

Improving Students' Achievement and Retention in Biology using Flipped Classroom and Powerpoint Instructional Approaches: Implication for Physics Teaching

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Abstract

In Enugu State, Nigeria, the study determined the efficacies of Flipped classroom and PowerPoint instructional approaches on students' achievement and retention in biology. Anon-equivalent groups quasi-experimental research design was used for the study with a sample size of 79 students. Students' achievement and retention in Biology were measured using Biology Achievement Test (BAT). Using Kuder-Richardson 20 (K-R20) formula, the internal consistency reliability coefficient of BAT was calculated to be 0.89. The test-retest method was used to assess the temporal stability of the reshuffled form of BAT, which was then subjected to Pearson correlation coefficient which yielded a correlation coefficient of 0.91. To answer the research questions, the data were analysed using mean and analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The study found that both flipped classroom and powerpoint instructional approaches enhanced students' biology achievement and retention. However, flipped classroom instructional approach was significantly ($p < .05$) more effective in enhancing biology students' achievement and retention than powerpoint. Based on the findings of the study, it was recommended that science teachers/science educators should adopt flipped classroom instructional approach for teaching biology and other science subjects like physics.

Keywords: Achievement, biology, flipped classroom, powerpoint, retention, science teaching

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I. Introduction

Biology is a field of natural science that is concerned with study of living things. Biology has a great position in the secondary school education curriculum due to its significance as a life science. However, in spite of students' preference of biology to physical science subjects like chemistry and physics, students underachieved in biology external examinations (Araoye, 2013; Nwagbo & Okoro, 2014; Ogundiwin, Osaaju, Adegoke & Ojo 2015). This is further substantiated by the WAEC chief examiner's report. Also, in Enugu state for instance where this study was carried out, there is poor achievement in external examinations (The tide news online, 2016). In addition, WAEC chief examiner's report of 2016 and 2017 observed improvement in students' achievement in biology. Although students' achievement improved in 2016 and 2017, 2018 WAEC Chief Examiners Report observed a decline in achievement of students in biology in external examinations. However, several recent studies have noted the decline in the achievement of learners in science subjects including Biology (Ugwuanyi et al., 2019a; Ugwuanyi et al., 2019b; Ugwuanyi & Okeke, 2020; Agboeze et al., 2020; Ugwuanyi, Okeke & Njeze, 2020; Ugwuanyi, Okeke, & Ageda, 2020; Onah et al., 2020; Njoku et al., 2020; Benson et al., 2020; Inyama, Nwagbo & Ugwuanyi, 2020; Ugwuanyi et al., 2020a). This fluctuation in students' achievement in biology, and not able to attain high achievement in the subject create gap that necessitated more studies in students' achievement in biology. Studies have also shown that instructional approaches influence students' achievement in biology (Nwagbo, 2006; Ugwu & Nzewi, 2015). In fact, research conducted by various science educators such as Abimbola (2013); Olorundare (2014); have shown that students performed poorly in science subjects.

However, there are several factors responsible for students' poor achievement in biology. These factors as revealed in literature include; lack of adequate instructional materials, poor instructional approach, lack of adequate laboratory activities (Ibitoye & Fape, 2007; Okebukola, 2004), use of ineffective method of teaching (Ezenwosu & Nworgu, 2013; Okoyefi, 2014), over loaded biology syllabus (Osuafor & Okigbo, 2013). Buttressing the above assertion on the causes of decline in students' achievement in biology examinations, ineffective instructional approaches used by teachers at senior secondary school level in Nigeria have been described as one of the major factors leading to students' poor achievement in biology examinations (Gambari, Yaki, Gana & Ughovwa, 2014). In line with this, Omoniyi (2006) revealed that poor instructional approaches lead to poor achievement and retention in science. Students' retention of biology contents is facilitated by instructional approach as this will enable them link the present learning with previous learning.

In line with the above, retention is the act of remembering or the ability to recall or recognize what has been learnt or experienced. Probably, if what has been learnt is retained, it may lead to higher achievement because retention is measured in collaboration with achievement (Iji, 2010). Retention is also the ability to store facts and remember things easily (Aninweze, 2014). This implies that if there is no proper storage structures developed in the learners, information recalling may be stained and consequently resulting to poor achievement. Many researchers such as Ogbonna (2007); Okereke (2006), have carried out studies in the past on retention in various fields, and all viewed retention as an important sustenance of achievement. This is supported by the assertion of Osemwinyen (2009) that poor achievement and retention in biology is as a result of poor instructional approach such as lecture/ expository approach, demonstration, discussion and so on. These poor instructional approaches place a greater emphasis on information transfer through memorization (Ibe & Nwosu,

2003). The shortcomings of these traditional instructional approaches resulted to the persistent search by researchers for innovative ways to stimulate effective teaching/learning of Biology.

Innovative instructional approach is a proactive approach to integrate new teaching methods into classroom. It encourages the teachers and students to explore and use all tools to uncover something new. Innovative instructional approaches help the students to develop creativity and problem-solving skills thereby fostering achievement and retention. The teacher serves as a facilitator, motivating and guiding students to construct their own knowledge (Guisti,2008). Examples of innovative instructional approaches are computer aided instruction, computer animation, cooperative learning, simulation, jigsaws, inquiry- based learning, powerpoint, flipped classroom and so on

Furthermore, research have been conducted on some of the innovative instructional approaches in the area of biology and the researchers advocated for their use in biology teaching since they are activity-based as well as ensure interactive, collaborative and tension- free classroom among learners (Ibe, 2004; Nzewi & Ibeneme, 2011).The innovative instructional approaches develop creativity in students and enhances students' achievement and retention in Biology. Hence, much attention should be placed on instructional approaches for students' active participation in learning. Therefore, there is need to focus research on innovative instructional approach that is technology based which could enhance effective teaching and learning.

Technology has become a fast-growing delivery tool in all educational institutions at all levels with the increased availability of the internet, computers, smart phones, Television, videotapes and other educational application. A considerable number of researches have been conducted on several of these technological media devices in identifying the kinds of educational contributions they can make to improve the teaching and learning of science in schools. Today's secondary school students live in a world of immediate gratification, with technology pervasive in their everyday lives. Teachers are faced with the challenge of creating lessons that are both inspiring and able to integrate the skills and techniques that students are familiar in and proficient in using when they have students like this. The flipped classroom evolved as a result of a desire to meet students' needs, develop 21st- century skills, and integrate technology into everyday teaching (Bishop & Verleger, 2013; Roeh, Reddy & Shannah, 2013).

The flipped classroom is one of the digital technologies in education for encouraging students to participate in active learning. The flipped classroom is a method of teaching and learning in which students watch a video lesson or recorded lectures outside of class while participating in hands on activities in class. The flipped classroom, also known as the reverse classroom, inverts the standard classroom model with homework done in class and lectures watched at home. The flipped classroom is a form of blended learning that combines face-to-face learning in the classroom with group discussion and learning outside of the classroom with video lessons and online collaboration. The flipped classroom allows the student to have a deeper learning experience when the teacher guides them through the material. The lower cognitive work is done at home while the higher cognitive learning is done in class with the teacher. The teacher in this case serves as a facilitator, motivating, guiding, and providing input on students' results (Bergmann & Sams, 2012). Hence, by using a flipped classroom approach to teaching and learning practices, the teacher can prepare lesson videos, and students can watch them outside of class. The flipped classroom allows students to watch the videos at their leisure and study at their own pace. This type of activity also increases student's collaborative learning outside of the classroom in distance education. As a result of flipping the class, the students can spend less time in the classroom listening

to lengthy lectures and more time solving in problems individually or collaboratively. The position of classroom instruction and out-of-class homework is reversed in a flipped classroom(also known as flipped learning or inverted learning). Before class students are given instructional materials, which usually include a video lecture that the teacher has prepared ahead of time (Overmeyer, 2012). According to Ugwuanyi et al. (2019b), the flipped classroom instructional approach involves assigning video lectures to the students for homework instead of the traditional classroom instructional lectures. Students watch the videos lessons at home and then return to class with a basic understanding of the subject information imparted by the video and collaborate with the teacher and peers to complete what is commonly known as homework in class. Similar to flipped classroom as a digital instructional approach is the power point instructional approach.

PowerPoint is a program that allows teacher to present their lessons in a more dynamic way than simply teaching and writing on the chalkboard. Teachers can focus on the class and interact with the students instead of writing on the chalkboard, because the text and the entire presentations are already there in the form of point file. Lengthy materials can readily be summarized and presented. Power point is a presentation software tool that is used in over 30 million presentations per day and is installed on 250 million computers around the world (Alley & Neeley, 2005). Powerpoint was created to improve learning by creating more organized and engaging presentations for the audiences (Amare, 2006). Power point presentations (PPPs) can be as straightforward as simple as text on a coloured screen. Tables, images, graphs, sound effects, visual effects, clips and other elements may be used in more complex presentations. Students who were exposed to PPPs as a teaching tool reported that their grades (Ugwuanyi, Nwankwo & Ugwuoke, 2016, Ugwuanyi et al., 2020a).

Several recent studies have shown that information technology approaches have a positive impacts on students' science achievement (Ugwuanyi et al., 2019a, 2019b; Ugwuanyi et al., 2020a, 2020b, 2020c; Ugwuanyi & Okeke, 2020), Social Science (Ejimonye et al., 2020a, 2020b) and Mathematics (Onah et al., 2020) However, None of those studies was conducted using Biology students. As a result, one can infer that in order to improve students' academic performance, contemporary instructional approaches involving technology (Flipped classroom and powerpoint) should be incorporated into biology education. This work was necessitated by the need to assess the efficacies of flipped classroom and powerpoint on biology students' achievement and retention. Based on the purpose of the study, the following hypotheses were formulated and tested at 0.05 level of significance to guide the study.

H₀: There is no significant difference in the mean achievement scores of students taught biology using flipped classroom and those taught with powerpoint presentation.

H₀: There is no significant difference in the mean retention scores of students taught biology using flipped classroom and those taught with powerpoint presentation approach.

II. Method

Design of the study and study site

A non-equivalent groups quasi-experimental research design was used in the study. The research was conducted in Obollo Afor Education zone of Enugu State.

Participants

All four thousand, eight hundred and twenty- eight (4,828) Secondary School Two (SS 2) Biology students in Forty- eight (48) public Secondary Schools in Obollo-Afor made up the study's population. The sample size comprised of seventy- nine (79). For sampling, multistage sampling procedure was used: purposive and simple random sampling (Balloting without replacement).

Validation and reliability of measure

The instrument for data collection was Biology Achievement Test (BAT). The instrument was developed by the researchers. BAT contained forty (40) multiple- choice items developed from contents the students were taught among which are: supporting tissues in animals, axial skeleton, appendicular skeleton and joints whose development was guided by test- blue print in order to ensure its content validity. Three (3) experts from the Science Education Department, University of Nigeria, face – validated the BAT, flipped classroom(FC)and powerpoint(PP) CD-ROM containing biology instructions, Lesson notes and marking guide. Using the Kuder-Richardson 20 (K-R 20) formula,the internal consistency reliability coefficient of BAT was calculated to be 0.89. The estimate of temporal stability of reshuffled form of BAT was determined using test-retest method and was subjected to Pearson correlation coefficient that yielded a correlation coefficient of 0.91.

Procedure

Prior to the experiment, students in both study groups took pretest on BAT. After the pre-test, both the flipped classroom (FC) and powerpoint (PP) groups were taught supporting tissues in animals for a period of three weeks. For the flipped classroom group, a day before class, the students were given DVD containing the biology topic of next class to be watched at home. Also prior to class, the flipped classroom group were paired and given CD-ROM containing video lesson on the topics selected to watch in the computer laboratory, without the teacher's guidance for 15 minutes. This made the students to have the basic knowledge of the content that will be taught in the class. The powerpoint group was not given CD-ROM to watch prior to class. Teachers used power point to teach them in class. The fourth week was assigned to post- testing. After two weeks, the reshuffled form of BAT was administered to both groups to test their retention. In all, seven weeks were used for the study from the training stage to the administration of the reshuffled form of BAT.

Ethical approval statement

Ethical approval for the conduct of this study was granted by the research ethical committee of the authors' university. Prior to the conduct of the research, the participants were given informed consent forms to read, fill and sign accordingly.

Data analysis

Data collected were analyses using mean and Analysis of Covariance (ANCOVA). The research questions were answered using mean while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA).

III. Results

The results of this study were presented in line with the research questions and hypotheses that guided the study.

Research Question 1: What is the efficacy of flipped classroom and power point instructional approaches on students' achievement in Biology?

Table 1: Mean and Standard deviation of achievement scores of students taught biology using flipped classroom and power point

| Group | Pretest | | | Posttest | | Mean Gain |
|-------------------|---------|-----------|------|-----------|-------|-----------|
| | n | \bar{X} | SD | \bar{X} | SD | |
| Flipped Classroom | 40 | 33.03 | 9.15 | 73.85 | 11.30 | 40.83 |
| PowerPoint | 39 | 30.38 | 9.37 | 60.79 | 8.88 | 30.41 |

Table 1 shows that the students taught biology using flipped classroom approach had pretest mean achievement score of ($M = 33.02$, $SD = 9.15$) and a posttest mean achievement score of ($M = 73.85$, $SD = 11.37$), while the students taught biology using powerpoint approach had pretest mean achievement score of ($M = 30.38$, $SD = 9.37$) and a posttest mean achievement score of ($M = 60.79$, $SD = 8.88$). The mean gain scores of 40.83 and 30.41 for the students in the flipped classroom group and those in the powerpoint group respectively indicate that the students in the flipped classroom group had higher posttest mean achievement score than their counterparts in powerpoint group.

Ho: There is no significant difference in the mean achievement scores of students taught biology using flipped classroom and those taught with power point

Table 2: Analysis of covariance (ANCOVA) of the difference in the mean achievement scores of students taught biology using flipped classroom and those taught with powerpoint instructional approaches

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Remark |
|-----------------|-------------------------|----|-------------|---------|------|--------|
| Corrected Model | 3643.926 ^a | 4 | 910.981 | 8.758 | .000 | |
| Intercept | 21378.023 | 1 | 21378.023 | 205.528 | .000 | |
| Pretest | 276.986 | 1 | 276.986 | 2.663 | .107 | |
| Treatment | 2721.521 | 1 | 2721.521 | 26.165 | .000 | S |
| Error | 7697.112 | 74 | 104.015 | | | |

| | | |
|-----------------|------------|----|
| Total | 370273.000 | 79 |
| Corrected Total | 11341.038 | 78 |

Table 2 shows that there is a significant difference in the mean achievement scores of students taught biology using flipped classroom and power point instructional approaches, with those taught using flipped classroom having a higher mean achievement, $F(1, 74) = 26.165, p < .05$. Since the associated probability value of 0.000 was less than 0.05 level of significance, the null hypothesis was rejected. Thus, inference drawn therefore was that flipped classroom instructional approach enhanced students' achievement in biology better than powerpoint.

Research Question 2: What is the efficacy of flipped classroom and power point instructional approaches on students' retention in Biology?

Table 3: Mean and Standard deviation of post-test scores and retention scores of students taught biology using flipped classroom and those taught with power point.

| Group | Posttest | | | Retention Test | | Mean Gain |
|-------------------|----------|-----------|-------|----------------|------|-----------|
| | n | \bar{X} | SD | \bar{X} | SD | |
| Flipped Classroom | 40 | 73.85 | 11.30 | 75.83 | 8.43 | 1.98 |
| PowerPoint | 39 | 60.79 | 8.88 | 62.05 | 9.24 | 1.26 |

Table 3 shows that the students in flipped classroom group had post-test mean score of ($M = 73.85, SD = 11.30$) and a retention mean score of ($M = 75.83, SD = 8.43$), while the powerpoint group students had post-test mean score of ($M = 60.79, SD = 8.88$) and a retention mean score of ($M = 62.05, SD = 9.24$). The mean gain scores of 1.98 and 1.26 for the students in the flipped classroom group and those in the powerpoint group respectively indicate that the students in the flipped classroom group had higher mean retention score than their counterpart.

H₀: There is no significant difference in the mean retention scores of students taught biology using flipped classroom and those taught with power point instructional approaches.

Table 4: Analysis of covariance (ANCOVA) of the difference in the mean retention scores of students taught biology using flipped classroom and those taught with power point instructional approaches

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Remark |
|-----------------|-------------------------|----|-------------|--------|------|--------|
| Corrected Model | 4140.538 ^a | 4 | 1035.135 | 16.614 | .000 | |

| | | | | | | |
|-----------------|------------|----|----------|--------|------|---|
| Intercept | 2750.411 | 1 | 2750.411 | 44.145 | .000 | |
| Posttest | 1377.130 | 1 | 1377.130 | 22.104 | .000 | |
| Treatment | 563.351 | 1 | 563.351 | 9.042 | .000 | S |
| Error | 4610.449 | 74 | 62.303 | | | |
| Total | 374183.000 | 79 | | | | |
| Corrected Total | 8750.987 | 78 | | | | |

Table 4 shows that there is a significant difference in the mean retention scores of students taught biology using flipped classroom and power point instructional approaches, with those taught using flipped classroom having a higher mean retention score, $F(1, 74) = 9.042, p < .05$. Since the associated probability value of 0.000 was less than 0.05 level of significance, the null hypothesis was rejected. Thus, inference drawn therefore was that flipped classroom instructional approach enhanced students' retention in biology better than powerpoint.

IV. Discussion

This finding showed that flipped classroom and powerpoint enhance students' achievement in biology. The increase in students' achievement observed in this study after being introduced to flipped classroom and powerpoint instructional approaches supports Vygotsky's theory of learning, which notes that students acquire a new information by social interaction with others. This encourages students to participate actively in the learning process. The study's high achievement backs up Bandura's social learning theory, which states that people learn new knowledge and behaviour by watching others. Students in flipped classroom gain knowledge by watching recordings of lessons and are required to learn complex new skills with little verbal instruction. Students in powerpoint gained knowledge after watching the slides.

However, it was further confirmed that there is a significant difference in the mean achievement scores of students taught biology with flipped classroom approach and those taught with powerpoint instructional approach in favour of those taught with flipped classroom. This finding is in agreement with the finding of Baki and Khaled (2016) who reported that students taught mathematics using flipped classroom performed significantly better than those taught that using conventional lecture method. It also agrees with the findings of Muhammad and Falalu (2016) who revealed that flipped classroom model enhances achievement of students in understanding the properties of matter concept in integrated science. Similarly, Ugwuanyi et al. (2019b), found that flipped classroom instructional approach enhanced students' achievement in physics. Ugwuanyi et al. (2020a) found that animated powerpoint presentation had significant effect on the students' achievement in physics. This result which showed that flipped classroom enhanced students' achievement better than powerpoint might be because flipped classroom instructional approach provides the students the opportunity to watch the learning video before class, that is, it provides the students the opportunity to gain first exposure prior

to class and increases interaction of the students with the teacher in class. This outcome is consistent with findings of Nwagbo (2006); Ugwu and Nzewi (2015) which pointed out that instructional approach affects the quality of output of instruction in science.

This finding showed that flipped classroom and power point significantly enhanced students' retention in the biology. This finding agrees with Okeyefi (2014), Aninweze(2014) and Chukwu (2011) that emphasized that biology teachers need to use innovative approach for students to retain learned concepts. It was further confirmed that there is a significant difference in the mean retention scores of students taught biology with flipped classroom approach and those taught with powerpoint instructional approach in favour of those taught with flipped classroom.

This finding is supported by Mankinde and Yusuf (2018) whose findings revealed that that students taught physics using flipped classroom significantly retained higher than those taught with conventional lecture method. This finding that flipped classroom improved students' retention better than powerpoint may be due to the fact that flipped classroom instructional approach encourages students to use video and other pre-recorded media putting learning in their hands. They have the ability to pause, rewind, and fast forward as needed. Students' retention improves as a result of this. Thus, the use of flipped classroom instructional approach provided a basis for improvement of learner' attainment in biology.

Implications for practice in physics teaching

- Teaching of science concepts especially physics can be enhanced when science teachers adopt the use of flipped classroom (FC) instructional approach in schools.
- Secondary school students' achievement and retention in Biology and other related science subjects like physics can be improved by the use of flipped classroom
- Using different experimental designs, the effectiveness of FC can be further proved.

V. Conclusion and Recommendations

The aim of this study was to see how effective flipped classroom and powerpoint instructional approaches are at improving students' achievement and retention in biology. Both technology-based instructional approaches (Flipped classroom and powerpoint) improved achievement and retention in Biology, according to the findings. Students who were taught biology using flipped classroom performed and remembered information better than those who were taught using a powerpoint instructional approach. According to the findings, the following recommendations were made:

1. Teachers should use flipped classroom and powerpoint instructional approaches to teach biology to enhance students' achievement and retention.
2. Teacher education programmes should restructure their special methodology courses to include flipped classrooms. This will enable biology teachers to receive sufficient flipped classroom training.
3. Flipped classroom and powerpoint instructional approaches should be included by the curriculum planners among the appropriate instructional approaches to teach biology in Nigerian senior secondary schools by curriculum planners.

4. Government should endeavour to equip computer laboratories in schools at all levels of education to enable students and teachers to have access to computers for flipped classroom teaching and learning.

Declaration of conflict of interest.

The researchers do not have any potential conflict of interest to declare.

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