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Effects of Flipped Learning Instructional Strategy on Secondary School Students Achievement in Mathematics in Ondo State

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ABSTRACT

This study looked at how well the flipped learning instructional strategy improved mathematics performance and examined whether gender variations affected performance under this technique. Under a quasi-experimental pretest-posttest control group design, one group received treatment using the flipped learning approach, while another group received instruction using traditional techniques. The study focused on Ondo State's senior secondary school (SS2) mathematics pupils. We randomly selected 80 students from four co-educational public Secondary schools in Owo, Ondo State. The Mathematics Achievement Test (MAT) was validated and assessed for reliability using the test-retest approach, producing a reliability value of 0.78. Research questions were examined using mean and standard deviation; hypotheses were tested using a t-test at a 0.05 significance level. Students exposed to flipped learning scored more in mathematics than those taught using traditional approaches, according to the results. While gender variances among students in the flipped learning group were not statistically significant, The performance of the experimental and control groups revealed notable variations. These results imply that, compared to conventional teaching methods, flipped learning is a more efficient instructional tool for raising mathematical performance. Schools should thus advise including flipped learning to improve student achievement. We should also plan professional development programs, such as seminars and workshops, to provide mathematics teachers with the necessary tools to implement this method successfully.

INTRODUCTION

Background of the Study

The expansion of any country's economy, technical innovation, industrial development, and scientific advancement all depend on mathematics in some capacity. Azuka (2015) underlined that mathematics is a fundamental topic since modern society mostly relies on it. Acknowledging its significance, the Federal Republic of Nigeria (FRN, 2013) made mathematics a mandatory course at both elementary and secondary levels of education and a basic requirement for admittance into tertiary colleges. Most people agree that mathematics is a fundamental science as well as a necessary instrument for comprehending fields such as physics, chemistry, engineering, and medicine. National development depends on mastering mathematics; therefore, effective teaching and learning of the subject in educational institutions is crucial to achieving this. The development of mathematics as a topic usually corresponds with the general socioeconomic success of a country.

Many times, people view pupils' mathematical ability as a strong predictor of their future academic and career success. Particularly considering the subject's importance for national development, teachers, researchers, parents, and legislators in Nigeria have grown worried about students' low mathematical ability. The diminishing quality of education has caused increasing frustration among teachers, researchers, parents, and legislators because they doubt the value of their educational investments. Over numerous years including 2010, 2011, 2012, 2015, and 2018 reports by the Chief Examiner of the West African Examinations Council (WAEC) continually show stagnation in mathematical performance among secondary school pupils. Despite several interventions, the subject still shows significantly lower performance levels compared to other subjects. Data revealed between 1991 and 2016 that just 27.31% of students in the May/June WASSCE received grades A1 through C6 in general mathematics, while 72.69% scored between D7 and F9 (Zalmon & Wonu, 2017).

Test results, grades, and degrees of educational attainment are common metrics of academic performance. Peer influence, teacher quality, and school atmosphere significantly shape student results (Badmus, 2021). Beyond personal achievement, student performance also shows the quality of the educational system. Incorporating several instructional methodologies into scientific education improves student learning results, claim Abbas and Idris (2024). Teachers are essential for the learning process; hence, their method of instruction will greatly affect the performance of their pupils. With an eye toward how gender might affect learning outcomes, this study aims to find the effects of the flipped learning method on undergraduate students' academic performance in science-based courses.

Effective pedagogical strategies are crucial in tackling the ongoing problems in mathematics education given the growing worldwide focus on student-centered learning. Daily life still depends on mathematics; hence, the continuous educational changes underline the need

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for efficient professional development for mathematics and science instructors. One cannot emphasize the value of mathematics education in Nigeria since it helps to enhance the nation's material and human resources. A weak mathematical basis often results in stagnation in the development of science and technology. At both the elementary and senior school levels, issues in teaching and learning the topic still garner attention.

Recent worldwide patterns in mathematics education support a change from rote memorization to more conceptual and experiential learning. By advocating for teaching strategies that stress meaningful comprehension over memorization, academics like Sternberg (2017) have shaped changes in the instruction of mathematics. Students' mathematical performance and interest remain low even with the introduction of tactics including discovery learning, inquiry-based learning, and laboratory approaches. The situation demands creative ideas with cultural relevance that could better involve students and enhance results.

Statement of the Problem

The ongoing underperformance of mathematical students remains a major cause of worry. Being a basic discipline in science and technology, mathematics is essential for educating pupils for the challenges of a technologically advanced society. Many students still find the topic difficult, nevertheless, which has wider consequences for national scientific and innovative progress. The government and educational players have responded to these difficulties by starting several projects. These comprise curriculum revisions, teacher retraining initiatives, instructional materials, and the hiring of trained staff. Notwithstanding these initiatives, national performance trends point to many pupils failing to reach the expected mathematical competency levels. With mathematics still a required course, senior secondary school pupils appear for the West African Senior School Certificate Examination (WASSCE) and the National Examinations Council (NECO) tests every year. Still, performance has regularly dropped below expectations. This tendency captures fundamental problems in mathematics instruction and learning. Results from the WASSCE between 2012 and 2017 reflect this low achievement tendency, as Table 1 shows. We need to gain a deeper understanding of the fundamental elements driving this tendency and explore alternative teaching strategies that can enhance learning outcomes. One such strategy with outstanding potential to improve student involvement and performance is the flipped learning method. This study is to evaluate its efficiency, particularly in relation to undergraduate scientific education, and investigate whether gender affects students' academic achievement under this approach.

Table 1: Performance of Nigerian Students in May/June WASSCE General Mathematics (2012–2017)

Year	Total Candidates	Credits (A1–C6)	% with Credits	D7–F9 Grades	% with D7–F9
2012	1,675,224	819,390	49.00%	852,834	51.00%
2013	1,543,683	555,726	36.00%	987,957	64.00%
2014	1,692,435	529,732	31.30%	1,162,703	68.70%
2015	1,593,442	544,638	34.18%	1,048,804	65.82%
2016	1,544,234	597,310	38.68%	946,924	61.32%
2017	1,559,162	923,486	59.23%	635,676	40.77%

Source: Test Development Division, West African Examinations Council (WAEC), Lagos.

Considering these alarming statistics and the fact that mathematics is subject to the limited classroom time for extensive curriculum coverage, there is a need to enhance classroom teaching with innovative pedagogical approaches to strengthen learning and optimize time for better student achievement in mathematics. The flipped classroom method includes students watching recorded lectures at home, leading to increased participation and collaboration during class time. However, there is still a need to engage students in activities that foster problem-solving skills and a scientific mindset, which are currently lacking due to insufficient laboratory resources and conventional teaching approaches in mathematics. The flipped classroom provides educators with a valuable opportunity to use video lectures, virtual labs, and simulations to enhance students' advanced cognitive functions, improve learning outcomes, and maintain engagement by fostering problem-solving skills. This research aims to examine the effects of flipped learning on secondary school students' mathematics attainment in Ondo State.

Purpose of the Study

This study's main goal is to investigate how flipped learning instructional strategies affect mathematics proficiency among secondary school students.

The study's specific objectives are to:

1. Examine whether students who are taught using the flipped classroom strategy and those who are taught using traditional methods differ significantly in their mathematical achievement.
2. Examine whether the flipped learning method of teaching mathematics affects the academic achievement of male and female students differently.

Research Questions

The following inquiries are the focus of the study:

1. Before the intervention, how did students in the

experimental and control groups do in mathematics?

2. Do the post-test mean scores of the students in the experimental group (flipped learning) and the control group (traditional instruction) differ significantly?

3. What is the difference between the mean performance scores of the male and female students in the experimental group before and after the treatment?

Research Hypotheses

The following null hypothesis will guide the study:

1. The mean pre-test scores of the students in the experimental and control groups do not differ statistically significantly.

2. The mean post-test scores of students who were taught using the flipped learning approach and those who were taught using traditional methods do not differ statistically significantly.

3. The mean pre-test scores for male and female students in the experimental group do not differ statistically significantly.

4. The post-test mean scores for male and female students in the experimental group do not differ statistically significantly.

Significance of the Study

This study carries important consequences for various stakeholders, including learners, tutors, school administrators, curriculum developers, future scholars, and the Ministry of Education and Culture. The study's findings will offer observable proof regarding the impact of reversed learning in mathematics instruction in Nigeria, particularly among mathematics and science tutors. It will give essential guidelines for mathematics instructors on implementing reversed learning-based instructions in teaching and related science concepts. Additionally, the findings will function as a reference and a resource for curriculum designers, educators, and researchers interested in the impacts of employing flipped learning in mathematics and science instruction. Moreover, the outcomes will provide valuable insights to help students develop a better attitude toward mathematics. It will also serve as an information base for the government at various levels (the Ministry of Education) to provide facilities like internet access and equipment needed for the project and to make policies that will permit schools to use the flipped learning method. It will help parents to make provisions for a handset with internet browsing for their children for learning and non-government organizations (NGOs) and other stakeholders in the education sector to assist in creating general awareness of the importance and benefits of flipped learning for our education.

Delimitation of the Study

This research work was delimited to some selected co-educational public secondary schools in the Owo local government area of Ondo State. The teaching topics were delimited to trigonometry and bearing in senior secondary school (SSS). 2. Curriculum for the purpose of this research

LITERATURE REVIEW

Theoretical Review

Constructivism, advocated by Jean Piaget and Lev Vygotsky, emphasizes learner-centered education. This theory suggests that learners develop knowledge through social interactions, language, and real-world experiences. In this approach, the tutor serves as a facilitator, guiding pupils in the learning process. As a collaborative teaching method, flipped learning promotes the development of critical thinking and problem-solving abilities, allowing students to actively construct their understanding. Connectivism theory by George Simmons is also applied to the implementation of flipped learning, an innovative method of teaching that leverages technology and networks through the use of laptops, smartphones, network data, etc.

Recent studies suggest that flipped learning can enhance learner engagement and create a hands-on learning setting, improving the behavioral, emotional, and cognitive dimensions of students' dimensions (Jamaludin and Osman, 2014). Flipped learning can be an effective teaching method, especially as modern students are adept at engaging with media and the internet, facilitating their access to video lectures and aiding in enhancing the growth of analytical and critical thinking abilities (Albalawi, 2018). The flipped classroom strategy acknowledges the variability in learners' learning intervals and durations, making students more adaptable to different learning environments (Hernandez, 2014). Research suggests that reversed learning is more effective for learners who are already academically successful rather than those with average to low performance levels (Calamlam, 2016). The primary aim of the reversed learning approach is to boost students' motivation by considering their abilities, uniqueness, and self-esteem (Aljaser, 2017).

Research indicates that the reversed learning model is efficient in acquiring content (Alsowat, 2016). Numerous studies have shown benefits in discussions or lectures and in practical learning, suggesting that the flipped classroom is conducive to improving learners' understanding in specific subjects (Zainuddin & Halili, 2016, 325-329). Reversed learning can enhance student achievement, learning, and engagement. Learners must maintain self-discipline and motivation to excel academically (Sifakaya & Ozdemir, 2018). Talbert (2017) characterizes the flipped classroom as encompassing collaborative aims establishment, experience planning, and progress assessment toward those goals. Uzoegwu (2014) notes that in flipped learning, the active involvement of all members benefits everyone, leading to a shared common fate among all participants.

Gender and Teaching/Learning Mathematics

Many findings have demonstrated the efficiency of the reversed teaching method in improving pupils' academic

performance, regardless of gender. Researchers such as Abbas and Idris (2024), along with Matazu and Isma'il (2023), advocate for its adoption as a preferred teaching method for science subjects. This study, therefore, implemented the reversed classroom method in science instruction and examined its impact on students' educational outcomes.

The efficiency of the reversed learning method in biology education has been widely explored. In Nigeria, Matazu and Isma'il (2023) conducted quasi-experimental research to compare the reversed classroom method with an improved lecture strategy in genetics education, focusing on students with different VAK (visual, auditory, and kinesthetic) teaching methods in Gusau, Zamfara State. Their findings indicated that visual learning was the most common preference among SS 3 pupils (40.76%), followed by auditory (31.52%) and kinesthetic (27.72%). The research further revealed that both reversed classroom teaching and the improved lecture method led to better educational attainment in genetics compared to the conventional approach, regardless of the pupil's learning styles. Abbas and Idris (2024) investigated how flipped classroom learning influences students' understanding of genetics concepts using a quasi-experimental design with pre-test and post-test measures, along with a non-equivalent control group. Their results indicated that students who learned through the flipped classroom model outperformed those taught using traditional lecture methods. Additionally, the study shows no tangible differences in educational attainment between male and female pupils who participated in flipped classroom learning.

Gender, as a socially constructed concept, encompasses roles, behaviors, and attributes that societies associate with men and women. It highlights the influence of social, cultural, and psychological factors in shaping masculinity and femininity. Gender disparities in education have long been a subject of debate, influencing students' perceptions and academic experiences (Armah *et al.,* 2021). Various studies have explored gender-based differences in academic achievement, with some research indicating variations in performance between male and female students (Worman & Hyder, 2020; Armah *et al.,* 2021). In other ways, some studies have reported no notable differences in scholarly success between male and female pupils across science subjects like mathematics, physics, chemistry, and biology (Musa *et al.,* 2024; Abbas & Idris, 2024; Matazu & Isma'il, 2023). In light of this, the current research explores how the reversed instructional strategy influences undergraduate students' academic achievement in science courses in Zamfara State, Nigeria.

Traits such as decisiveness, logical reasoning, intelligence, self-confidence, assertiveness, diplomacy, and conciseness in speech are commonly linked to males, while characteristics like fearfulness, submissiveness, and lack of tact are often attributed to females, and talkativeness is often associated with females.

Samba and Eriba (2013) discovered that male students outperformed their female counterparts in science and technology-related subjects, regardless of whether they were taught by male or female teachers at the senior secondary school level; students' achievement remained consistent. However, Ugwuadu (2013) explained that there is no tangible difference in mathematics and science success between male and female students, regardless of their teacher's gender."

According to Denga (2014), both male and female students have the cognitive capacity for logical reasoning and problem-solving. Similarly, Okeke (2016) observed that gender composition plays a significant role in students' educational attainment. Omoniyi (2016) examined the effectiveness of the Vee-mapping technique in addressing gender disparities in Ondo State, Nigeria, and discovered no notable disparity in the scores of male and female pupils exposed to this method.

Khan (2012) introduced the concept of students watching instructional videos at home and engaging in problem-solving activities during class, thereby reversing the traditional classroom approach, a method further discussed by Kronholz (2012). Akingbemisilu (2014) examined the impact of reversed learning on college students' educational attainment in biology, noting a slight increase in mean scores but no significant effect due to certain influencing factors. Flaherty and Philips (2015) observed improved academic performance and overall satisfaction with the reversed learning method. Adegun (2016) emphasized that academic success is influenced by a child's ability to excel, highlighting childhood intelligence as a strong predictor of future achievement. Similarly, Westwood (2018) asserted that effective teaching and learning of practical skills depend, in part, on instructional methods that actively engage students' learning senses.

This method fosters a more profound comprehension and grasp of the subject based on students' preferences (Alsowat, 2016; Moore, Gillett & Steele, 2014). Peterson (2016) discovered that exploring a revered classroom approach positively influenced students, resulting in higher satisfaction and achievement than traditional lecture methods. McCallum *et al.* (2015) affirmed that student engagement in learning activities can be enhanced through a model involving note-taking, video viewing, and collaboration. The finding agrees with Edtestrebsky (2014, 2016) and Kirch (2012), who reported that FLIS resulted in high student performance. This result corroborates that of Soult (2016), that adoption of FLIS by teachers of science would do everything to improve students' scores in problem-solving tasks. The study also corroborates with the study by Bhagat *et al.* (2016).

The research found that students engaging in flipped learning demonstrated enhanced performance, suggesting the effectiveness of this approach for tutoring mathematics in secondary schools (Bhagat *et al.*, 2016). However, three other studies (Clark, 2015; DeSantis *et al.*, 2015; Kirvan *et al.*, 2015) discovered no tangible difference in attainment between pupils in mathematics classrooms

utilizing the reversed model and those in classrooms with other teaching methods. Clark (2015) argues that flipped classrooms promote greater student collaboration and engagement, deliver high-quality teaching, transition teaching to a student-centered approach, and utilize class time more effectively, which enhances student critical thinking and fosters positive learning attitudes. Computers can respond to students' individual interests and challenges, providing personalized learning materials. Khan Academy (Khan Academy, 2012)

Another factor might be that teachers are unaware of advances in pedagogical tools, which have progressed beyond what they experienced in their education (Fullan, 2016). If four years of higher education fail to produce reflective and innovative teachers, it raises questions about how meaningful transformation can be brought about in our educational system. Teachers need to undergo a change themselves to become agents of meaningful change in the education system. Beginning with initial teacher education (Senge, 2017), educators should adopt appropriate teaching methods that align with specific goals and desired outcomes. This transition from a tutor-centered method to a student-centered method, exemplified by flipped learning, indicates a move toward more effective teaching practices. The influence of teaching methods on pupil learning remains a subject of significant interest in educational research (Hightower, 2011).

MATERIALS & METHODS

The Research Design

The study employed a pre-test/post-test control group quasi-experimental design.

Population of the Study

All public Senior Secondary School 2 (SSS2) mathematics students in Ondo State, Nigeria, make up the study's population.

Sample and Sampling Techniques

Due to the need for schools that allow the use of flipped learning devices, such as laptops and phones, four public secondary schools in Owo Local Government Area, Ondo State, were selected using the purposive sampling technique. 20 senior secondary school (SS2) mathematics students were chosen at random from each of the sampled schools, and the Owo local government area was chosen at random from among the 18 local governments that comprised the state. There were 80 pupils in the samples, 40 of whom were male and 40 of whom were female. Also, 40 students were randomly selected for the experimental group and 40 for the control group.

Research Instrument

The Mathematics Achievement Test (MAT), a data collection tool, was created using previous WAEC and NECO questions on trigonometry and bearing from three consecutive years. With four options for each of the 25 multiple-choice items, the MAT functioned as both a pretest and a post-test. Experts in the Department of Science Education thoroughly evaluated the test's accuracy and applicability before validating it. The purpose of the MAT was to evaluate students' mathematical proficiency. At the significance level of 0.05, Pearson Correlation (PPMC) yielded a reliability coefficient of 0.78.

Given that WhatsApp is one of the most widely used apps, it was utilized as a digital tool to project flipped learning materials to students so they could view the lecture.

Administration of the Instrument

The researcher gave the Mathematics Achievement Test (MAT) as a pretest the first week following the schools' orientation and instruction. Students in the experimental (FLIS) and control groups took the pretest prior to the start of the intervention. While the control group was instructed using traditional methods, the experimental group was exposed to the flipped learning approach. Topics on trigonometry and bearing from the SS2 mathematics syllabus were covered during the four-week intervention, which ran from week two to week five. At the end of the six-week intervention, both groups received the Mathematics Achievement Test (MAT) as a post-test.

RESULTS AND DISCUSSION

Research Question 1: What is the Performance Score of Students in the Experimental and Control Groups Before Treatments?

We used table 2 to answer research question 1.

Table 2 showed the mean score of students for the experimental and the control group before treatment. The mean of the experimental group is 5.05, and the standard deviation is 1.552. The control group's mean stands at 5.33, with a standard deviation of 1.385. This result revealed that there was no disparity in the mean score of students in both groups before treatment. Hence, this means the two are homogeneous before treatment.

Table 2: Showing the mean and Standard deviations of Performance score of the students in the experimental and control group

Group Name	N	Mean	Std.D	Mean difference
Experimental	40	5.05	1.552	0.28
Control	40	5.33	1.385	

Research Question 2: Will there be any Disparity in the Post-Test Mean Score of Students in the Experimental and Control Groups?

In answering this question 2, Table 3 was used.

From table 3, the post-test mean score of students in the experimental group is 20.17, and the standard deviation

Table 3: Showing post-test mean score of students in experimental and control group

S/N	Group	N	Mean (X)	Std.D
1	Experimental	40	20.17	2.531
2	Control	40	9.35	2.293

was 2.531. While the post-test mean score of the control group is 9.35, the standard deviation was 2.293. It showed the observed mean difference of 10.82.

The result revealed that the high disparity in the post-test mean score of students in the experimental and control groups, with a mean difference of 10.82, is in favor of the experimental group, which is the group taught mathematics using flipped learning.

Research Question 3: What is the Performance of Male and Female Students in the Experimental Group before and after Treatments?

In answering this research question 3, table 4 was used.

Table 4 revealed that Male had the mean scores of 5.25 and 20.15 before and after the treatment, respectively. The mean difference in pretest and post-test mean difference of male students is 14.90, which shows improvement in favor of the post-test mean score of male students in their performance. And female students had mean scores of 4.85 and 20.20 before and after treatment, respectively. The mean difference in pretest and post-test mean scores of female students is 15.35, which shows improvement in favor of the post-test mean score of female students' performance in the experimental group, which is taught mathematics using a flipped learning strategy.

Nevertheless, the post-test mean score of male students, which is 20.15, and of female students, which is 20.20, are indicating that both male and female students are at the same level in their performance after treatment using flipped learning, whereas at the pretest level, the male mean score is 5.25 and the female mean score is 4.85. Which shows that male performance is better than that of females?

Table 4: Showing performance means score of male and female students in the experimental group before and after treatment

Gender	N	Tests	Mean(X)	Std.D	Mean difference
Male	20	Pretest	5.25	1.682	14.90
		Post-test	20.15	2.498	
Female	20	Pretest	4.85	1.424	15.35
		Post-test	20.20	2.628	

Testing of Hypotheses

Hypothesis 1

There is no significant difference in the pretest mean score of students in the experimental and control groups.

Table 5 was used to test hypothesis 1

Table 5: Summary of T-test showing difference in the pretest mean score of students in the experimental and control group

Group	N	Mean(X)	Std.D	Df	t. cal	P-val.	Decision
FLIS (Experimental)	40	5.05	1.552	78	0.851	1.994	Not sig.
Conventional (control)	40	5.33	1.385				

P > 0.05 level of significant

The table showed that the t-calculated value of 0.851 is less than the P-value of 1.994 at 0.05. Level of significance (t-cal = 0.851 < P-value = 1.994): the null hypothesis was not rejected. Thus, the result revealed that there is no significant difference in the pretest mean score of the experimental and control groups.

Hypothesis 2

There is no significant difference in the post-test mean score of students taught mathematics using flipped learning instructions (experimental) and conventional methods (control).

Table 6: Summary of t-test showing difference in post-test mean score of students taught mathematics using flipped learning instructions (experimental) and conventional method (control)

Group	N	Mean (X)	Std.D	df	t-cal	P- Val.	Decision
Experimental	40	20.18	2.531	78	20.047	0.000	Significant
Control	40	9.35	2.293				

P < 0.05 level of significant

We used Table 6 to test hypothesis 2.

The table shows that the t-calculated value of 20.047 is greater than the P-value of 0.000 at the 0.05 alpha level (t-cal = 20.047 > P-value = 0.000) at the 0.05 level of significance. This means that there is a significant difference between the post-test mean score of the experimental group taught with the flipped learning method and the post-test mean score of the control group. Thus, the null hypothesis that says there was no significant difference in the mean score of students taught mathematics using flipped learning and conventional methods was rejected. It revealed that flipped learning improved students' performance more than the control group.

Hypothesis 3

There is no significant difference in the pretest mean score of male and female students in the experimental group.

Table 7 was used to test for this hypothesis.

Table 7: Showing t-test analysis for gender difference in means score of students in experimental group before treatment.

Gender	N	Mean	Std. D	df	t-cal	P-Val	Decision
Male	20	5.25	1.682	38	0.040	0.422	Not Sig
Female	20	4.85	1.424				

P > 0.05 level of significant

The table showed that, since the t-calculated value of 0.040 is less than the P-value of 0.422 at the 0.05 level of significance (t- cal = 0.040 < P-value 0.422), the null hypothesis was not rejected. Thus, the result revealed that there is no significant difference between male and female pretest mean scores of the students in the experimental group.

Hypothesis 4

There is no significant difference in the post-test mean score of male and female students in the experimental group.

Table 8 was used to test this hypothesis 4.

The table indicates that the calculated t-value is 0.062, while the p-value is 0.951 (t-value = 0.062 < p-value = 0.951) at a 0.05 significance level. Since the p-value is greater than the significance level, the null hypothesis was not rejected. This result suggests that there is no significant difference in the performance of male and female students in the experimental group who were taught mathematics using the flipped learning approach.

Table 8: Showing t-test analysis for gender difference in means score of students in experimental group

Gender	N	Mean	Std. D	df	t-cal	P-Val	Decision
Male	20	20.15	2.498	38	0.062	0.951	Not Sig
Female	20	20.20	2.628				

P > 0.05 level of significant

Discussion

Before the intervention, the experimental and control groups' average scores were 5.05 and 5.33, respectively, according to the study's first finding. This minor variation suggests that the students in both groups had similar baseline knowledge and performance levels prior to the intervention. This conclusion is in line with Westwood's (2018) assertion that instructional strategies that actively engage students' senses are crucial for the successful teaching of practical skills.

Another important finding was the difference in the post-test average scores between students in the control group and those exposed to the flipped learning instructional strategy (FLIS). Therefore, this result showed that students who received instruction using FLIS outperformed their counterparts in the control group, who received a mean score of 9.36 and had a mean score of 20.17. The findings suggested that FLIS was more effective than the conventional approach at raising students' mathematics proficiency. The result is consistent with the findings of Estestrebsky (2014, 2016) and Kirch (2012), who found that FLIS led to high student performance. This result supports Soult's (2016) assertion that science teachers' use of FLIS would greatly raise students' performance on problem-solving tasks. Additionally, the study supports Khan's (2012) assertion that flipped learning is an effective teaching method that produces the intended outcomes. This finding is also consistent with the research conducted by Bhagat *et al.* (2016).

According to the research findings, male students in the experimental group had a higher average before the intervention. The performance score differs significantly from that of female students. Nevertheless, the experimental group's average scores improved for both male and female students following the intervention. This outcome is consistent with Samba and Eriba's (2013) findings that, at the senior secondary school level, male students performed better than their female counterparts in science and technology courses, irrespective of the gender of the teacher. However, Ugwuadu (2013) found that, independent of the gender of the teacher, there were no appreciable differences in the achievement of male and female students in mathematics and science.

Additionally, Table 5's results demonstrated that, prior to the intervention, there was no discernible difference between the experimental and control groups' average academic performance scores. According to this, both

groups were homogeneous prior to the treatment, having a similar level of prior knowledge at the beginning. According to Adegun (2016), academic achievement is the result of a child's capacity for learning and performance, and this finding is consistent with that definition.

Students in the experimental group outperformed those in the control group, despite the groups' initial similarities. This difference became apparent after flipped learning was implemented. This improvement suggests that flipped learning outperformed traditional teaching techniques. This finding is in contrast to Akingbemisilu's (2014) research, which discovered that although flipped learning raised undergraduate biology students' average scores somewhat, it had no discernible effect on overall performance because of a number of influencing factors. Additionally, Table 7 shows that there was no discernible difference between male and female students in the experimental group in terms of their pretest average performance scores. It implies that prior to the intervention, both genders' levels of knowledge were similar. This conclusion is in line with the findings of Denga (2014), who proposed that both male and female students are capable of solving problems that call for logical thinking. Furthermore, in secondary schools in Ondo State, Nigeria, Omoniyi (2016) examined the impact of the Vee-mapping technique on gender-related performance disparities in chemistry instruction.

There was no discernible difference in the performance of male and female students exposed to this teaching method, according to the study. According to the study findings in Table 8, there is no discernible difference in the post-test scores of male and female students who received flipped instruction in mathematics. Using this strategy, female students (20.20) performed marginally better academically than male students (20.15), but the t-test analysis in Table 8 indicated that the difference between the two groups was not statistically significant. The method's practice-based learning may be the reason for the performance of female students. All things considered, these results corroborate those of Ugwuadu (2013), who concluded that there was no discernible gender difference in student achievement.

CONCLUSION

1. Flipped learning proved to be more effective than traditional teaching methods in enhancing students' mathematical performance.

2. Gender had no discernible effect on students' performance in mathematics, regardless of the use of traditional teaching methods or flipped learning.

Recommendation

The study's findings prompt the following recommendations:

1. To incorporate flipped learning into their lessons, mathematics teachers should get ongoing training and professional development. Through seminars, workshops, and conferences, the government or professional associations like the Mathematics Association of Nigeria (MAN) and the Science Teachers Association of Nigeria (STAN) can facilitate these training programs.

2. Curriculum planners should incorporate flipped learning techniques into the national mathematics curriculum. Additionally, to enable the successful implementation of flipped learning, school schedules should allot more instructional time to mathematics.

3. Everybody involved in the education sector, including the Parent Teacher Association (PTA), the Old Students Association of the schools, Non-Governmental Organizations (NGOs), and various governments at different levels, should help raise awareness of the advantages of flipped learning for both teachers and students. They should also help provide the facilities required for the strategy to be

REFERENCES

Abbas, M. (2023). *Effects of flipped classroom learning on academic achievement and perception in genetics concepts among secondary school students in Gusau LGA, Zamfara State, Nigeria.*

Abbas, M., & Idris, A. (2024). Flipped classroom learning and academic achievement in genetics concepts among secondary school students in Gusau, Zamfara State, Nigeria. *FNAS Journal of Mathematics and Science Education, 5*(3), 108–115.

Adegun, C. O. (2016). Childhood intelligence and later academic achievement: A systematic review. *Journal of Education and Developmental Psychology, 6*(1), 1–13. https://doi.org/10.5539/jedp.v6n1p1

Akingbemisilu, A. (2014). *The effect of flipped classroom strategy on Adekunle Ajasin University students' achievement in some concepts of biology* [Unpublished seminar paper]. Teacher Education Department.

Albawi, A. S. (2018). The effects of using flipped classroom achievements at University of Tabuk. *International Journal of Research in Education and Science, 4*(1), 198–200. https://doi.org/10.21890/ijres.383137

Aljaser, A. M. (2017). Effectiveness of using flipped classroom strategy in academic achievement and self-efficacy among education students of Princess Bint Abdulrahman University. *English Language Teaching, 10*(4), 6. http://doi.org/10.5539/elt.v10n4p6

Alsowat, A. (2016). Reading comprehension strategies and difficulties faced by EFL learners. *Journal of Language and Linguistics, 15*(30), 538–553.

Armah, S. E., Akayuure, P., & Armah, R. B. (2021). A comparative study of male and female distance learners' mathematics achievement. *Contemporary Mathematics and Science Education, 2*(1), Article 21001. https://doi.org/10.30935/conmaths/9288

Azuka, F. B. (2015). Mathematics education for sustainable development: Implication to the production and retention of mathematics teachers in Nigerian schools. *British Journal of Education, 3*(1), 45–51.

Bhagat, K. K., & Chang, C. Y. (2016). The impact of the flipped classroom on concept learning in high

school. *Educational Technology & Society, 19*(3), 135. Retrieved from https://www.researchgate.net/publication/286047548

Calamlam, G. J. (2016). Factors affecting the academic performance of students. *International Journal of Education and Research, 4*(6), 1–12.

Clark, K. R. (2015). Effects of flipped model instruction on students' engagement and performance in secondary school classroom mathematics. *Journal of Educators Online, 12*(12), 91–115.

Denga, D. I. (2014). *Education measurement, continuous assessment and psychological testing*. Rapid Educational Publishers.

DeSantis, J., Van Curen, R., Putsch, J., & Metzger, S. (2015). Flipped classroom vs. traditional classroom: A comparative study. *Journal of Educational Technology Development and Exchange, 7*(1), 1–18.

Edtestrebsky, A. (2014). Flipping the classroom: A study of the effects on student engagement. *Journal of Educational Technology Development and Exchange, 6*(1), 1–18.

Edtestrebsky, A. (2016). The flipped classroom: A review of the literature. *Journal of Education and Human Development, 5*(1), 1–15.

Federal Republic of Nigeria. (2013). *National policy on education*. National Education Research Council Press.

Finkel, E. (2012). Flipping the script in K–12. *District Administration, 48*(10), 28–30.

Flaherty, & Craig-Philips. (2015). *The use of flipped classrooms in higher education: A scoping review.* Higher Education, Article retrieved from ScienceDirect database on April 4, 2015.

Fullan, M. (2016). *The new pedagogical students as change agents.* Corwin Press.

Hightower, M. (2011). *Teaching methods. In Encyclopedia of Education* (Vol. 2, pp. 63–74). Macmillan.

Khan, S. (2012). *The one world schoolhouse: Education reimagined.* Twelve.

Kirch, P. (2012). The flipped classroom: A pedagogical approach to increase student engagement. *Journal of Teaching and Learning with Technology, 1*(1), 1–12.

Kronholz, J. (2012). Can Khan move the bell curve to the right? *Education Digest, 78*(2), 23–30.

Matazu, S. S., & Isma'il, A. (2023). Effect of flipped classroom instruction and enhanced lecture method on academic performance in genetics among students with visual–auditory–kinesthetic (VAK) learning styles in Gusau, Zamfara State, Nigeria. *Pedagogy, 1*(2).

McCallum, S., Schultz, J., Sellke, K., & Spartz, J. (2015). An examination of the impact of active learning on student outcomes in higher education. *Journal of Educational Technology Development and Exchange, 7*(1), 1–20.

Moore, S. A., Gillette, J., & Steel, W. (2014). Reading comprehension: Strategies for success. *Journal of Educational Research, 107*(4), 289.

Okeke, E. A. C. (2016). Gender difference in the understanding of some important science concepts. *Nigeria Journal of Education, 2*(1), 125–132.

Omoniyi, A. O. (2016). Use of Vee mapping technique as a metacognitive strategy on gender related differences in teaching chemistry students in secondary school in Ondo State, Nigeria. *Journal of Science and Technology Education, 1*, 186–193.

Peterson, D. (2016). Flipped classrooms and discovery learning. In S. D'Agustino (Ed.), *Creating holistic technology enhancing learning experiences* (pp. 1–12). IGI Global. https://doi.org/10.4018/978-1-5225-0252-5.ch001

Samba, R. M. O., & Eriba, J. O. (2013). *Innovative approach in teaching difficult science concepts*. Destiny Ventures.

Senge, P. M. (2017). *The fifth discipline: The arts & practice of the learning organization*. Random House.

Sikaraya, D., & Özdemir, S. (2018). The effect of a flipped classroom model on academic achievement, self-directed learning readiness, motivation and retention. Malaysian *Online Journal of Educational Technology, 6*(1). Retrieved from http://www.mojet.net

Soult, J. (2016). Flipping the classroom: A study of the effectiveness of the flipped classroom model. *Journal of Educational Technology Development and Exchange, 8*(1), 1–18.

Sternberg, R. J. (2017). Reforming education: A triarchic theory of intelligence-based approach. *Journal of Educational Psychology, 109*(4), 522–535.

Talbert, R. (2017). *Flipping the classroom: A guide for educators*. Stylus Publishing.

Ugwuadu, N. J. (2013). *Effects of multiple intelligence based instructional approach on students' cognitive achievement and retention in learning introductory technology* [Unpublished M.Ed. thesis, University of Nigeria Nsukka].

Uzeogwu, G. N. (2014). The flipped classroom: A survey of research. *Journal of Education and Human Development, 3*(1), 1–10.

West Africa Examinations Council. (2018). *Chief examiner's report on mathematics performance*. WAEC.

Westwood, P. (2018). *Inclusive and adaptive teaching: Meeting the challenge of diversity in the classroom.* Routledge. https://doi.org/10.4324/9781351061261

Workman, J., & Heyder, A. (2020). Gender achievement gaps: The role of social costs to trying hard in high school. *Social Psychology of Education, 23*(6), 1407–1427. https://doi.org/10.1007/s11218-020-09588-6

Zainuddin, Z., & Halili, S. (2016). Flipped classroom research and trends from different fields of study. *International Review of Research in Open and Distributed Learning, 17*(3), 325–329.

Zalmon, L. G., & Wonu, N. (2017). Comparative analysis of students' mathematics achievement in West African Senior Secondary Certificate Examination in Nigeria. *European Journal of Research and Reflection in Educational Sciences, 5*(1), 5–6.