group and those in the blended learning (experimental) group?

Table 1: Comparison of pretest mean scores of control and experimental groups

Group	N	Mean	SD	Mean Diff	SEM	df	T	P-value
Pretest Control	16	3.93	1.06	0.06	0.81	30	0.15	0.88
Pretest Expt	16	3.87	1.08					

Table 1 show that the scores of the pretests of the control and experimental group are very close to each other. While the arithmetic mean of the pretest scores of control group is 3.93 and standard deviation is 1.06, the arithmetic mean of the pretest scores of experimental group is 3.87 and standard deviation is 1.08. The difference between the pretest achievement mean scores is 0.06 which is not significant. Hence the two groups can be said to be equivalent before treatment.

Hypothesis One: There is no significant difference between the pretest achievement mean score of students in the control group and those in the experimental group. The p-value is 0.88 (>0.05). Therefore, there isn't a significant difference between the pretest scores of the groups. So, the group equality between the groups is enabled.

Research Question Two: Is there a significant difference in the pretest and posttest achievement mean es of students in control group?

Table 2: Comparison of pretest and posttest mean scores of control group

Group	N	Mean	SD	Mean Diff	SEM	df	T	P-value
Pretest Control	16	3.93	1.06	4.57	0.32	15	-14.44	0.05
Posttest Control	16	8.50	1.37					

Analysis presented in Table 2 shows that the arithmetic mean of the pretest scores of control group is 3.93 and standard deviation is 1.06 and the arithmetic mean of the posttest scores of experimental group is 8.50 with a standard deviation of 1.37. It is used paired samples T-test to define the significancy of the sub problem. Because the obtained p value = 0.05, it is seen that there is a significant difference between the pretest and posttest scores of the control group, with a mean difference (increase in the posttest) of 4.57 after teaching with the lecture method.

Research Question Three: What is the difference in the pretest and posttest achievement mean scores of students in the experimental group?

Table 3: Comparison of pretest and posttest mean scores of experiment group

Group	N	Mean	SD	Mean Diff	SEM	df	T	P-value
Pretest Expt	16	3.87	1.08	8.82	0.59	15	15.04	0.000
Posttest Expt	16	12.69	1.70					

The pretest mean score of the experiment group is 3.87 with a standard deviation of 1.08 while the posttest mean score of the same experiment group is 12.69 with a standard deviation of 1.70. The mean difference between the scores is 8.82, a significant difference. This shows that students recorded 8.80 points increase in academic achievement when taught using blended learning model. The p-value is 0.000 (< 0.05) showing that there is significant difference in the mean scores on pretest score and posttest score of the experiment group.

Research Question Four: How does the posttest achievement mean scores of students in the control group differ from those in the experimental group?

Table 4: Comparison of posttest mean scores of control and experiment groups

Group	N	Mean	SD	Mean Diff	SEM	df	T	P-value
Posttest Control	16	8.50	1.37	4.19	0.57	30	7.33	0.000
Posttest Expt	16	12.69	1.70					

The results presented in Table 4 show that the posttest mean score of students in the control is 8.50 with a standard deviation of 1.37. The posttest score of experiment group is 12.69 with standard deviation of 1.70. both scores differ by 4.19 points. Considering tables 2 and 3, it is clear that both lecture and blended learning resulted in improvement in students' achievement in chemical kinetics. However, while the increase in achievement of students in the control class is 4.57 (8.50-3.93), while the increase in the experiment group is 8.82 (12.69-3.87). This shows that blended learning strategy improves students' achievement in chemical kinetics than the lecture method.

Hypothesis Two: There is no significant difference between the posttest achievement mean score of students in the control group and those in the experimental group. From the results, p – value is 0.000 and is less than 0.05. This means that the difference between the posttest scores of control and experiment groups is significant in favor of the experiment group. Therefore, there is a statistically significant difference in the mean scores on posttest control of students and that posttest experiment group.

Research Question Five: What is the difference in the retention mean scores of students in the control and experimental groups?

Table 5: Comparison of retention mean scores of control and experiment groups

Group	N	Mean	SD	Mean Diff	SEM	df	T	P-value
Retention Control	16	5.68	1.45	5.63	0.51	30	11.09	0.000
Retention Expt	16	11.31	1.40					

A look at Tables 3, 4 and 5 reveal that the retention scores of both control and experiment groups are lower than the posttest mean scores. But the difference is lower in the experimental group. While the difference between the posttest and retention scores of the experimental group is 1.38 (12.69-11.31), that of the control group is 2.82 (8.50-5.68). Meanwhile, the retention score of the control group is 5.68 while that of the experiment group is 11.31. The mean difference between the retention scores is 5.63.

Hypothesis Three: There is no significant difference between the retention achievement mean score of students in the control group and those in the experimental group. Based on the results presented in Table 5, p = 0.000 (< 0.05). This means that there is a difference in the retention scores in favor of the experiment group. The hypothesis fail to be accepted. Therefore, there is a statistically significant difference between the retention achievement mean score of students in the control group and those in the experimental group

DISCUSSION OF THE RESULTS

The study found that there is a statistically significant difference between the achievement of students in the control group and those in the experiment group. Students who were taught using blended learning strategy achieved higher and better than those in the control (lecture) class. This result agrees with those of Camahalan and Ruley (2014), Hall, Cohen, Vue, and Ganley (2015), Huang and Hong (2016), and Dziuban, Graham, Moskal (2018). These researchers did find statistically significant increases for the experimental group that used blended learning when compared to a group that used traditional lecture method of teaching. Camahalan and Ruley (2014). concluded that the increase in scores was because the teacher was able to spend more one-on-one time with students, which helped to increase their understanding of the material. Other studies that did not use a control group also found increases in achievement for students (Ahn, Beck, Rice, & Foster, 2016). However, the result did not agree with those of several studies. For example, there were two studies that actually showed that students in the blended learning group had slightly lower scores than those in the control group (Siko, 2014). The reasons for positive gains in blended learning compared to mixed results or negative gains are

complex and varied, but many of them relate back to the quality of the study itself and the way that blended learning was implemented.

The study also found out that there is a statistically significant difference between the retention achievement mean score of students in the control group and those in the experimental group. This result is similar to that of Chinwendu and Olele (2020) who found out that blended learning increased the retention of Physics by students who participated in the study. It also agrees with the findings of Suleiman, Salaudeen and Falode (2017) who investigated the effects of computer based blended learning strategy on secondary school chemistry students' retention in individualized and collaborative learning settings in Minna - Niger state, Nigeria. They concluded that computer based blended learning resulted in improved students' retention in chemistry in collaborative learning settings better than in individualized learning setting in lecture method.

CONCLUSION AND RECOMMENDATIONS

The study showed that blended learning has beneficial effects for students both in improving their achievement and retention of chemistry concepts. It provides diversity of learning opportunities and enhancements to the students. Educational practices designed within blended environment are beneficial to the students in terms of contentment, learning, attention and motivation. The study recommends that blended learning be made a compulsory teaching strategy by chemistry teachers in schools and colleges. Compulsory periodic training and retraining of chemistry teachers in schools in the knowledge of ICT should be made a part of teacher training programs in teacher training institutions. Students should be helped early to acquire computer knowledge and how to use it for online learning.

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