International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 6 Issue 2, February 2019

ISSN: 2394-4404

Improving Students' Participation In Chemistry Learning Through The Use Of Flipped Classroom Instruction

Enekwechi Emelda Ego

Department of Natural Science, School of General Studies, Federal Polytechnic, Oko, Anambra state, Nigeria

Chikwendu Angela Adanna

Mater Amabilis Secondary School, Umuoji, Anambra State, Nigeria

Okeke O.C. Sam

Nwanze Azubuike Cornelius

Department of Science Education, Nnamdi Azikiwe University, Awka

Abstract: ***This study investigated the effect of Flipped Classroom Instruction (FCI) on students' participation in chemistry classroom. Three hypotheses were tested in the study. A quasi-experimental, pretest posttest non-equivalent control group design was utilized in the investigation. The population consist of 1, 821 senior secondary two (SS2) chemistry students in all 61 public secondary schools in Awka Education Zone of Anambra state for the 2016/2017 academic session. A sample of 100 students from four single sex (two males and two females) schools were purposively selected for the study. Learner's Participation Questionnaire (LPQ) was used as an instrument for data collection. The instrument was validated by three experts in the Department of Science Education and Education Foundations. Cronbach alpha was used to establish the reliability of LPQ which yielded reliability indices of 0.9. Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings of the study showed a significant main effect of FCI on students' participation in chemistry. Furthermore, there was no significant interaction between teaching approach and gender on chemistry students' participation. The study recommended that classroom teachers should use FCI to make more time available for in-class active learning and to promote students ownership of the learning process.***

Keywords: Flipped Classroom, Participation, chemistry, active learning, gender

I. INTRODUCTION

Science and technology is a vehicle which a nation can use to accelerate economic growth, increased productivity, competitiveness, job creation, development for self-reliance and overall development. Every branch of science such as chemistry has important contribution to make in a nation's technological advancement. The contributions of chemistry to the scientific and technological development in many countries cannot be over-emphasized. Knowledge of chemistry plays a vital role in the quality of life of different nations. In Nigeria, chemistry has provided the theoretical base for the synthesis of medicines, soap, paints, shoes, textiles, detergents and cosmetics, fertilizers, cement, ceramics, margarine, plastics, glass. Jegede (2007) affirmed that chemistry occupies a central position in science learning because of its remarkable contributions in areas such as petroleum, engineering, medicine, textile industry, agriculture and pharmacy. Knowledge of chemistry helps to position students in undertaking numerous career opportunities such as becoming chemists, pharmacists, doctors, chemical engineers, biochemists, agricultural scientists, geologists among others.

Despite the increasing importance and usefulness of chemistry to the world at large, and Nigeria in particular, the

secondary school students' performance in the subject remain discouraging. Serious concern has been expressed by parents and the society in relation to the poor performance of students in chemistry in the senior school certificate examinations. According to Oli (2013), West African Examination Council (WAEC) reported a summary of 37.87 pass of students in chemistry in the year 2011. Okoli (2011) also reported a summary of 33.4 pass of students in chemistry in the year 2010. There is rather a fluctuating poor performance of students in chemistry in West African Senior School Certificate Examination. West African Examination Council (WAEC) published results from 2009 to 2017 showed that performance of chemistry students is not encouraging since the raw mean score of students' performance in chemistry have remained below 39. The result for the last five years shows fluctuating poor performance and the credit passes are mostly the borderline. A number of factors have been adduced to be responsible for the poor performance of students' in chemistry.

The reasons adduced for the poor performances of students by WAEC Chief Examiners include: Students' non adherence to instructions, poor knowledge of most chemistry concepts, lack of skills on the usage of technical terms where required, poor knowledge of laboratory set-up and names of laboratory apparatus, poor mathematical skills, and lack of active participation in the learning process among others. Similarly, researchers have advanced reasons for poor performance of students, in relation to the unsatisfactory performance. Njoku (2004) and Jegede (2007) reported factors such as poor instructional strategies, societal influence, teacher factor, infrastructural problems, lack of interest as well as poor study habit on the part of chemistry students as factors affecting students' performance. Poor methods of instruction was equally reported by Njelita (2005) as a factor affecting performance of students. Njelita was of the view that most educators employ teacher-centered instruction in delivering their lessons. In consonance with this view, Jegede, (2007) pointed out that the type of instructional plan used by teachers determine how effective learning could be, hence good teaching makes learning more meaningful.

There is need for educators to shift from teacher-directed instruction such as lecture method (chalk and talk method) to a more active learning environment where students participate actively and make use of their creative minds. Poor methods of instruction can be supplemented with enhanced activity-based and participatory method of instruction. For example, the direct method of instruction most often used by teachers can be supplemented with flipped classroom instruction (FCI). The direct instruction (DI) which is sometimes referred to as chalk and talk or lecture method is widely used in secondary schools, it is a teacher-centred approach. According to Joyce, Weil and Calhoun (2000) it is a teaching strategy, which relies strictly on lesson plans and lectures with little or no room for variation.

Generally, a direct instruction proceeds through five phases. Joyce, Weil and Calhoun (2000) described the five phases as orientation, presentation, structured practice, guided practice and independent practice. In the first phase, the teacher clarifies the goal of the lesson, explains why the lesson is important, ties the lesson to previous lessons and students' prior knowledge, and motivates the students. These ensure the students' mental set and prepare them for the lesson. This is followed by the second phase which involves presentation or demonstration of new materials to the students. In this phase teachers using direct instruction give multiple examples and provide accurate illustrations. The third phase is guided practice where the teacher structures the initial practice by leading the students through step-by-step and giving feedback on correct and incorrect responses. This is followed by phase 4 which check for understanding and provides feedback verbally or in writing. The final phase (phase 5) of a direct instruction lesson is independent practice, which is meant to reinforce the knowledge or skill acquired. This can be accomplished through homework. According to Allan, DI is highly teacher-centred. This largely promotes passive listening and less active participation by students in learning. This may lead to loss of interest and frustration on the part of students. DI does not furnish students with processing skills required in the 21st century; hence, more activity based instruction such as flipped classroom instruction (FCI) is advocated.

FCI is not entirely a new instructional approach but an older approach to teaching that has become more organized. Strayer (2012) used the phrase-inverted classroom, which is an earlier version of the flipped classroom where the initial learning is done outside the classroom. Flipped classroom instruction is an educational method of instruction that consists of internet-based instruction outside the classroom and interactive group learning activities inside the classroom. It can simply be described as schoolwork at home and homework at school (Willis, 2014). In FCI, students work on assigned activities outside the classroom (having prior knowledge) and inside the classroom they discuss and interact on the same materials. In this instance, the use of educational technology and activity learning are the two major components of the flipped classroom instruction, which blends online and in-class learning based on activities. Flipped classroom presents study guides to students through bulk SMS, which are practiced by the students as homework before the topic is treated in the class. This is a contrast with the traditional teaching method, which involves teaching the topic in the class before homework is given.

FCI changes the environment of initial introduction of new topic to an interactive class where every student is capable of contributing to the topic. It incorporates formative and diagnostic evaluations, as well as promotes meaningful face-to-face learning activities (Natalie 2015). The flipped classroom instruction provides the teacher with a means of achieving the desired student-centred learning environment where students participate actively in the learning process. Student participation in teaching and learning process is an essential quality in any educational experience. Most researchers are of the view that students' participation increases their critical thinking ability, enhances their intellectual development and improves their academic achievement (Abdullah, Bakar & Mahbob, 2015; Siti Maziha, 2010). Student's participation in classroom activities implies involvement in the classroom processes and procedures. This involvement may be described as active or passive. While active participation includes asking questions, voicing opinion or involving in class discussion in the class; passive

participation involves taking notes, sitting quietly and listening (Abdullah, Bakar and Mahbob, 2015).

However, Steel, Laurens and Huggins (2013) provided a broader perspective of classroom participation when they described it as a range of student activities undertaken before, during and after class. This suggests that class participation can be categorized as in-class participation and out-of-class participation. While the former deals with student activities undertaken inside the classroom, the later includes those undertaken outside the classroom. Whether activities are outside or inside the classroom, it is important that students engage actively. In this study, students' participation in chemistry implies students' involvement in both in-class and out-of-class activities associated with the learning of the subject. The researchers, given the potentiality of FCI to improve participation in the learning process were poised to investigate the effect of flipped classroom instruction on students' participation in chemistry learning.

PURPOSE OF THE STUDY

The purpose of this study is to investigate the effect of flipped classroom instruction (FCI) on students' participation in chemistry learning. Specifically, the study determined the:

- ✓ Effect of FCI on students' participation in chemistry when compared to those taught using DI.
- ✓ Effect due to gender on students' participation in chemistry.
- ✓ Interaction effect of instructional methods (FCI & DI) and gender on students' participation in chemistry.

HYPOTHESES

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

- ✓ There is no significant difference in the mean participation scores of students taught chemistry using FCI and those taught using DI.
- ✓ There is no significant difference in the mean participation scores of male and female students.
- ✓ There is no significant interaction effect of teaching methods and gender on the participation of the students in chemistry.

II. METHOD

The study adopted quasi-experimental design. Specifically, the study used pretest posttest non-equivalent control group design. Symbolically, the design is represented as follows:

O1	X	O2
O1	~X	O2

Figure 6: Diagrammatic Representation of the Design of the Study

Where
O_1 refers to pre-test
X refers to treatment with FCI
~X refers to treatment with direct instruction
O_2 refers to post-test

---- Dashed lines separating two rows show two groups not equated by random assignment (Nworgu, 2015)

The study was carried out in Awka Education Zone of Anambra State, Nigeria. The population of this study consisted of 1, 821 senior secondary year two (SS2) students offering chemistry in all the 61 public secondary schools in Awka Education Zone of Anambra state for the 2016/2017 academic session. The population was made up of 766 male and 1055 female SS2 chemistry students (Post Primary Sschool Service Commission, Awka, 2017). The sample for the study consisted of 100 SS2 chemistry students (63 males and 47 females). The sampling was multifaceted. Purposive sampling technique was used to select two single sex (male) senior secondary school out of seven boys public secondary schools in Awka Education Zone. In the same way, two single sex (female) schools in Awka Education Zone were selected. The four schools also have other common characteristic like qualified and experienced chemistry teachers, standard and equipped chemistry laboratories, have written WAEC for at least ten years. In the second stage, experimental and control groups were assigned to the two boys schools and two girls schools by simple random sampling technique: toss of coin. The two schools (males and females) that choose head were assigned to experimental groups while the schools (males and females) that choose tail were assigned control groups. Finally, one intact class in each of the four schools was used for the study. Three schools out of the four schools have three streams/classes of SS2 students offering chemistry. One intact class was selected by random sampling technique which involved writing, one yes and two no on three different pieces of papers and folding them for a pick (use of ships of paper or lucky dip).

The instrument for data collection was Learner's Participation Questionnaire (LPQ). The Learner's Participation Questionnaire (LPQ) was also developed by the researcher in order to assess students' involvement in the learning of chemistry. It comprised of 11 items based on students' experiences in learning chemistry in secondary school. A 4-point scale developed by the researcher with response options of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) was used to collect the data. The response options were scored 4, 3, 2 and 1 respectively. The instrument and lesson plans were given to three experts, two in the Department of science Education and one in the Department of Education Foundations (Measurement and Evaluation) all from Nnamdi Azikiwe University, Awka. The validation was mainly based on clarity of expressions, none ambiguity, relevance and ability of the instruments to measure what they are expected to measure. All suggestions, comments and corrections were considered by the researcher before the final copy of the instrument was produced. The instruments was thereafter administered to 20 chemistry students of two single sex (male and female) secondary schools that were not involved in the sample for the study but have similar academic environment and background with the schools used for the study. The reliability of LPQ was established using Cronbach alpha which gave coefficient of internal consistency of 0.90.

The researcher then organized a training programme for research assistants (chemistry teachers) in their various schools in order not to interfere with the school activities. The

teachers that taught the control groups had a discussion with the researcher individually on how to use the lesson plan prepared by the researcher. The training for the experimental group was mainly an interactive session with the individual teachers in order to get them acquainted with the flipped classroom instructional procedure. The instrument was administered to the students by their chemistry teachers (research assistants) under the supervision of the researcher. The students' responses were marked and kept by the researcher. The experimental groups were then taught using flipped classroom instruction for four weeks while the control groups were taught using direct instruction.

The experimental groups were taught using flipped classroom instruction which involves the following stages:

WEEK ONE: The researcher sent study guide lines/hints concerning the topic to be treated and a short video tutorial to the students through their contact phone numbers. The research assistants equally gave the study guide directly to the students especially for those living in the dormitory who may not have access to phones. These study guides were provided to the students three or more days before the class time/day of the lesson.

The study guideline on periodic table (PT) sent to the experimental group were; look at the PT chart carefully, What is it made up of? Name the first 30 elements of the PT. PT has 8 vertical column known as groups and horizontal rows known as periods, name two elements from each group, PT contains metals, metalloids, non-metals and transition elements. The students prepared themselves for the lesson using the above study guidelines (outside class activities). For the inside class activities which was the real teaching of the topic, the students were engaged in activities such as group discussions, class discussions, and mapping out block of elements from the periodic table chart.

- ✓ Group Discussions: The teacher placed the students in groups of 5 members and asked them to discuss the periodic table using the study guideline given/sent to them previously. During the group discussion, the teacher goes round the different groups to ensure that order is maintained and that the materials are being discussed. Every student is expected to write down points from the discussion.
- ✓ Class Discussion and Interaction: The teacher calls the different groups together for a general discussions/interaction on the topic (period table) using the same study guide lines. The students were asked to map out blocks of elements from the displayed PT chart. The teacher moderates/directs the discussion; using the PT chart and the study guide lines, the teacher ensures that every aspect is well discussed. The teacher encourages the students to ask questions concerning the topic, as well as stating the challenges they encountered during the outside class activities (on the study guide).

WEEK TWO: Outside class activities- The students in the experimental group received study guideline from the researcher and the research assistants. The study guidelines were drawn from the topic to be treated which included: the different families of the periodic table: alkali metals (group 1 Element), the halogens (group 7 elements), the noble/rare gases (group O elements) and electronic configuration of atoms in groups 1 to 7. Students were requested to find out the group that belong to S-block, P-block, D-block and F-block elements. A video that discussed the above study guideline was equally sent to the students by the researcher. This enabled the students to be fully ready for the lesson/inside class activities. The teacher allowed the students to introduce the topic for the lesson and ask them to bring out their findings concerning the topic.

The following activities were used by the teacher; group discussion, drawing electronic configuration of different elements, and mapping out blocks from the periodic table chart. The teacher moderated/directed every aspect of the activities during the lesson and encouraged the students to ask questions where necessary.

WEEK THREE: Outside class activities- The researcher/research assistants sent study guideline.

Inside class activities- The teacher introduced the lesson by asking the students to name the materials/items sent to them for the outside class activities. Group discussions and interactions were used by the research assistants.

WEEK FOUR: Outside class activities: Students in the experimental groups received study guideline on chemical reaction to be treated. The study guide contains the following: what is reactant and products? What is rate of chemical reaction? Name the factors affecting rates of chemical reaction. Differentiate between exothermic and endothermic reactions. This enabled the students to be prepared for the lesson.

Inside class activities: The teacher placed the students in groups of five for discussion on the topic using the study guideline. The teacher went round the different groups, monitored and directed the discussions. Class interaction was used to summarize the inside class activities.

Generally, the treatment involved:

- ✓ Outside-class activities
- ✓ Inside-class activities (class time/lesson period)

- ✓ Outside class activities

  - The students were exposed to material/topic before the day of the lesson
  - The students were exposed to the materials/topic using quiz/simple questions that guided them in exploring the material/topic.
  - The materials/topics were accessed through textbooks, more capable peers, internet and mobile phones (mobile video format).
  - Materials were given to the students at least 3-days before the lesson.

- ✓ Inside-class activities/class time: This section involve the following:

  - Question and answer: Questions were posed by the teacher or the students and were mainly based on the material the students were exposed to.
  - Co-operative method: The students were placed in small groups to interact on their findings concerning the material/topic given to them previously. The group activity has a duration of twenty-five minutes,

after which the whole class came together, for a general interaction with the teacher as a facilitator.

- Class discussion: The teacher guided and directed the students on a discussion of the material previously given to them.
- Demonstration, experiments and guided discovery collaborations that involved active participation of the students were also used, as the class time is enough to engage the students.

In the in-class activity part of the flipped classroom, the students were actively engaged in the learning process. Their critical thinking, interest and attitude towards learning were well challenged. The in-class activities involved the teacher sharing ideas with the students and not the teacher talking to the students.

In the use of the flipped classroom instruction (FCI) the students were engaged in active construction of knowledge, build mental models of what is learnt, integrate and apply the content of study. The class time was quite enough to accommodate the use of various active learning approaches, as the students were privileged of having prior knowledge of the material before coming to class.

The pre-test items were rearranged and administered to both experimental and control groups in their various classrooms after the treatments. The items were collected, scored and analyzed. The hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. ANCOVA was used to take care of the initial differences among the groups. In that case pretest scores were used as covariate measures. The decision for the hypotheses was that whenever the Pvalue was less than 0.05, the null hypothesis was rejected; otherwise, the null hypothesis was not rejected.

III. RESULTS

Source of variation	SS	Df	MS	F	Sig.	Decision
Corrected Model	1882.334[a]	4	470.583	91.802	.000	
Intercept	122.046	1	122.046	23.809	.000	
Pretest	499.017	1	499.017	97.349	.000	
Gender	5.990	1	5.990	1.169	.282	NS
Method	134.088	1	134.088	26.158	.000	S
Method*Gender	15.536	1	15.536	3.031	.085	NS
Error	486.976	95	5.126			
Total	149595.000	100				
Corrected Total	2369.310	99				

Table 1: ANCOVA on Interaction Effect of Instructional Approaches and Gender on Students' Participation in Chemistry

HYPOTHESIS 1: There is no significant difference in the mean participation scores of students taught chemistry using FCI and those taught using DI.

Table 1 shows that there was a significant main effect of the treatment on the participation of students in chemistry F (1, 99) = 26.158, P<0.05. Therefore, null hypothesis was rejected. Thus, there is significant difference in the mean participation scores of students taught chemistry using FCI and those taught using DI in favour of those taught using FCI. This is shown in the mean participation scores of the students taught using FCI and DI as shown in table two.

Methods	N	Pretest Mean	Posttest Mean	Gain in mean
FCI	62	36.27	41.15	4.88
DI	38	31.16	33.84	2.68

Table 2: Mean Participation Scores of Students in Chemistry

Table 2 reveals that the students taught chemistry using FCI had higher pretest mean participation score, posttest mean score and gain in mean score in chemistry, than those in the control group taught using DI.

HYPOTHESIS 2: There is no significant difference in the mean participation scores of male and female students.

Table 1 also shows that there was no significant main effect due to gender on the participation of students in chemistry F (1, 99) = 1.169, P>0.05. Therefore, null hypothesis was not rejected. Thus, there is no significant difference in the mean participation scores of male and female students.

HYPOTHESIS 3: There is no significant interaction effect of teaching methods and gender on the participation of the students in chemistry.

Table 1 further shows that there was no significant interaction effect of teaching methods and gender on participation of students in chemistry F (4, 99) = 3.031, P>0.05. Therefore, null hypothesis was not rejected. Thus, there is no significant interaction effect of teaching methods and gender on students' participation in chemistry.

IV. DISCUSSION

The finding of the study shows that FCI effectively increased the participation of students and was significant when compared to those taught using DI. The result of the finding suggests that FCI has many learning activities that students can participate in than the DI. This is in line with the findings of Kurtz (2014) who reported that FCI provides opportunities that will enable the teacher create different learning activities that can address students' differences in such a manner that typical lecture method alone cannot do. FCI, being a student-centred strategy contributed to the higher mean participation scores of the chemistry students. This agrees with the view of Willis (2014) that flipped instruction consists of activities that enable students to participate effectively in the learning process. Murray and Lang (1997) also pointed out that students who participate actively in a learning process will learn the subject matter more effectively than students taught in the traditional lecture approach. This agrees with the findings of Ikonta and Maduekwe (2005) who reported that students taught with new strategy other than what was conventional, recorded a significantly better performance.

The findings of the study also revealed that gender is not a significant factor in students' participation in learning. The result further showed no significant interaction effect of teaching methods and gender on chemistry students' participation. Although, research studies has explicitly reviewed or experimented gender dimension in students' participation, Abdullah, Bakar and Mahbob (2012) showed that in two out of the three classes observed, female students

had greater participation scores than the male counterparts and their findings contradicts the findings of this study. The findings of the study is in contrast from that of Ojo (2004) who found out that male students performed significantly better than females in mathematics. The data from the results revealed a no gender difference in chemistry students' mean achievement scores when taught periodic table and chemical reactions.. The finding contrast that of Enechi (2013) who reported that male students achieved higher in chemistry than their female counterparts. Jegede (2007) also pointed out that gender has impact on students' achievement in chemistry and other science related subjects.

V. RECOMMENDATION

In the light of the findings of the study, the researcher recommends the following:

- ✓ Serving teachers may not very familiar with flipped classroom instruction and its benefits; seminars, workshops and conferences should be organized by relevant professional bodies and the government to educate them on FCI.
- ✓ Curriculum planners should incorporate FCI in the curriculum for pre-service teachers in order to popularize the approach among trainee teachers

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