# Effect Of Flip Classroom And Think-Pair-Share Instructional Strategies On Students' Achievement In Biology In Enugu Education Zone

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*Abstract: Effect of flip classroom and think-pair-share instructional strategies on students' achievement in biology in Enugu education zone. Three research questions and four null hypotheses guided the study. A quasi-experimental research design was adopted for the study. The population of the study consisted of 5,213 senior secondary year two biology students in Enugu Education Zone of Enugu state, out of which 144 students were involved in the study. The instrument used for data collection was Biology Achievement Test (BAT) validated by experts from Nnamdi Azikiwe University, Awka with a reliability coefficient of 0.81. The research questions were answered using mean and standard deviation. The null hypotheses were tested at 0.05 level of significance using Analysis of Covariance. The findings revealed think–pair-share instructional strategy was significantly more effective in improving students' achievement in biology than flipped classroom instructional strategy and conventional method. Flipped classroom instruction also significantly improved achievement more than conventional method. The authors recommended that school administrators should organise seminars and workshops on how to adopt and use Think-Pair-Share instructional strategy in the teaching and learning of biology.*

*Keyword: flip classroom, think-pair-share, achievement, biology, achievement*

## I. INTRODUCTION

Biology is defined as the science that deals with the study of living things, it attempts to understand the teeming diversity of life on earth which we are all part of (Ramalingam, 2016). It is a branch of science that involves the systematic study of living things that ranges from microbial to larger organisms (Asogwa, Muhammed, Asogwa & Ofegbu, 2016). It is an integral science subject which provides contents in the training of students who want to study medicine, nursing, pharmacy, forestry and fisheries among others. At least a credit level pass in biology at Senior Secondary Certificate Examination (SSCE) is a requirement for the study of biology related disciplines at a higher level.

The objectives of the biology curriculum are to prepare students to acquire: adequate laboratory and field skill in biology, meaningful and relevant knowledge of biology, the ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture as well as reasonable and functional scientific attitude (FRN, 2013). In pursuance of the above stated objectives of biology curriculum, the contents and context of the curriculum place emphasis on field studies, guided discovery, laboratory techniques and skills along with conceptual attitude (FRN, 2013). This could be why Pratoomtong (2011) posited that to achieve these objectives of the biology curriculum, emphasis should be placed on the teaching and learning process in order to allow students develop their highest potentials.

Biology teachers however often adopt the teacher centred approach to instruction which is often more suitable for covering large content areas which is common with most biology topics, teaching large number of students and covering the scheme of work This invariably leads to poor achievement of students in those concepts. As a result, research in science

education in Nigeria has continued to seek ways of teaching for meaningful learning of biology concepts among other science subjects. The search for more innovative way of making the teaching and learning of biology more meaningful is further necessitated by the fact, despite the importance of biology, students' achievement have remained generally abysmal.

The West African Examination Council (WAEC) Chief Examiner's Report shows that from 2007 to 2012, the percentage number of students who made credit pass and above was below 40%. From 2013 to 2018, there continuous increase in the percentage number of students who made credit pass and above every year. However, a closer look at the report shows that in 2013, 1,648,363 students enrolled with 51.73% representing 852,699 students who made credit pass and above. In 2014, with 1,365,384 enrolled, 57.42% which is greater the percentage of those of the previous year made credit pass and above. Though the percentage there was higher in 2014, it only represented 766,936 of the students which is less compared to the 852,699 students of the previous year (2013) who made credit pass and above. This trend is also observed in year 2015 and 2016 as well as between 2017 and 2018. The report of the Chief Examiner suggests that instead of a continuous rise in the number of students' making credit passes and above, the number of students rise in one year and fall the next year. This deficient achievement of students in biology is a great concern to many. Asogwa et al. (2016) asserted that the continual poor academic achievement of students in biology calls for closer look into how the subject is taught.

Academic achievement deals with the extent students have gained from a particular course of instruction. According to Omachi (2010) achievement is the scholastic standing of a student's performance at a given moment. Academic achievement is generally regarded as the display of knowledge attained or skills developed in the school subject (Busari, 2011). Ajuar (2006) pointed out that students' academic achievement entails successful academic progress attained through effort and skill. This is often cognitive based and measured by examination or continuous assessment. Hassan (2006) pointed out that effective learning and sound academic achievement contributes to national development. It is something of great importance to parents, teachers and students themselves; even the larger society is aware of the long term effects of high and low academic achievement since the product of schools are expected to shape the destiny of the society. The achievement of students can be improved if they are able to retain what they have been taught in school (Hassan, 2006).

Evidence has shown that there is high rate of failure in biology examinations, which could be traceable to the quality of teaching. The WAEC Chief Examiner's Report (2016) suggested that students' performance in biology could be improved through meaningful and proper teaching. According to the report, teachers should help students develop interest in biology by increasing the level of participation of the students during the learning process of biology. It is pertinent therefore, to look for interventions that could be manipulated in order to find their effects on learning outcomes. This could address the problems of teaching and learning of biology in schools. The use of flipped classroom instruction and think-pair-share instructional strategy in teaching biology is activity-oriented and could bring about active participation during lesson. Based on this, the researcher sought to use flipped classroom instruction and think-pair-share instructional strategies in teaching biology students two units of SS2 biology contents and compared their effects with teaching using conventional method.

A flipped classroom instructional strategy is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom (Alvarez, 2011). It moves activities, including those that may have traditionally been considered homework, into the classroom. In a flipped classroom, students watch online lectures, collaborate in online discussions, or carry out research at home while engaging in concepts in the classroom with the guidance of a mentor. The flipped classroom intentionally shifts instruction to a learner-centered model in which class time explores topics in greater depth and creates meaningful learning opportunities, while educational technologies such as online videos are used to 'deliver content' outside of the classroom. In a flipped classroom, 'content delivery' may take a variety of forms. Often, video lessons prepared by the teacher or third parties are used to deliver content, although online collaborative discussions, digital research, and text readings may be used (Lakmal & Dawson, 2015).

There may also be a symbiosis or complementation between the flipped classroom technique and cooperative learning. Schoolwork, also commonly known as "homework", is done jointly and in cooperation with the group as the teacher moves the time spent explaining the subject to the flipped classroom method. In this way, the student has to assimilate and understand the content of more theoretical weight at home, through the recordings made by the teacher. The time in class is dedicated to the development of tasks and problem solving and/or doubts through cooperative learning such as think-pair-share.

Think-pair-share is a strategy designed to provide students to think on a given topic by enabling them to formulate individual ideas and share the ideas with another student (Abdurrahman, 2015). To implement the think-pair-share cooperative strategy, the teacher poses a question, preferably one demanding analysis, evaluation, or synthesis, and gives students about one minute to think through the appropriate responses during the teaching and learning process. Students then turn to a partner and share their responses. During the third step, student's responses can be shared within a four-person learning team, within a larger group, or with an entire class during a follow-up discussion unlike in conventional teaching methods.

Conventional method of teaching is a teacher-centered, student-peripheral teaching approach in which the teacher delivers a pre-planned lesson to the students with or without the use of instructional materials (Asogwa et al, 2016). According to her, in using this method, the teacher 'talks about the subject' while the students 'read about the subject'. However, conventional method as will be used in this study involves more than 'talking' and 'reading' about biology for it

allows some interaction between the teacher and the students in terms of asking and being asked questions on the topic of discussion. Thus, to some extent this interaction can help to improve the achievement of biology students irrespective of gender.

## PURPOSE OF THE STUDY

The purpose of this study was to investigate the effects of flipped classroom instruction and think-pair-share instructional strategy on students' achievement in biology. Specifically, the study sought to determine the:
✓ Difference in the mean pretest and posttest achievement scores of students taught biology using flipped classroom instruction (FCI), think-pair-share instructional strategy (TPSIS) and those taught using conventional method.
✓ Difference between the mean achievement scores of male and female students taught biology using FCIS.
✓ Difference between the mean achievement scores of male and female students taught biology using TPSIS.
✓ Interaction effect of instructional strategies and gender on the achievement of students in biology.

## RESEARCH QUESTIONS

The following research questions guided the study:
✓ What is the difference between the mean pretest and posttest achievement scores of students taught biology using flipped classroom instructional strategy (FCIS), think-pair-share instructional strategy (TPSIS) and those taught using conventional method?
✓ What is the difference between the mean achievement scores of male and female students taught biology using FCIS?
✓ What is the difference between the mean achievement scores of male and female students taught biology using TPSIS?

## HYPOTHESES

The following null hypotheses were tested at 0.05 level of significance:
✓ There is no significant difference between the mean pretest and posttest achievement scores of students taught biology using flipped classroom instructional strategy (FCIS), think-pair-share instructional strategy (TPSIS) and those taught using conventional method.
✓ There is no significant difference between the mean achievement scores of male and female students taught biology using FCIS.
✓ There is no significant difference between the mean achievement scores of male and female students taught biology using TPSIS.
✓ There is no interaction effect of instructional strategies and gender on the achievement of students in biology.

## II. METHOD

The design adopted for the study is quasi-experimental, specifically the pretest-posttest non-equivalent control group design. The area of the study is Enugu Education Zone of Enugu state. The population of the study is 5,213 SS2 biology students in Enugu Education Zone of Enugu State (Source: Post Primary School Management Board, Enugu). The sample for the study is 144 senior secondary school year two (SS2) biology students which was drawn using a multi-stage sampling procedure. The instrument for data collection is Biology Achievement Test (BAT). The BAT is made of 20 objective questions drawn from past WAEC questions on the selected biology topics with each question having answer option lettered A-D. A table of specification was used to ensure that adequate number of questions were included from each content area taught. The instrument was validated by experts from Nnamdi Azikiwe University, Awka. The reliability of the BAT was established using Kudder-Richardson Formula 20 (KR-20) which yielded a reliability coefficient of 0.81.

The treatment was conducted in two phases. The first phase was the training of the research assistants. The second phase was the treatment for the experimental groups and control group. The experimental groups one and two received treatments using FCIS and TPSIS respectively. In experimental group one, the treatment using FCIS involved the students doing most of the learning outside the classroom with the teacher acting as a facilitator. In the flipped classroom, the teacher provided the students with study hints and guide on what they are expected to know at the end of their study. With the guide and content of learning, the teacher gave students the websites to visit to log in and study on the topic. Students were assigned to internet enabled laptops on which they are to surf internet and watch third party tutorials, videos, animations and text book explanations on the concept being studied. Students were required to write down the knowledge gained to be shared in the classroom during the normal classroom classes.

In the think-pair-share classroom, students were assigned numbers one to four. For each week, students were paired differently after the instruction. In week one, all students assigned one, paired with other students assigned one, same for students with numbers two through to four. In the second week, odd number students were paired together and even numbers too. In the third week, odd numbered students were paired with even numbered students. In the fourth week, students were allowed to choose their partners at random. The essence of the variation in pairing was to ensure that students interact with a good number of other students during their pair activity all through the treatment. In each lesson, the teacher introduced a concepts and what is to be learnt in the classroom, give a brief explanation and ask students to think and read the concept, after that, students were allowed to pair with others. The pairing exercise involved students discusses and sharing ideas only among the pair to further understand what their read and thought about. After the pairing, the students were called at random to explain what they learnt or given exercise to do which were marked by their pairs in the next lesson. The control group were taught using conventional

method. Students in the control group were not introduced to the internet and were not involved in any group activities.

BAT was administered as pretest before the commencement of the treatment. This was done without any feedback or revisions. After the treatment, BAT was administered as posttest after the four weeks treatment and as post posttest after three weeks of posttest. The data from each test was collated for analysis. Data relating to the research questions were analyzed using mean and standard deviation. The hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 alpha level. The choice of ANCOVA was to eliminate initial group difference. The decision rule is that the null hypothesis was rejected when Pvalue is less than or equal (P≥0.05) but when Pvalue is greater than 0.05, the null hypothesis will not be rejected.

## III. RESULTS

*RESEARCH QUESTIONS 1:* What is the difference between the mean pretest and posttest achievement scores of students taught biology using flipped classroom instructional strategy (FCIS), think-pair-share instructional strategy (TPSIS) and those taught using conventional method?

| Method | N | Pretest Mean | Pretest SD | Posttest Mean | Posttest SD | Mean Gain |
|---|---|---|---|---|---|---|
| FCIS | 50 | 29.16 | 5.65 | 72.46 | 6.58 | 43.4 |
| TPSIS | 51 | 23.80 | 7.56 | 77.31 | 6.00 | 53.51 |
| CONVENTIONAL | 43 | 28.95 | 4.29 | 69.79 | 4.25 | 40.84 |

*Table 1: Mean Pre-test and Posttest Achievement Scores of Students taught Biology using FCIS, TPSIS and those taught using Conventional Method*

Table 1 shows that the group taught biology using FCIS has mean gain achievement score of 43.4, those taught using TPSIS has mean gain achievement score of 53.51 while those taught using conventional method has mean gain achievement score of 40.84. The spread of score was greatest in the posttest mean of those taught using FCIS (6.58), followed by those taught using TPSIS (6.00), while those taught using conventional method having the least scores spread (4.25).

*RESEARCH QUESTION 2:* What is the difference between the mean achievement scores of male and female students taught biology using FCIS?

| Gender | N | Pretest Mean | Pretest SD | Posttest Mean | Posttest SD | Mean Gain |
|---|---|---|---|---|---|---|
| Male | 23 | 29.61 | 3.26 | 73.09 | 5.00 | 43.48 |
| Female | 27 | 28.78 | 5.97 | 71.93 | 7.80 | 43.15 |

*Table 2: Difference Between the Mean Pre-test and Posttest Achievement Scores of Male and Female Students taught Biology using FCIS*

Table 2 shows that the male students taught biology using FCIS has mean gain achievement score of 43.48 while the females has mean gain achievement score of 43.15. The female students has a more homogeneous score (5.00) in the posttest than the females (7.80).

*RESEARCH QUESTION 3:* What is the difference between the mean achievement scores of male and female students taught biology using TPSIS?

| Gender | N | Pretest Mean | Pretest SD | Posttest Mean | Posttest SD | Mean Gain |
|---|---|---|---|---|---|---|
| Male | 28 | 24.86 | 6.51 | 77.07 | 4.75 | 52.21 |
| Female | 23 | 22.52 | 7.02 | 77.61 | 5.73 | 55.09 |

*Table 3: Mean Pre-test and Posttest Achievement Scores of Male and Female Students taught Biology using TPSIS*

Table 3 shows that the male students taught biology using TPSIS has mean gain achievement score of 52.21 while the females has mean gain achievement score of 55.09. The spread of scores was greatest among the females in the posttest (5.73) than among the male (4.75).

*HYPOTHESIS 1:* There is no significant difference between the mean pretest and posttest achievement scores of students taught biology using flipped classroom instructional strategy (FCIS), think-pair-share instructional strategy (TPSIS) and those taught using conventional method.

| Source of variation | SS | Df | MS | F | P-value | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 1903.353[a] | 3 | 634.451 | 109.572 | .000 | |
| Intercept | 15325.805 | 1 | 15325.805 | 2646.812 | .000 | |
| Pretest | 517.876 | 1 | 517.876 | 89.439 | .000 | |
| Method | 360.419 | 2 | 180.210 | 31.123 | .000 | S |
| Error | 810.641 | 140 | 5.790 | | | |
| Total | 778141.000 | 144 | | | | |
| Corrected Total | 2713.993 | 143 | | | | |

*Table 4: ANCOVA on Difference between the Mean Achievement Scores of Students taught using FCIS, TPSIS and those taught using Conventional Method*

Table 4 shows that at 0.05 level of significance, 1df numerator and 143 df denominator, the calculated F is 31.123 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is a significant difference between the mean pretest and posttest achievement scores of students taught biology using flipped classroom instructional strategy (FCIS), think-pair-share instructional strategy (TPSIS) and those taught using conventional method.

| (I) Method | (J) Method | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| FCIS | TPSIS | -1.647* | .587 | .006 | -2.807 | -.487 |
| | CLM | 2.793* | .501 | .000 | 1.803 | 3.783 |
| TPSIS | FCIS | 1.647* | .587 | .006 | .487 | 2.807 |
| | CLM | 4.440* | .595 | .000 | 3.263 | 5.617 |
| CLM | FCIS | -2.793* | .501 | .000 | -3.783 | -1.803 |
| | TPSIS | -4.440* | .595 | .000 | -5.617 | -3.263 |

*Table 5: Scheffe PostHoc Analysis on Significance of Mean Difference in Achievement between Groups*

Table 5 reveals that significant difference exists between the mean biology achievement scores of students taught using FCIS and TPSIS in favour of TPSIS. Table 5 also reveals that a significant difference exists between the mean biology achievement scores of students taught using FCIS and conventional method in favour of FCIS. Table 5 further shows that there is significant difference between the mean biology achievement scores of students taught using TPSIS and conventional method in favour of TPSIS. This shows that the direction of significance moves from TPSIS followed by FCIS.

*HYPOTHESIS 2:* There is no significant difference between the mean achievement scores of male and female students taught biology using FCIS.

| Source of variation | SS | Df | MS | F | P-value | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 18.418[a] | 2 | 9.209 | 4.162 | .022 | |
| Intercept | 2163.355 | 1 | 2163.355 | 977.648 | .000 | |
| Pretest | 1.676 | 1 | 1.676 | .757 | .389 | |
| Gender | 18.020 | 1 | 18.020 | 8.143 | .006 | S |
| Error | 104.002 | 47 | 2.213 | | | |
| Total | 262645.000 | 50 | | | | |
| Corrected Total | 122.420 | 49 | | | | |

*Table 6: ANCOVA on Difference between the Mean Achievement Scores of Male and Female Students taught using FCIS*

Table 6 shows that at 0.05 level of significance, 1df numerator and 49df denominator, the calculated F is 8.143 with Pvalue of .006 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is a significant difference between the mean achievement scores of male and female students taught biology using FCIS in favour of the males.

*HYPOTHESIS 3:* There is no significant difference between the mean achievement scores of male and female students taught biology using TPSIS.

| Source of variation | SS | Df | MS | F | P-value | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 89.329[a] | 2 | 44.665 | 5.961 | .005 | |
| Intercept | 3786.441 | 1 | 3786.441 | 505.348 | .000 | |
| Pretest | 85.684 | 1 | 85.684 | 11.436 | .001 | |
| Gender | 6.474 | 1 | 6.474 | .864 | .357 | NS |
| Error | 359.651 | 48 | 7.493 | | | |
| Total | 305297.000 | 51 | | | | |
| Corrected Total | 448.980 | 50 | | | | |

*Table 7: ANCOVA on Difference between the Mean Achievement Scores of Male and Female Students taught using TPSIS*

Table 7 shows that at 0.05 level of significance, 1df numerator and 50df denominator, the calculated F is 0.864 with Pvalue of .357 which is greater than 0.05. Thus, the null hypothesis was not rejected. Therefore, there is no significant difference between the mean achievement scores of male and female students taught biology using TPSIS.

*HYPOTHESIS 4:* There is no interaction effect of instructional strategies and gender on the achievement of students in biology.

| Source | SS | df | Mean Square | F | Sig. | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 2073.983[a] | 6 | 345.664 | 73.992 | .000 | |
| Intercept | 9189.624 | 1 | 9189.624 | 1967.123 | .000 | |
| Pretest | 164.895 | 1 | 164.895 | 35.297 | .000 | |
| Method | 332.635 | 2 | 166.317 | 35.602 | .000 | |
| Gender | 145.699 | 1 | 145.699 | 31.188 | .000 | |
| Method * Gender | 58.270 | 2 | 29.135 | 6.237 | .003 | Sig |
| Error | 640.010 | 137 | 4.672 | | | |
| Total | 778141.000 | 144 | | | | |
| Corrected Total | 2713.993 | 143 | | | | |

*Table 8: ANCOVA for Testing of Interaction Effect of Teaching Strategies and Gender on Students' Biology Achievement*

Table 8 shows that at 0.05 level of significance, 1df numerator and 143 df denominator, the calculated F is 6.237 with Pvalue of .003 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is interaction effect of instructional strategies and gender on the achievement of students in biology.
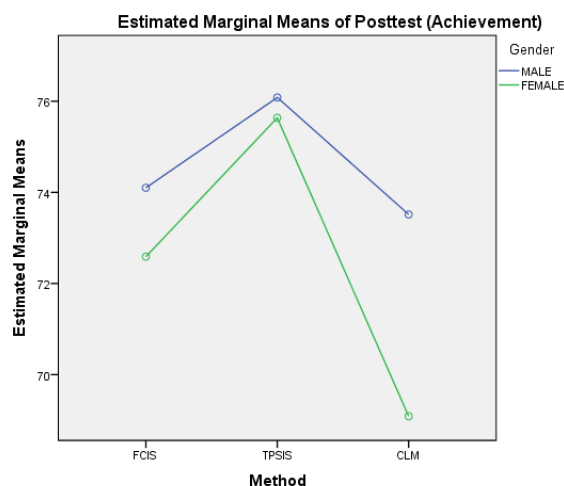


Covariates appearing in the model are evaluated at the following values: Pretest (Achievement) = 27.20

*Figure 1: Plot of Interaction Effect of Teaching Strategies and Gender on Students' Biology Achievement*

The plot of the interaction effect between teaching strategies and gender on mathematic achievement is significant and ordinal.

## IV.  DISCUSSION

The finding of the study revealed that students taught biology using think-pair-share instructional strategy (TPSIS) has significantly higher achievement that those taught using flipped classroom instructional strategy. The observed result in favour of TPSIS is due to the fact that the stages of instruction in think-pair-share instructional strategy gave the students a greater level of interaction with the learning material and information as well as a higher personal or individualized responsibility for learning. The first stage which allowed the students to think about a concept question helped the teacher to gain the attention of the students and engage them in a very serious cognitive process which clearly directed their learning towards the objectives of instruction. Students' learning was guided towards learning the expected content with the cognitive questions in the 'think' stage. Having to think first also immediate gave the students a sense of responsibility towards the learning of what was being taught.

The second stage which involved sharing with another student boosted learning achievement since the responsibility to try to share a correct answer made students to prepare and learn the concepts personally. It was observed that after each assignment at the end of the lesson, students studied just to make sure that they have something correct to share at the 'pair' stage after the thinking stage. The improvement in achievement is heightened more by the fact that students had to prepare to share with the larger class and prepared to answer related questions before being called out.

The finding of the study is in line with the findings of Ribhi (2017) that there are statistically differences in grades of students due to group variable and the differences were in favour of the think-pair-share instruction. The findings of the study also supported the findings of Anaduaka, Sunday and Olaoye (2018) that attention-deficit hyperactive students taught mathematics using think-pair-share and cooperative strategy achieved better than those taught with conventional method for both JS2 and SS2 classes.

The finding of the study also showed that students taught using flipped classroom instruction had significantly better achievement than those taught using conventional methods. The result of the study favoured flipped classroom instruction because students' collaboration in online discussion enabled them to explore the topics in greater depths thereby facilitating a proper understanding of the topics. Also, because the lessons were presented in a variety of forms online, students had better learning experience than those in the conventional group. The adoption of flipped classroom instructional strategy also gave students opportunity for more learning activities which enabled them to interact with the learning materials enough to understand them.

The finding of the study lends credence to the findings of Renata (2018) that students in the flipped classroom instruction out-performed those in the traditional group. The findings of the study also supported the findings of Ugwoke, Edeh, and Ezemma (2018) that there a significant difference in the mean achievement of students taught using flipped classroom instruction and those taught using traditional instruction. The finding of the study is also in line with the findings of Asiksoy and Sorakin (2018) that that in comparison to the control group students, the learning achievement of the experimental group taught using flipped classroom students increased significantly.

The findings of the study further showed that think-pair-share instructional strategy also improved achievement in biology significantly better than those in the conventional strategy. Students in the think-pair-share instruction had more learning experience given that they had to think, share with a pair and the larger class. It afforded students the opportunity to ask questions and learn from their classmate those concepts which were difficult to understand and not only form their teacher. The finding of the study is in line with the findings of Adenkunle (2015) that students taught with guided discovery and think-pair-share strategies obtained significantly higher posttest mean scores than those in the lecture strategy. The findings of the study also supported the findings of Ogunyebi (2018) that there was a significant difference between the posttest means scores of students exposed to think-pair share and conventional strategies.

The findings of the study showed that there was significant difference between the mean achievement scores of male and female students taught using FCIP in favour of the male. There was also a significant ordinal interaction of teaching strategies and gender on students' achievement in biology. This showed that when gender was considered, teaching with think-pair-share instructional strategy favoured the males more in terms of achievement than the females. The finding of the study contrasts to the finding of Ribhi (2017) that there are statistically differences due to gender at the significance level (0.05) in favour of females instead of the males. The findings of the study also contrast that finding of Anaduaka, Sunday and Olaoye (2018) that think-pair-share cooperative strategy was not gender biased for both junior and senior students. The findings of the study is in line with the findings of Gambari, Bello, Agboola and Adeoye (2016) on achievement that gender differences with respect to the effects of flipped classroom instructional model on achievement was not significant. The findings of the study also are supported by the findings of Makinde and Yusuf (2018) that no significant difference in the post-performance of both male and female students in flipped classroom was observed.

## V. CONCLUSION

The study established that TPSIS was significantly more effective in improving students' achievement in biology than FCIS and conventional method. FCIS also significantly improved achievement more than conventional method. The study concluded therefore, that TPSIS is most effect strategy for improving students' achievement in learning biology than FCIP and conventional learning strategy.

## VI. RECOMMENDATIONS

Based on the finding and conclusion of the study, the following recommendations were made:
- ✓ Biology teachers in secondary school should adopt and integrate TPSIS in the teaching and learning of biology.
- ✓ School administrators should organise seminars and workshops on how to adopt and use TPSIS in the teaching and learning of biology.

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