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Effect of Flipped Classroom Approach on Chemistry Students' Academic Achievement and Retention in Colleges of Education, Yobe State, Nigeria

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Abstract
This study investigated the effects of flipped classroom approach on Chemistry students' academic achievement and retention in colleges of education, Yobe State Nigeria. Le Vygotsky's theory provided the theoritical framework for the study. Two research questions and two hypotheses were formulated to guide the study. A pretest-posttest and postposttest control group quasi-experimental research design was employed in the study. The population of the study comprised of 524 NCE II Chemisty students from two colleges of education in Yobe State. Purposive and simple random sampling techniques were used to select 106 NCE II chemistry students. The experimental group (N=44) were taught redox concepts using flipped classroom approach while the control group (N=62) were taught the same redox concepts using lecture method of teaching. Redox Concept Achievement Test (RECAT) was the instrument used for data collection which was validated and tested for reliability. Mean and Standard Deviation were used to answer the research questions and the hypotheses were tested using independent sample T-test at 0.05 level of significance using SPSS software. The findings of the study revealed that the students taught redox concepts using flipped classroom approach have significantly higher academic achievement and retention scores than those who were taught using lecture method of teaching. Based on the findings, it was recommended among others that Chemistry lecturers/teachers should adopt the use of flipped classroom approach because it is a studentcentered learning strategy that improves students' academic performance.
Keywords: Flipped classroom, Redox concepts, Academic achievement, Retention

Introduction
For decades, educators and scholars have challenged the effectiveness of entirely lecture-based teaching methods. Several studies have shown that when students are actively involved in the learning process, they perform better (Adedoja, 2016; Odo & Eze, 2017; Makinde, 2020). As a result, the learning model must change from teacher-centered to student-centered, which can be

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done by active learning methods. This is an important educational approach which recognizes that teaching can be ineffective when it focuses solely on the transmission of curriculum content without considering whether anything is being learned. An environment for active learners encourages students to be engaged in solving problems, sharing ideas, giving feedback, and teaching each other. Therefore, to move away from traditional teacher-centered lecture model, many educators are exploring the flipped classroom approach which consists of an attractive combination of pedagogy and technology (Makinde, 2017). This approach provides educators with many opportunities to engage students with an ample space of learning styles and pedagogies during the classroom contact hours to solve problems.

Flipped classroom approach is guided by Vygotsky's learning theory (1978), who viewed learning as a process that occurs when a learner is assisted by others who are more competent in the skills being learnt. Flipped classroom, an emerging instructional approach, revolves around students doing most of the learning, reading, and lectures at home and teachers utilizing all of the class time for application and collaboration. The major purpose of a flipped classroom is to enhance student learning and achievement by reversing the traditional model of a classroom, focusing class time on student understanding rather than on lecture (Abah, Igber & Age, 2017; Makinde, 2017). In a typical flipped classroom model, teachers post their lectures in forms of short videos, PowerPoint, and tutorials online/offline for students to watch and study at home prior to the next class session. Then, during the class session, students are devoted to expanding on and mastering the material through collaborative learning exercises, projects, and discussions (Chen, 2016). According to Vygotsky (1978), to solve these tasks students either worked individually or in groups under the supervision of the instructor. In essence, a flipped classroom is one in which the time and place for homework and lectures are reversed. Lectures are observed and accomplished at home, while homework is addressed collaboratively in the classroom with the help of a teacher or an instructor (Makinde, 2020).

Akingbemisilu (2017) conducted research on the effect of animation and video-based flipped classroom strategy on pre-degree students' learning outcomes in Practical Biology in Southwestern Nigeria. The result from the study revealed that there was a significance main effect of treatment on achievement, attitude and practical skills in practical biology. Students in the animated flipped classroom strategy had the highest mean achievement score followed by the students in the video-based flipped classroom strategy and then the control group. In a similar study conducted by Makinde (2017) on the effect of a developed flipped classroom package on secondary school students' performance in mathematics in Lagos state, Nigeria, revealed that there was a significance difference in the post-test and retention performance based on the ability level of students in favour of the flipped classroom. Several literatures were reviewed on the effectiveness of flipped learning and findings from the studies revealed that there is a positive effect of the flipped learning approach on academic achievement and retention of students compared to the traditional learning approaches irrespective of the implementation period (Ugwoke, Edeh & Ezemma, 2018; Aycicek & Yelken, 2018; Efiuvwere & Fomsi, 2019; Karagol & Esen, 2019; and

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Bawa & Baba, 2020). In another similar studies conducted by Odewumi and Yusuf (2018), and Stratton, Chitiyo, Mathende, and Davis (2019) on the impacts of flipped classroom approach found that there is no significant difference in the performance of students taught using flipped classroom model and those taught conventional methods of teaching. The undergoing study therefore tried to test the model in teaching NCE students on the topic of redox concepts and to see whether there would be an improvement in their poor academic performance in the topic and chemistry in general.

Masykuri and Afifa (2019) opined that, one of the difficult areas that had been identified by researchers on chemistry topics is reduction-oxidation (redox) concept. Redox concept is a basic concept of redox reaction that has abstract and concrete characteristics, using logically mathematical calculations, requires memorizing, understanding, symbolic application and daily life experiences. Redox concept is a basic concept for students before learning more complex concepts such as redox titrations. Misconceptions on basic concepts affect students in learning redox titrations and other related topics.

Flipped model strategy would help students to achieve better academic performance since they have ample time to study the material over and over for several times before the commencement of the regular class meeting with the teacher. The students can also discuss among themselves on the grey areas before the normal class time and with the teacher during the discussion period in class. Through this process, learning is made easier, concrete, simple and interesting to the students and the teacher's role of explaining bulky content is simplified to the role of a facilitator. This will positively improve the academic achievements of the students and what is learned through this process will be retained permanently by the students.

Retention is the ability of the learner to recall information, ideas or learning activities at a later time which he/she may be asked to mention, write or remember after some times (Yusuf & Umar, 2019). Alake (2015) sees retention as the ability to store information which can be easily recalled from the short- and long-term memories. Therefore, retention is a very important aspect of students learning or rather an aspect of measuring the cognitive ability of learners. A retention test occurs after learning has taken place. Usually, the subject is brought back at varying time periods usually days, or weeks after learning the task to determine how much the student has retained.

Objectives of the Study

This research work intends to;

1. Determine the effect of flipped classroom approach on the academic achievement of students in redox concepts.
2. Find the retention ability of students when exposed to flipped classroom approach and lecture method of teaching redox concepts.

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Research Questions

The following research questions were formulated to guide this study.

1. What is the effect of flipped classroom approach on the academic achievement of students in redox concepts?
2. What is the retention ability of students when exposed to flipped classroom approach and lecture method of teaching redox concepts?

Research Hypotheses

The following hypotheses were developed to guide the research;

1. There is no significant difference in the academic achievement of students taught with flipped classroom approach and lecture method of teaching redox concepts.
2. There is no significant difference in the retention ability of students taught using flipped classroom approach and lecture method of teaching redox concepts.

Methodology

The study employed pretest-posttest and post-posttest control group quasi-experimental design. The design comprised of two groups; the experimental and the control groups. The experimental group was taught using Flipped Classroom Approach (FCA) while the control group was taught using Lecture Method of Teaching (LMT). The population of the study comprised of 524 NCE II chemistry students of Umar Suleiman colleges of education Gashua (constitute the experimental group) and Federal College of education (Technical) Potiskum (constitute the control group) in Yobe State. The sample size for the study is 106 which were carefully selected from the two colleges of education. The sampling techniques used in the study were purposive and simple random sampling techniques. Purposive sampling technique was used to select the experimental group since the criteria for being in the group lies on the possession of laptop computer, desktop computer or android smart phone device that has facilities to play mp4 video. 44 students met the criteria and therefore selected to constitute the experimental group. However, a simple random sampling technique was used to select 62 students to form the control group.

The instrument for data collection in this study was Redox Concept Achievement Test (RECAT). The RECAT items were constructed based on NCE II syllabus by the researcher on the concepts of redox. The instrument was validated and the reliability index was calculated to be 0.76 using Pearson Product Moment Correlation Coefficient. The data collection was conducted by the researcher and the research assistant(s). Both the experimental and the control groups were pretested by the researcher and the research assistant thereby establishing level of performance to ascertain equivalency. The main treatment for this study is the teaching of redox topic using FCA for the experimental group and LMT for the control group. The treatments for both the two groups lasted for six weeks, after which a posttest was administered to both the two groups to ascertain the level of performance. After two weeks interval from the posttest, a post-posttest (retention test) was then administered to determine the retention ability of the two groups. The data that were

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collected for the study from both the two groups were analyzed using descriptive statistics of mean and standard deviation to answer the research questions, and inferential statistics of independent T-test to test the null hypotheses at 0.05 levels of significance.

Results

A descriptive statistic in the form of mean and standard deviation were used to analyze the pretest and posttest scores between the two groups.

Research Question 1

What is the effect of flipped classroom approach on the academic achievement of students in redox concepts?

Table 1: Pretest and Posttest Mean Achievement Scores of Students Taught Using Flipped Classroom Approach and Those Taught Using Lecture Method of Teaching

Group	N	Pretest $\bar{}$	Pretest SD	Posttest $\bar{}$	Posttest SD	Gained Mean
FCA	44	13.82	4.90	22.95	6.08	9.13
LMT	62	13.90	4.64	18.03	4.18	4.13
Mean Difference		0.08		4.92		5.0

Table 1 reveals that students taught using FCA have pretest mean achievement score of 13.82 and posttest mean achievement score of 22.95 with gained mean achievement score of 9.13, while those in the LMT class have pretest mean achievement score of 13.90 and posttest mean achievement score of 18.03 with gained mean of 4.13. The students in the experimental group have higher posttest mean achievement score than those in the control group. The difference between the gained mean achievement scores of the two groups is 5.0 in favor of those who were taught using FCA.

Research Question 2

What is the retention ability of students when exposed to flipped classroom approach and lecture method of teaching redox concepts?

Table 2: Mean Retention Scores of Students Taught Redox Concepts Using Flipped classroom approach and Lecture Method of Teaching.

Group	N	$\bar{}$	SD	Mean Difference
FCA	44	22.68	5.12	
LMT	62	16.84	3.36	5.84

Table 2 presents the results of mean retention scores of students taught redox concept using FCA and LMT. From the result students taught using FCA have mean retention scores of 22.68

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with standard deviation of 5.12 while those taught using LMT have mean retention scores of 16.84 with standard deviation of 3.36. The mean difference between the two groups is 5.84. This shows that students taught redox concept using FCA have high retention scores than their counterparts in the control group.

Hypotheses Testing

The null hypotheses formulated for the purpose of this research were tested at 0.05 Levels of significance using SPSS software.

Hypothesis 1

There is no significant difference in the academic achievement of students taught using flipped classroom approach and lecture method of teaching redox concepts.

Table 3: Independent Sample T-Test Analyses for Posttest Mean Achievement Scores of the Experimental and Control Groups.

Group	N	$\bar{}$	SD	Df	t-cal	p-value	Remark
FCA	44	22.95	6.08				
LMT	62	18.03	4.18	104	4.94	0.000	Significant

p=0.05

Table 3 shows the analysis of the independent sample t-test for posttest academic achievement scores of the experimental and control groups. The observed p-value was 0.000 which is less than the level of significance 0.05 with df=104. The null hypothesis one is hereby rejected and the reason for the rejection of the hypothesis is because the observed p-value (0.000) is less than the level of significance 0.05. Therefore, there is significant difference between the academic achievement scores of NCE II Chemistry students taught redox concepts using FCA and those taught using LMT, in favor of the experimental group (t-cal.= 4.94, df=104, p=0.000<0.05).

Hypothesis 2

There is no significant difference in the retention ability of students when taught using flipped classroom approach and lecture method of teaching redox concepts.

Table 4: Independent Sample T-Test of the Mean Retention Scores of Students Taught Redox Concepts Using Flipped Classroom Approach and Lecture Method of Teaching.

Group	N	$\bar{}$	SD	Df	t-cal	p-value	Remark
FCA	44	22.68	5.12				
LMT	62	16.84	3.37	104	7.09	0.012	Significant

p=0.05

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From Table 4, the observed p-value is 0.012 with df=104 which is less than the level of significance 0.05. Based on comparability of p-values, the null hypothesis two is hereby rejected. The reason for the rejection is that, the observed p-value is less than the significant level. Therefore, there is a significant difference in the mean retention scores of students taught redox concepts using FCA and those taught using LMT, in favor of the experimental group (t-cal=7.09, df=104, p=0.012<0.05).

Discussion of Findings

Based on the findings from this study, it was found that the mean achievement score of the experimental group was higher than that of the control group. It was further revealed that there is a significant difference in the academic achievement of NCE II chemistry students taught redox concepts using flipped classroom approach and those taught using lecture method of teaching, in favor of those taught using FCA. This result implies that the use of FCA in teaching redox concepts enhances the academic achievement of NCE II students. This finding is in agreement with the findings of Akingbemisilu (2017), Makinde (2017), Ugwoke, Edeh and Ezemma (2018), Ayecicek and Yelken (2018), Efiuvwere and Fomsi (2019), Karagol and Esen (2019) and Bawa and Baba (2020) who found that students learning activities based on FCA have higher academic achievement scores than students who were taught through the LMT.

The findings of this study also revealed that, the experimental group has higher mean retention score than the control group. It was also found that there is a significant difference in the retention ability of NCE II students taught redox concepts using flipped classroom model and those taught using lecture methods of teaching, in favor of the experimental group. This means that when FCA is used to teach redox concepts, it enhances the students' retention ability. This finding is in agreement with the findings of Makinde (2017), Ibrahim and Haruna (2017) and Sirakaya and Ozdemir (2018). This observation could be attributed to the fact that, learning material used in the FCA appeal to many different sensory organs, and this can be effective in ensuring more permanent learning for students in the flipped classroom.

Conclusion

This study investigated the effects of flipped classroom approach on NCE II students' academic achievement and retention in redox concepts in colleges of education, Yobe State, Nigeria. The result of the study revealed that there is a significant difference both in the academic achievement and retention of students taught redox concepts using flipped classroom model and those who were taught using lecture method, in favor of the experimental group.

Recommendations

From the findings of this study, the following recommendations were made:

1. Chemistry lecturers/teachers should adopt the use of flipped classroom approach because it is a student-centered learning strategy that improves students' academic performance.

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2. Teachers are encouraged to teach topics/courses that requires high students' retention ability using flipped classroom model

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