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# RE-ENGINEERING SCIENCE AND TECHNOLOGY EDCATION WITH FLIPPED CLASSROOM STRATEGY: INFLUENCE OF SCHOOL LOCATION ON JUNIOR SECONDARY TWO STUDENTS' INTEREST AND ACHIEVEMENTIN JOS, NIGERIA

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## ABSTRACT

The study focused on re-engineering science technology education with flipped classroom strategy: on interest and achievement of junior secondary two students in Basic Science and Technology in Jos south local government area of Plateau State, Nigeria. The sample for the study comprised 161 students selected from a population of 18,636 students in 109 schools in the area of study. The non- randomized pre-test, post-test experimental control group design was employed in the study. A Basic Science and Technology Achievement Test (BSTAT) and Students' Interest in Basic Science and Technology Questionnaire (SIIBSAQ) were used to collect data from the sample. The BSTAT was content validated while the construct validity of the SIIBSAQ was established, by experts in Science Education and Technology and Research and Evaluation Departments in the Faculty of Education, University of Jos, Nigeria. The reliability indices of the BSTAT and SIIBSAQ were determined as 0.93 and 0.85 using Cronbach alpha method. Two research questions and one hypothesis were used to guide the study. The experimental group was taught Basic Science and Technology concepts using the flipped classroom strategy and the control group was taught the same concepts using the traditional lecture method. The teaching exercise lasted for four weeks. Three research questions raised to guide the study were answered using mean and standard deviation while two hypotheses formulated were tested using Multiple Analysis of Covariance (MANCOVA) at 0.05 level of significance. The results showed that the experimental group had a higher interest and achievement mean scores than the control group. intere. It was concluded that the flipped classroom strategy enhanced students' interest and achievement in Basic Science and Technology. It was therefore recommended that teachers should re-engineer science and technology teaching and learning by incorporating flipped-classroom strategy in Basic Science and Technology classrooms for enhanced interest and achievement outcomes.

## Introduction

Science has been defined in diverse ways by different authors; as the study of nature, a body of knowledge, a way of life, a way of thinking, a method, a process and a product. For instance, Njoku (2018) defines science as a systematic study of nature through observation and experimentation, leading to accumulation of an organized body of knowledge useful for solving human problems. Science is the study of natural phenomena and is distinct from other fields of study because it relies on the hypothetical deductive, experimental approach. Olarinoye (2022) perceives science as a body of knowledge obtained by methods based on observation. The term technology refers to the application of science.

Science is taught at the secondary school level of education as Physics, Chemistry and Biology whereas at the basic level of education, the form of science taught is referred to as Basic Science and Technology. Basic Science and Technology has been restructured in line with emerging issues of global and national concerns under the themes, Basic Science, Basic Technology, Information Technology, Physical and Health Education. Okorie (2012) describes Basic Science and Technology as the engine room for national growth and development. For any nation to grow to its peak in terms of technology, its science education programmes need to be aligned to the needs of its citizens for sustainable national development. Science and technology teachers therefore, need to emphasize the use of interactive teaching approaches such as constructivism, activity-oriented, hands-on, minds-on and computer-mediated instructional techniques; meaningful pedagogy which should be used to bring students close to science and technology. The teaching and learning of the subject matter require the use of discovery approach, as well as, innovative methods that stimulate students' interest, promote creativity and achievement. Ozoji (2020) posited that the teaching and learning of science should involve activities and room given to students to think or reason about what they are doing in order to look for relationships which may enhance and build up a store of scientific techniques. Adequate teaching and learning environments should be provided, such as well-equipped laboratories, functional libraries, classrooms, and the use of modern materials for teaching, creating more concrete knowledge and interest in science and technology; encouraging the application of imaginative thinking and linking classroom science and technology to everyday life in society.

To re-engineer science and technology education, the curriculum needs to be carefully designed and implemented to encourage creativity, self-productivity, innovation independence, adaptation in the use of new teaching approaches. Gotom, Ozoji andOdigiri (2020) posits that exposure to technological equipment in teaching such as computer and internet, video-automated teaching, exposes learners and teachers to think in the same direction as their counterparts in other nations of the world. This, to a large extent would help in producing self-productive scientists for sustainable national development.

One of the objectives of teaching Basic Science and Technology is to equip learners with foundational skills and knowledge for subsequent science studies at the higher levels of education (Umar, Ozoji&Ikpechukwu, 2018) and effective living in a world that is knowledge-based and technologically driven. The objectives appear to far from meeting the expected results. A survey of the BECE results of Plateau State for 10 years (2008-2018) revealed that students' achievement in Basic Science and Technology was very poor. These may be due to the abstract and difficult nature of Basic Science and Technology concepts, as well as student-related factors, such as, negative attitudes towards the subject, low motivation and lack of interest.

Interest could be defined as an activity one enjoys and devotes time in doing or studying. According to Alhadabi (2021) interest is a powerful motivational process that energizes learning. A further essential feature of interest is its intrinsic nature. It is also associated with one's pronounced readiness to acquire new knowledge and, as such, an important factor in science and technology education because it more often than not leads to success and meaningful learning of the subject. On the contrary, lack of interest is associated with low achievement in science and technology-related concepts (Nworgu, 2012).
Owoeye and Yara (2011) in their studies on school location and academic achievement of secondary school students in Ekiti State, Nigeria posited that studies on school location as regards influence on academic achievement do not yield the same results. While some show that urban students achieve better in examinations than their rural counterparts, others show that rural students (in spite of all odds) do better. Some other findings however indicate that no particular setting (urban or rural) has more superiority than the other. In their studies on the influence of study of interest and school location on the attitudes of secondary school students towards mathematics in Ekiti State, Adebule and Aborisade (2013) opined that, students, resident in urban centers had more access to libraries, laboratories, etc., than those in rural setting. Conversely, Achimugu (2018) in his own study found out that geographical location did not significantly predict outcomes in school achievement. Furthermore, some other studies (Bosede, 2010) cited in Okorie and Ezeh (2016) showed no difference in academic achievement of students because of location. Conversely, Agbir (2004), cited in Okorie and Ezeh (2016) showed that rural students performed better on practical skills in chemistry than their urban counterparts did. The influence of location on students' academic achievement remains controversial and inconclusive. However, Adebule and Aborisade (2013) posited that lack of social amenities in rural areas affects such amenities are electricity, pipe borne water, technical resources, safe and secure facilities that are vital to successful educational programmes, particularly in the sciences. Similarly, Ogunleye and Adepoju (2011) observed that the location of a school has a significant role to play in the educational attainment of students in the school. In Nigeria, despite the critical role science plays in human existence and national

development, achievement of students in junior secondary school basic science is nothing to write home about. Some of the problems identified as responsible for this ugly trend include school location among others.

One of the ways of enhancing learning outcomes in science and technology courses is through engagement of learners in interactive instructional strategies, such as multi media-simulation, flipping, blended learning and cooperative learning strategies. Bishop and Verleger (2013) defined the flipped classroom as consisting of a two-part technique that includes group learning activities in the classroom that are interactive, and, individual instruction outside of the classroom that is computer-based and given prior to class. However, while Bergmann and Sam (2014) focus on technology, a learning object could include non-digital elements such as a traditional textbook or reading assignment

The flipped classroom (FC) refers to using technology to provide lectures outside of the classroom, while assignments with concepts are provided inside the classroom through learning activities (Clark, 2013). The FC is a classroom where homework is done at school and school work done at home. The flipped classroom is made up of three components, namely, pre-class component that requires students' interaction with learning materials through online or offline activities, in-class activities which has to do with interactions between the learners and the teacher and student-student collaborative learning in the class for real understanding of science and technology concepts.The school work is the recorded lessons' videos adopted or adapted by the teachers on specific topics in the subject. The students would have to watch the video at home online or offline in the absence of the teacher. Then, do the homework (assignments) in the class in the presence of the teacher who would provide assistance in the area of difficulties and monitor the learning progress in the class. Instead of using face-to-face classroom time mainly to inform, communicate and generate awareness, the flipped instructor generally moves this type of activity to an asynchronous environment (Makinde &Yusuf, 2017). Research suggests flipped classroom as one solution to this problem (Berrett, 2012; Alverze, 2012; Rozinah& Siti, 2014; Gotom, Ozoji&Odigiri, 2020).

The use of flipped classroom strategy has been widely acknowledged and it addresses some of the challenges encountered in science and technology instruction, such as, creating room for teachers to allocate more time to student-learning environments (Eryilmax&Cigdemoglu, 2019). Furthermore, flipped-classroom strategy has cognitive and affective outcomes (Sookoo-Singh &Boisselle,2018). Studies carried out in flipping has been published in higher education (Butt, 2014; Thompson & Mombourquette (2014). Most of the studies showed encouraging outcomes. For instance, participants in flipping were more excited, engaged and satisfied (Daves, 2013; Butt, 2014) more open to cooperative learning (Sayer, 2012) and had better achievement outcomes (Fulton, 2012; Bishop & Verleger, 2013; Mishel, 2014; & Gambari, 2016). On the contrary, there was no change in the academic outcomes of students engaged in flipping in the study carried out

by Findlay-Thompson and Mombourquette (2014). In another study by Sookoo-Singh and Boisselle (2018) on students' motivation and achievement when exposed to flipping no difference in achievement was found. However, there appears to be paucity of studies in flipped-classroom strategy at the basic level of education and in Basic Science and Technology in Nigeria, particularly, in this era of Covid 19 pandemic, hence, the need for this study on, re-engineering science, technology education: Influence of school location on junior secondary two students' interest and achievement in Basic Science and Technology in Jos, Nigeria.

**Purpose of the Study**

The study focused onre-engineering science and technology education: Influence of school location on junior secondary two students' interest and achievement in Basic Science and Technology in Jos, Nigeria. Specifically, the objectives of the study were to investigate:

1. The difference between the post-test mean interest scores of JS two students in experimental and control groups.
2. The difference between the mean achievement scores of JS two students exposed to flipped classroom strategy and those exposed to the lecture method of teaching.
3. The extent to which flipped-classroom strategy would improve JSS two students' achievement in Basic Science and Technology due to school location?

To achieve the stated objectives, the following research questions were raised and hypothesis tested at 0.05 level of significance:

**Research Questions**

1. What is the difference between the post-test mean interest scores of JS two students in experimental and control groups?
2. What is the difference between the mean achievement scores of JS two students exposed to flipped-classroom strategy and those exposed to the lecture method of teaching?
3. To what extent will the flipped-classroom strategy improve JS two students' achievement in Basic Science and Technology due to school location?

**Hypotheses**

1. There is no significant difference between the combined post-test achievement and interest mean scores of students exposed to flipped classroom strategy for teaching Basic Science and Technology and those who were not exposed after controlling for the effect of the continuous covariates (pretest achievement and interest scores).
2. There is no significant interaction effect of treatment and location on the combined Post-test achievement and interest mean scores of students exposed to flipped classroom strategy for teaching Basic Science and Technology and those who were not after controlling for the effect of the continuous covariates (pretest achievement and interest scores).

## Method

The study employed the non-randomized pre-test, post-test quasi experimental control group design. The sample for the study comprised 161 students selected from a population of 18,636 students in 109 schools in the area of study. A Basic Science and Technology Achievement Test was used to collect data for the study. There were two sections in the instrument, namely section A and section B. Section A consisted of students' personal data, such as, name of student, subject, gender, name of school and school location while section B consisted of 40 multiple choice questions with each question having four options, A-D. The BSATAT was based on the curriculum as regards Health Education with the sub-topics, **First aid and safety education.**

The Students' Interest Scale had two sections; namely, section, A and section B. Section A consisted of students' personal data, such as, name of student, gender, age, name of school, date and school location while section B consisted of 21 questions with each having five options of Strongly agree, Agree, Undecided, Disagree and Strongly Disagree. The instrument was adapted from Graham (2013).

The development of BSATAT was carried out based on the test development procedure. This is a process that ensured that relevant and appropriate items were included in the BSATAT. In this regard, the Basic Science and Technology curriculum and syllabus re-structured by the Nigerian Educational Research and Development Council (FRN, 2009) were consulted for appropriate information and guideline in the construction of the test items, as well as, consulting the past questions for BECE for standard questions. Furthermore, standard recommended text books were used in the teaching of the topic First aid and Safety education, such as Okeke, Banwo, and okebule (2014) was consulted by the researchers for lesson planning and drafting of questions. In addition, a video learning material was developed and burnt on a Compact Disc (CD) and uploaded on a YouTube (https://youtu.be/bs0HCJ_FTJQ. The CD plates were given to the students as well as a YouTube link to watch and study the learning materials for two weeks. The distribution of test items was done using a table of specifications such that they covered knowledge, comprehension, understanding and application levels of cognitive objectives.

The SIIBSATQ developed by Graham (2013) was adapted and used to measure students' interest towards Basic Science and Technology. The adapted SIIBSATQitemswere re-written to elicit students' interest in Basic Science and Technology. The Items in the (BSATAT) and (SIIBSATQ)were validated by subjecting them to content validation by two experts: a senior lecturer in Tests and Measurement and a senior lecturer in Science and Technology Education. The experts were each given a copy of the BSATAT, table of specifications, SIIBSATQ and instrument evaluation guide. The instruments were validated in terms of clarity of the questions asked, proper wording of the items, appropriateness of the questions/ items to the students' level of understanding and

experience. The assessment and inputs of the experts formed the basis for modification or rejection of some of the items**.**

The Cronbach alpha method was used to establish the internal consistencies of BSATAT and SIIBSATQ as 0.93 and 0.85, respectively. The use of Cronbach alpha method was justified because the responses were dichotomous. The trial testing of the instruments was carried out on 60 JS2 students offering Basic science and technology in one of the public schools in Jos south local government area of Plateau State. The BSATAT and SIIBSATQ were administered as pre-tests to the experimental and control groups. The two teachers used as research assistants for the experimental group helped in the distribution of DVD or CD and the YouTube link (https://youtu.be/bs0HCJ_FTJQ) to their students in experimental group while those of control group were taught using the traditional teaching method. The teaching and learning exercises took four weeks after which post-test of the BSATAT and SIIBSATQ were administered.

The research questions raised for the study were answered using descriptive statistics while the null hypothesis was tested using a two-way Multivariate Analysis of Covariance (MANCOVA) at 0.05 level of significance.

**Results**

**Research Question One**

What is the mean difference between the post-test mean interest scores of the students in the experimental and control groups?

**Table 1: Mean Difference Between Post-test Mean Interest Scores of JS Two Students in Experimental and Control Groups**

| Group | N | 1 | SD | Mean Difference |
|---|---|---|---|---|
| **Experimental** | 82 | 79.94 | 9.45 | 12.60 |
| **Control** | 79 | 67.34 | 8.03 | |

Table 1. reveals that the mean difference between the post-test mean interest scores of JS2 students in the experimental and control group. In the experimental group, the post-test interest mean score is 79.94 with 9.45 as standard deviation, while the control group mean achievement score for Post-test in terms of JS 2 students' interest is 67.34 with SD as 8.03. The mean difference between the Post-test interest scores of the students in experimental and control groups is shown

as 12.60.

**Research Question Two**
What is the mean difference between the post-test mean achievement scores of the students in the experimental and control groups?

**Table 2: Mean Difference between Post-test Mean Achievement Scores of JS two Students in Experimental and Control Groups**

| Group | N | 1 | SD | Mean Difference |
|---|---|---|---|---|
| **Experimental** | 82 | 78.68 | 16.27 | |
| | | | | 20.16 |
| **Control** | 79 | 58.52 | 6.63 | |

Table 2. shows that the mean difference between the post-test mean achievement scores of JS two students in experimental and control groups. For the experimental group, the post-test mean achievement score is 78.68 with SD 16.27 while for the control group the post-test mean achievement score is shown as 58.52 with SD 6.63. The mean difference between the post-test mean achievement scores of the students in the experimental and control groups is shown as 20.16.

**Research Question Three**
To what extent will flipped classroom strategy improve JS two students' achievement scores in Basic Science and Technology due to school location.

**Table 3: Posttest Mean Achievement Scores of Urban and Rural JSS Two Students Exposed to Flipped Classroom Teaching Strategy**

| Location | n | 1 | SD | Mean Difference |
|---|---|---|---|---|
| Urban | 34 | 71.53 | 9.90 | |
| | | | | -12.22 |
| Rural | 48 | 83.75 | 9.32 | |

Table 3. shows the post-test mean achievement scores of JS two students in urban and rural areas. The post-test mean achievement score of students in urban schools is 71.53with SD 9.90 while for students in rural schools, the post-test mean achievement score is shown as 83.75 with SD 9.32. The Flipped-classroom strategy improved the post-test mean achievement scores of students in rural schools to a moderate extent.

Hypothesis 1

There is no significant difference between the combined post-test achievement and interest mean scores of students exposed to flipped classroom strategy for teaching Basic Science and Technology and those who were not exposed after controlling for the effect of the continuous covariates (pretest achievement and interest mean scores).

**Table 4.**
**Wilks' Lambda Multivariate Test of Effects of Flipped Classroom Teaching Strategy on Students' Interest and Achievement Scores while Controlling for the Covariates**

| Effect | | Wilks' Lambda | F | Ho df | Error df | *p* value | Partial Eta Squared | |
|---|---|---|---|---|---|---|---|---|
| Intercept | .265 | 208.495 | 2.000 | 150.000 | | .000 | .735 | |
| **Pre-test_Int.** | .968 | 2.459 | 2.000 | 150.000 | | .089 | .032 | |
| Pretest_Ach | | .856 | 12.637 | 2.000 | 150.000 | .000 | .144 | |
| Group | | .148 | 431.893 | 2.000 | 150.000 | .000 | .852 | |
| Gender | | .994 | .446 | 2.000 | 150.000 | .641 | .006 | |
| Location | .875 | 10.732 | 2.000 | 150.000 | | .000 | .125 | |
| Group*Gender | | .997 | .237 | 2.000 | 150.000 | .790 | .003 | |
| Group*Location | | .928 | 5.859 | 2.000 | 150.000 | .004 | .072 | |
| Gender*Location | | .977 | 1.753 | 2.000 | 150.000 | .177 | .023 | |
| Group*Gender*Loc | | .997 | .226 | 2.000 | 150.000 | .798 | .003 | |

Table 4. shows a statistically significant difference between the students exposed to flipped classroom teaching strategy and those that were not on the combined dependent variables (post-test achievement and interest scores) after controlling for pretest achievement and interest scores, $F(2,150) = 431.893$, $p<.001$, Wilks' Lambda $\Lambda = .148$, partial Eta = .852. The partial Eta squared .852 shows that 85.2% of the variance in the combination of the dependent variables (post-test achievement and interest scores) was

accounted for by levels of the independent variable (group taught with flipped classroom teaching strategy and the group taught with conventional method). Wilks' Lambda ʌ value of .148 shows that 14.8% variance in the combined dependent variables was not explained by differences in the groups of students taught Basic Science and Technology with different methods. The finding suggests that use of flipped classroom strategy for teaching Basic Science and Technology enhanced students' achievement and interest.

Ho 2: There is no significant interaction effect of treatment and location on the combined Post-test achievement and interest mean scores of students exposed to flipped classroom strategy for teaching Basic Science and Technology and those who were not after controlling for the effect of the continuous covariates (pretest achievement and interest scores).

In Table 4 the main effect of location, $F(2,150) = 10.732$, $p<.001$; as well as the interaction effect of group and location on the combined dependent variables after controlling for the pretests were significant, $F(2,150) = 5.859$, $p=.004$. The findings suggest that location is a significant factor in the use of flipped classroom strategy for enhancing JSS Two students' achievement and interest in Basic Science and Technology.

**Discussion**

The results of the study show that the flipped classroom strategy was effective in improving students' achievement in Basic Science and Technology. This is in agreement with the findings of Fulton (2012), Bishop and Verleger (2013), Mishel (2014) and Gambari (2016) which showed significant differences in the achievement mean scores of students taught science concepts using flipped classroom strategy. It therefore means that achievement in science and technology courses even at the junior secondary level of education could be enhanced through re-engineering of Basic Science and Technology education with the use of flipped-classroom instruction. The enhanced achievement outcomes of students in the experimental group could be as a result of the engagement of students in on-line activities which were interactive, collaborative and which must have led to critical thinking and creativity among students exposed to flipping. Another factor related to success may be as a result of prior knowledge of concepts by students when they engaged in online learning. Results of the study also showed that the flipped classroom strategy improved students' interest in on-line activities in basic science and technology concepts. The results are in line with that of Johnson (2010) which revealed that engaging students in on-line activities enhance their interest in science. On the contrary, the finding of this present study is at variance with those of Findlay-Thompson and Mombourquette (2014), Sookoo-Singh and Boisselle (2018) which showed no difference in achievement outcomes of students exposed to flipping.

The fact remains that in the present research, efforts were made to ensure that the tasks given to the experimental group were familiar, structured, engaging and were given

sufficient time. These may have contributed to the success of the experimental group. It therefore implies that if flipped classroom strategy must be effective in re-engineering science and technology education as was the case in this study, the teacher should carefully plan the instruction, provide well prepare online resources and adequate time for peer and teacher-student interaction, structure the tasks to be given and allow for the use of prior knowledge.

## Conclusion

The study has revealed that re-engineering Basic Science and Technology education with activity-based, innovative techniques, such as, the flipped-classroom strategy is capable of improving students' interest and achievement in Basic Science and Technology irrespective of school location and in the Covid 19 era.

## Recommendation

Based on the findings of the study, it was recommended that teachers should re-engineer basic science and technology teaching and learning particularly in this era of covid 19 by integrating innovations, activity-based interactive teaching techniques, such as, the flipped classroom strategy into Basic Science and Technology classrooms in both urban and rural areas for improved achievement outcomes and interest of students in Basic Science and Technology.

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