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Effects of Flipped Classroom Strategy on Achievement and Retention of Basic Science Students' in Lagos State-Nigeria

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Abstract
Basic Science and Technology concepts are taught in junior senior secondary schools to equip students with basic knowledge and skills in science and technology to meet contemporary societal needs. Therefore, the study examined Flipped Classroom Learning Strategy (FCLS) and its effects on students' achievement and retention in Basic Science. The quasi-experimental, pretest-posttest control group design was adopted. Three Lagos State Educational Districts were randomly selected and two Junior Secondary Schools were randomly selected from each District. Intact class was used from each school and treatment was randomly assigned to the schools. The experimental group was taught using the Flipped Classroom Learning Strategy (n=213) and the control group exposed to the conventional teaching of lecture (n=239), totaling 452. Two research hypotheses were formulated and tested in the study. The instruments used were: Instructional guides for the FCLS and the lecture method; Basic Science Achievement Test (r=0.78) and Basic Science Student Retention Test. The treatment lasted seven weeks. Data were subjected to descriptive statistics, Analysis of covariance and Estimated Marginal Means (EMM) at 0.05 level of significance. The findings revealed that there was a significant main effect of treatment on students' achievement in Basic Science ($F_{(1;\,450)} = 97.42$; $p<0.05$, partial $\eta^2 = 0.18$). It showed that the main effect of treatment was significant on students' retention in Basic Science ($F_{(1;\,450)} = 36,56$; $p<0.05$, partial $\eta^2 = 0.08$). Based on the results, it is recommended that teachers should be encouraged to employ student-centered instructional strategies, such Flipped Classroom Learning Strategy which is activities based to promote creativity and enable the students to achieve well and have retentive memory.

Keywords: Students achievement, Retention, and Flipped classroom learning strategy

Introduction

Basic Science is the subject that unifies all the science subjects that is being taught from the primary level to junior secondary school. Basic Science is a subject that lays basic foundation for the studying of sciences (Biology, Chemistry and Physics) in the senior secondary school (Afuwape & Olugbuyi, 2019). The Basic Science curriculum has been specified by the Federal Government of Nigeria in the National Policy on Education to be a broad field system which encompasses various aspects of science subject areas of Physics, Chemistry, Biology, Geology, Astronomy and Environmental Science synthesizing them to provide a unified and holistic nature of science (FGN, 2014). It is a subject that tries to avoid the undue stress on the distinctions between the various scientific field by presenting the concepts and principles of science in a unified form (Ogonnaya, okafor, Abonyi & Ugama, 2016). Basic Science is very important in the concept of basic education as it is the foundation upon which all other educational attainment lays, but there is a record of students' poor achievement in Basic Science which is also affecting students' achievement in core higher science subjects in the senior secondary school. Abonyi and Ibe (2014) in their study discovered poor academic achievement of students in Basic Science. This poor academic achievement is of great concern to stake holders as it has the tendency to translate into poor performance in higher levels of school science ventures in Physics, Chemistry and Biology (Ogynleye, 2009).

In Lagos state where this study is been carried out, there has been an outcry of students' poor academic achievement in Basic Science which is seen in the poor performance of junior school students in Basic Science and Technology in Basic Education Certificate Examination (BECE) in Lagos state in the last decade as presented in Table 1.

Table 1: Students enrolment and performance in BECE in Basic Science and Technology from 2012-2021

Year	No of candidates	Distinction to Credit (1-6) with Percentages	Pass (D7-E8) with Percentages	Fail 9 with percentage	Percentage of Total Failed (D7, E8 and F9)
2012	97, 216	29,553 (30.4)	48,414(49.8)	19,249 (19.8)	67,663(69.6)
2013	99, 074	24,669 (24.9)	58,949 (59.5)	15,456 (15.6)	74,40 (75.1)
2014	154,283	115,712(75)	26,537 (17.2)	12,034(7.8)	38,571(25)
2015	149,286	83,152(55.7)	45,980(30.8)	20,154(13.5)	66,373(44.4)
2016	129,932	93,291(71.8)	33,782(26)	2,859(2.2)	36,641(28.2)
2017	149,035	79287(53.2)	55,739(37.4)	14,009(9.4)	69,748(46.8)
2018	166,557	95,104(57.1)	64,791(38.9)	6,662(4.0)	71,453(42.9)

2019	171,948	95,087(55.3)	76,517(44.5)	344(0.2)	76,861(44.7)
2020	174,959	114,773(65.6)	58,786(33.6)	1,400(0.8)	60,186(34.4)
2021	191,378	102,678(53.7)	87,437(45.6)	1263(0.7)	78,760(41.2)
Average		54.27			45.23

Source: *Lagos State Examination Board Lagos, Nigeria*

However, literature from past researches have attributed students' poor achievement in Basic Science to various factors which include: inadequate exposure of students to activities, students' poor attitudes and interest (Ojekwu & Ogunleye, 2020) which lead to poor preparation, inability to comprehend questions and lack of retentive memory, lack of effective methods of teaching science subjects, gender insensitivity and lack of qualified science teachers (Abonyi & Ibe, 2014). Anaekwe (2019) that studied problems associated with teaching of science also discovered that there is a serious problem with the teaching of Basic Science which is leading to students' under-achieving in Science, Technology, Engineering and Mathematics (STEM) in senior secondary schools.

Researchers such as Kabutu, Oloyede and Bamidele (2015), and Ekon (2013) discovered that inappropriate teaching methods used by teachers in Basic Science and Technology instruction as contributors to students' under-achievement in these subjects. This has led to poor performance on the part of the students in Basic Science (Ogunleye & Ojo, 2019). Also, researches (Abimbola, 2013; Olorundare, 2014) revealed that students performed poorly in science subjects. This agrees with Okeke (2015) that studied problems associated with teaching of Basic Science and also discovered that students were under-achieving in Basic Science due to poor teaching strategy. This is supported by the study of Olorundare (2014) and Ogunleye (2012) that showed clearly that students' performed poorly in science subjects. Despite the efforts of the Nigerian government and Science Teachers Association of Nigeria to put an end to poor academic achievement in science, academic achievement in Basic Science both in internal and external examination is still below average due to poor teaching strategy implying that the current educational standard is weak (Ogunleye, 2011).

Moreover, poor instructional strategy of teaching is one of the major causes of students' underachievement (Ogunleye and Bamidele, 2013; Okoyefi, 2014; Bamidele and Ogunleye, 2017). Further, Adonu, Nwagbo, Ugwuanyi and Okeke (2021) affirm that innovative instructional strategies help students to develop problem-solving and creative skills which will foster their achievement and retention. Basic Science being a relatively new subject and a foundation for learning science need to be taught with strategies that could allow the students have good understanding of the subject; be able to retain what they have learnt and apply it in solving future problems. Ugwu, Jatatua and Gwamna (2020) revealed teaching strategy is mostly the determinant of the level of students' retention.

In line with the above, retention is the ability to recall or recognize what has been experienced or learnt. Academic retention is a measure of how long students can remember the contents they are exposed to in a particular course (Onyenma & Olele, 2020). Retention is also the ability to store facts and remember things easily (Aninweze, 2014). The ability to retain what has been learnt may lead to higher achievement as retention is measured in line with achievement (Iji 2010). Based on this, retention in Basic Science can be seen as a measure of how long students can remember the concepts they are taught in Basic Science and their ability to remember retrieve and apply these concepts when required. This shows the amount of what the students have learnt that is being stored in the long term memory. Inability to remember what was learnt showed that students learn only for examination and the grades they get, that after the exams most students tend to forget most part of what they learnt. This is not good because students' need to have long term retention of the knowledge of science so that students can later apply such knowledge to solve real live problems in their environment /workplaces to bring about development in the society. It is necessary that students should be made to pass through learning experiences that will help them retain the knowledge they gained for a long time after exams so they can apply them somewhere else later.

Jiya (2011) defines retention as the ability to remember facts and ideas. The ability to store and remember things experienced or learnt at a later time by an individual is retention (Bichi, 2012). Maikano (2016) believes that in any teaching and learning process students' retention is very important because the ultimate target of our educational endeavor which is permanent and meaningful learning can be achieved through this. For teaching and learning of Basic Science to help the students to later study the core science subjects in their senior secondary school they should be able to retain what they are taught. This implies that when students are able to properly retain information they will be able to recall the information helping them to achieve well academically. Ryan and Reid (2015) stated that students' retention depend on the appropriateness of the teaching strategy. This implies that poor instructional strategies like lecture strategy, expository strategy, demonstration strategy, discussion strategy and so on used by teachers has led to poor retention by students which has also affected their achievement. Balarabe (2016) identified inappropriate and uninspiring strategies of teaching adopted by teacher as a factor militating against students' attainment of the objectives of science.

Therefore, for teaching of Basic Science to be effective with students actively participating in the learning process and taking ownership of learning there is need for the students' to be taught with innovative strategies. To this end, Ogunleye and Oladehin (2012) used 'circle-the-sage' mode of cooperative learning and Ogunleye and Bamidele (2014) tried classwide peer tutoring for teaching science. All these yielded moderate positive results but the performance of students is yet to rise to the level of excellence. More innovative strategies like

flipped classroom strategy which will develop creativity in the students that will enable the students understand science concepts being taught, have high academic achievement, retain what is learnt and apply the knowledge in future to solve societal problems.

Flipped classroom is a technological based learning strategy where students actively participate in the learning process. The Flipped Classroom is a teaching strategy where students watch the videos lessons, read the lesson materials at home at their own pace outside the classroom and participate in activities in the classroom while the teacher guides them through the activities. The lower cognitive work is done at home by the students while the teacher guides through the higher cognitive learning in the classroom. According to Mohanty and Parida (2016), flipped classroom is a conjoined learning model that allows learners to learn freely by bringing out basic content out of the planned time, allowing educator to be involved in interactive learning activities and group discussion during the lesson period in the class to promote higher-level thinking.

Flipped classroom, also known as the inverted learning involves flipping or inverting the educational space such that activities that are usually done in the classroom are now done at home and the activities done at home now done in the classroom. It is blended learning that combines learning outside the classroom with printed materials, videos and online exposure with face-to-face learning in the classroom with group discussion and the teachers' guidance. Here the teacher serves as a facilitator that guides the students through the learning process providing input on their results. It is a learning strategy that helps the teacher to help the students to actively learn during the lesson by giving students learning materials and presentations to be viewed at home or outside the class.

Moreover, Lo, Hew and Chen (2017) stated that flipped classroom approach enables teachers to spend more in-class time on student-centered instructions such as teachers' individual assistance and group discussion. Flipped classroom has some indirect educational outcomes such as promoting more independent learning, improving students' communication skills and changing students learning habits and attitude (e.g. revisiting the online materials before examination). Wiginton (2013) revealed that flipped classroom strategy allows the students to interact well with the teacher and their mates in the class, it allows them apply and practice the knowledge and to prove their learning performance and higher order thinking skills at every given opportunity. In order words teachers allow students to manage their responsibilities, learning process and self-regulation by applying active learning strategies. According to Ugwuanyi et al. (2019), the flipped classroom strategy involves giving video lectures to the students for homework instead of traditionally giving them lectures in the classroom. Students watch these videos at home at their own convenient time, and then return

to the classroom with the knowledge already acquired to work in groups with their classmates with the guidance of the teacher to use that knowledge to solve problems in the classroom

The purpose of this work is to find the effects of flipped classroom learning strategy on students' achievement and retention in Basic Science. The following hypothesis were formulated to guide the study and tested at 0.05 level of significance.

Ho1: There is no significant effect of treatment on students' achievement in Basic Science.

Ho2: There is no significant difference in the marginal Post-Achievement scores of the Treatment and Control groups.

Ho3: There is no significant effect of treatment on students' retention in Basic Science.

Ho4: There is no significant difference in the marginal Post-Achievement scores of the Treatment and Control groups.

Research Design

The quasi-experimental, pretest-posttest control group design was adopted. All three hundred and thirty-seven thousand, seven hundred and twenty four (337,724) Junior Secondary School students in Lagos state. The sample size comprised four hundred and fifty-two (452) Junior Secondary School II students from six public schools in Lagos state. Lagos state was stratified along the six existing educational districts I, II, III, IV, V, VI and educational districts I, II and VI were randomly selected. Educational districts I, II and VI has 46, 56 and 52 Junior Secondary Schools respectively. Disproportionate stratified random sampling technique was used to select two schools from each district ensuring however that the schools selected from had the necessary facilities for implementing the instructional strategies being used in the study.

The instruments for data collection were Basic Science Achievement Test (BSAT). The instrument was constructed by the researchers. BSAT contained 50 objective questions developed from the content areas of Work, energy and power, potential and kinetic energy, calculation involving work done, energy transfer when work is done, family life education, and kinetic theory. The items were developed using the test blue print to ensure content coverage and the six levels of Bloom's taxonomy of educational objectives. Three experts from the department of science education, university of Ibadan did the face and content validity of the instrument. Kuder-Richardson (KR-20) was used for the reliability that gave 0.78. The Operational Guide on Flipped Classroom Strategy (OGFCIS) was used by three independent raters to assess teachers and the inter-rater reliability was assessed using Scott's π method.

Procedure

Pretest was administered by research assistants who were Basic Science teachers to students in both groups after which one school from each district was taught the listed topics with the flipped classroom strategy (experimental group) and one intact class from each of the sampled district was taught with the conventional lecture strategy (control group) for seven (7) weeks.

Steps involved in Flipped Classroom Learning Strategy

Step I: Prior to in-class meeting A

Students read the printed material.

Step II: Prior to in-class meeting B

Students completed the assignment before the class and completed the note.

Step III: In-class activities A

Teacher assessed students' ability to master contents reviewed prior to class

Step IV: In-class activities B

Students participated in active learning activities by discussing and answering in groups their assignment done at home to deepen their understanding of the content

Step V: Feedback A

Students presented the result of their findings to the class in groups

Step VI: Feedback B

Facilitator corrected the students' misconceptions and give the students material and assignment for the next class.

The instructions were taught by the research assistants (the Basic Science teachers in the schools selected) who had earlier been trained on the use of the respective instructional strategies to use in the study. BSAT was reshuffled and given to the students immediately after treatment as Post-test to check the effects of treatment on students' achievement. The BSAT was reshuffled again and given to the students by the ninth week which was two weeks after treatment to test for retention.

Data Analysis

Data collected were analyzed using Analysis of Covariance (ANCOVA). Hypotheses were tested at 0.05 level of significance.

Results

Ho1: There is no significant main effect of treatment on students' achievement in Basic Science

Table 2: Analysis of Covariance (ANCOVA) of Post-Achievement by Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1497.828	2	748.914	53.338	0.000	0.192
Intercept	9104.503	1	9104.503	648.426	0.000	0.591
PreAchievement	182.656	1	182.656	13.009	0.000	0.028
Treatment	1367.882	1	1367.882	97.421	0.000*	0.179
Error	6290.332	448	14.041			
Total	88759.000	451				
Corrected Total	7788.160	450				

R Squared = 0.19 (Adjusted R Squared = 0.19) * denotes significant p<0.05

Table 2 revealed that there was a significant main effect of treatment on students' achievement in Basic Science ($F_{(1; 450)} = 97.42$; $p<0.05$, partial $\eta^2 = 0.18$). Table 2 indicated the effect size of 18.0%. This means that 18.0 per cent of the total variation observed in students' post-achievement scores in Basic Science in this ANCOVA model was due to the significant main effect of the treatment. Therefore, hypothesis 1 was rejected.

Ho2: There is no significant difference in the marginal Post-Achievement scores of the Treatment and Control groups.

In order to explore the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out and the result is presented in Table 3.

Table 3: Estimated Marginal Means for Post-Achievement by Treatment and Control group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Strategy (FCS)	15.25	0.26	14.75	15.76
Conventional Strategy (CS)	11.76	0.24	11.28	12.23

Table 3 revealed that students in the Flipped Classroom Strategy (FCS) treatment group had the higher adjusted mean score in their post-achievement in Basic Science (15.25) followed by those in the Conventional Lecture Strategy (CS) control group (11.76). This order is represented FCS > CS and has been shown to be significantly different (p<.05). The hypothesis is hereby rejected.

Ho3: There is no significant main effect of treatment on students' retention in Basic Science

Table 4: Analysis of Covariance (ANCOVA) of Retention by Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	485.861	2	242.930	20.704	0.000	0.085
Intercept	4200.946	1	4200.946	358.038	0.000	0.444
PostAchievement	2.667	1	2.667	0.227	0.634	0.001
Treatment	428.945	1	428.945	36.558	0.000*	0.075
Error	5256.498	448	11.733			
Total	59940.000	451				
Corrected Total	5742.359	450				

R Squared = 0.09 (Adjusted R Squared = 0.08) * denotes significant p<0.05

Table 4 shows that the main effect of treatment was significant on students' retention in Basic Science ($F_{(1; 450)}$ = 36,56; p<0.05, partial η^2 = 0.08). The effect size (8.0%) implying that 8.0 per cent of the total variations observed in students' retention mean scores in Basic Science was due to the result of the significant main effect of the treatment. Hence, hypothesis 3 was rejected.

Ho4: There is no significant difference in the marginal Post-Achievement scores of the Treatment and Control groups.

To explore the degree of this significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out and presented in Table 5.

Table 5: Estimated Marginal Means for Retention by Treatment and Control group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Strategy (FCS)	12.10	0.25	11.61	12.59
Conventional Strategy (CS)	9.96	0.23	9.50	10.41

Table 4 showed that students in the Flipped Classroom Strategy (FCS) treatment group had the higher adjusted mean score in their retention in Basic Science (12.310) followed by those in the Conventional Strategy (CS) control group (9.96). This order is represented FCS> CS. These differences had been shown to be significant (p<.05) and the hypothesis was rejected.

Discussion of Findings

The findings of this study revealed that students exposed to Flipped Classroom Strategy obtained higher achievement level than their peers in the control group. The findings of this study is supported by the findings of Strayer (2012) that great achievement occurs with Flipped Classroom Strategy, the strategy enable students to achieve higher academically. This is because flipped classroom allows students to be responsible for their learning, encourage collaborative learning and reduce stress on the students. Edward Deci and Richard Ryan theory of self-determination sees autonomy, competence and relatedness as the psychological needs that motivate a person's action, these three needs encourages engagements among learners and intrinsic motivation is being enhanced by a learning environment that fulfill the three needs, leading to increased engagement and the development of positive attitude towards learning by the learners (Gagne and Deci, 2005).

When Basic Science students are intrinsically motivated working through the learning material at home will be interesting to the students, giving more time for group work in the class. Bruner advocated for spiral curriculum, in which instruction should be from simple to complex. Flipped Classroom Strategy allows students to be taught from simple to complex. Thus, when Basic Science content is structured in a way that they would be easily understood and grasped by the learners, it would enhance students' performance. Therefore, Basic Science teachers should plan and present the body of knowledge in a simple form that the students can recognize and relate to their experiences and it should be from simple to complex.

The findings of this study also revealed significant effect of treatment on students' retention in Basic Science with an effect size of (is it 6.0% or 8.0% as we have on page 9). This proved that Flipped Classroom Strategy is of immense importance in improving the retention of the students. This finding is supported by Sarawagi (2016) that discovered that Flipped Classroom learning improved students' learning and retention. This finding is also corroborated by the findings of Ryan and Reid (2015) who reported flipped classroom as efficacious on the retention of students in chemistry concepts.

Constructivist theory by Brunner advocated for students' centered learning which should emphasized on hands-on and mind-on activities, through which they will discover new ideas, develop interest and critical thinking skills. Moreover, engaging in science activities enables the students to solve societal problems with the knowledge acquired. The application process would enable an individual to go beyond information given which was advocated by Brunner and this would come to play based on individual retention level.

The finding of this study is buttressed by the findings of Makinde and Yusuf (2018) that discovered that students taught mathematics using Flipped Classroom Strategy have higher retention than students taught with conventional strategy. This finding revealed that Flipped

Classroom Strategy improved students' retention better than the Conventional Strategy may be due to the fact that Flipped Classroom Strategy encourages students to use videos and other printed materials that can be used at the time convenient for the students allowing the students to learn at their own pace helping students to improve in their achievement and retention of concepts learnt in Basic Science.

Implications of the Study

The study and its findings have the following implications:

a. Adopting the use of Flipped Classroom Strategy for teaching the subject can enhance the understanding of the concepts taught.
b. The use of Flipped Classroom Strategy can improve achievement and retention in Science.
c. Other researchers can prove the efficacy of the Flipped Classroom Strategy.

Conclusion and Recommendation

The study determined the effect of Flipped Classroom Strategy on the achievement and retention of Basic Science students which are of concern. It is evident from the result of this research that when Flipped Classroom Learning Strategy was used for teaching junior secondary school students, it improved their achievement and retention of science concepts.

In conclusion, it is evidence that Flipped Classroom Strategy is more effective in enhancing the level of students' achievement and retention in Basic Science than the Conventional Strategy. Scientific knowledge and skills of secondary school students are being nurtured when they are being guided by teachers and taught with strategies where learning and exploration are hands on and mind on. From the findings, the following recommendations were made:

1. Basic Science teachers should be encouraged to employ student-centered instructional strategies, such Flipped Classroom Strategy which is activities based to promote creativity and enable the students to achieve well and have retentive memory.
2. Necessary materials and teaching apparatus should be provided for teachers to use innovative strategies for proper delivery of their lessons. Likewise, teachers should improvise where standard instructional materials for the teaching of Basic Science are not available.
3. Government at the State and Federal levels should always train and retrain teachers in the use of innovative strategies for delivering of Science classes through workshops, conferences and seminars.

4. Curriculum planners and developers in science subjects for secondary schools should emphasize the use of innovative strategies like Flipped Classroom Strategy for teaching Science subjects.

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