



Journal of Educational Technology and E-Learning Innovations (JETELI)

VOLUME 1 ISSUE 1 (2025)



PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

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

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Article Information

Received: May 17, 2025

Accepted: June 20, 2025

Published: June 30, 2025

Keywords

Achievement, Flipped Learning, Gender, Mathematics

ABSTRACT

This study looked at how well the flipped learning instructional strategy improved mathematics performance and looked at whether gender variations affected performance under this technique. One group received treatment utilizing the flipped learning approach, and another instructed using traditional techniques under a quasi-experimental pretest-posttest control group design. The study focused on Ondo State's senior secondary school (SS2) Mathematics pupils. Eighty Students were randomly chosen from four co-educational public high 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 were obtained. 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. Professional development programmes including seminars and workshops should also be planned to equip mathematics teachers with the tools required to apply 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 physics, chemistry, engineering, and medicine. National development depends on its mastery; so, good teaching and learning of the topic in educational institutions is important to reach this. The development of mathematics as a topic usually corresponds with the general socioeconomic success of a country.

Many times, mathematical ability is seen as a strong predictor of pupils' 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 mounting annoyance among those involved since they doubt the returns on their educational expenditures. 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. The subject nevertheless records rather lower performance levels than others despite several treatments. 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. Student results are greatly shaped by elements including peer influence, teacher quality, and school atmosphere (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, claims Abbas and Idris (2024). Teachers are very important for the learning process, hence their method of instruction will greatly affect the performance of their pupils. With an eye towards 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 of efficient professional development for mathematics and science instructors. One cannot emphasize the value

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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. This demands creative ideas with cultural relevance that could better involve students and enhance results.

Statement of the Problem

Statement For those involved in education in Nigeria, 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. Better knowledge of the fundamental elements causing this tendency is needed as well as investigation of other teaching strategies that can help better learning results. One such strategy with great 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

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.

students' academic achievement under this approach.

Considering this 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, areas that are deficient due to insufficient laboratory resources and conventional teaching approaches in Mathematics. The flipped classroom offers a valuable opportunity for educators to leverage video lectures, virtual labs, and simulations to develop students' advanced cognitive functions and enhancing learning results and maintaining engagement by developing problem-solving abilities. 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 enquiries 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 study will be directed by the following null hypotheses:

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 Learner's, Tutors, school administrators, curriculum developers, future Scholar, and the Ministry of Education and Culture. The study's findings will offer observable proof regarding 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 give valuable insights to help students develop a better attitude towards Mathematics. It will also serve as an information based for government at various level (ministry of education) to provide facilities like internet facility and equipment needed for the project, also to make policy that will permit school to use flipped learning method. It will help parent to make provisions of hand set with internet browsing for their children for learning, Non-Government Organization (NGO) and others stake holder in education sector to assist in creating general awareness of the important and benefits of the flipped learning to our education.

Delimitation to the Study

This research work was delimited to some selected Co- education public secondary school in 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

Lev Vygotsky and Jean Piaget promoted constructivism, which places a strong emphasis on learner-centered

education. According to this theory, language, social interactions, and real-world experiences help students acquire knowledge. This method involves the tutor acting as a facilitator, helping students along the way. Flipped learning is a collaborative teaching approach that encourages students to actively construct their understanding while also developing their critical thinking and problem-solving skills. Because flipped learning is a cutting-edge teaching strategy that makes use of networks and technology via laptops, smartphones, and internet data, George Siemens' connectivism theory also applies to its implementation.

According to recent studies, flipped learning can improve students' behavioural, emotional, and cognitive learning while also increasing learner engagement and fostering a hands-on learning environment (Jamaludin and Osman, 2014). It can be a useful teaching strategy, particularly since students today are skilled at using the internet and media, which makes it easier for them to access video lectures and supports the development of their analytical and critical thinking skills (Albalawi, 2018). By acknowledging the variability in learners' learning durations and intervals, the flipped classroom approach helps students become more adaptive to various learning environments (Hernandez, 2014). Compared to students with average to low performance levels, research indicates that reversed learning works better for students who are already academically successful (Calamlam, 2016). According to Aljaser (2017), the main goal of the reversed learning approach is to increase students' motivation by taking into account their skills, individuality, and self-worth. The reversed learning model has been shown to be effective in learning new material (Alsowat, 2016). Numerous studies have demonstrated the advantages of discussions or lectures as well as hands-on learning, indicating that the flipped classroom is helpful in enhancing students' comprehension of particular subjects (Zainuddin & Halili, 2016). Student engagement, learning, and achievement can all be improved through reversed learning. Students who want to succeed academically need to stay motivated and disciplined (Sifakaya & Ozdemir, 2018). According to Talbert (2017), a flipped classroom includes experience planning, goal-setting, and progress evaluation. Everyone benefits from everyone's active participation in flipped learning, according to Uzoegwu (2014). Numerous studies have shown how effective the reversed teaching approach is at raising students' academic achievement, irrespective of their gender. Scholars like Matazu and Isma'il (2023) and Abbas and Idris (2024) support its use as the preferred approach to teaching science. Thus, this study used the reversed classroom approach to teach science and looked at how it affected the learning outcomes of the students.

MATERIALS AND METHODS

The Research design

The Study of employed 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. Additionally, 40 pupils were chosen at random to be in the experimental group and another 40 to be in the control group.

Research Instrument

Using previous WAEC and NECO questions on trigonometry and bearing from three years in a row, the Mathematics Achievement Test (MAT), the data collection tool, was created. 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 utilised 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. Both groups were given the Mathematics Achievement Test (MAT) as a post-test at the conclusion of the six weeks.

RESULTS AND DISCUSSION

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

In answering the research question 1, table 2 was used.

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	

The 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. While the mean of the control group is 5.33 and the standard deviation is 1.385.

This result revealed that, there was no disparity in the mean score of students in both group before treatment.

Hence, this mean the two are homogeneous before treatment.

Research Question 2: Will There be Any Disparity in the Post-Test Mean Score of Students in the Experimental and Control Group?

In answering this question 2, Table 3 was used

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

From table 3, the post-test mean score of students in experimental group is 20.17 and the standard deviation was 2.531. While the post-test mean score of the control group is 9.35 and the standard deviation were 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 group, with mean difference of 10.82 which is in favor of the experimental group, which are 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 these research question 3, table 4 was used. Table, 4 revealed that Male had the mean score 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 show improvement in favor of post-test mean score of male students in their performance. And Female students had mean score of

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	

4.85 and 20.20 before and after treatment respectively. The mean difference in pretest and post -test mean score of female students is 15.35 which show improvement in favour of post-test mean score of female student's performance in experimental group which are taught mathematics using 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 female mean score is 4.85. Which show that male performance is better than that of female?

Testing of Hypotheses

Hypothesis 1

There is no significant difference in the pretest means score of students in the experimental and control group Table 5 was used to test hypothesis 1 The table showed that the t-calculated value of 0.851 is

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

less than 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 means score of Experimental and Control group.

Hypothesis 2

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

Table 6 was used to test for this hypothesis 2. The table shows that t-calculated value of 20.047 is greater than P-value of 0.000 at 0.05 alpha level (t-cal = 20.047 > P-value = 0.000), at 0.05 level of significance. This means that there is a significant difference between post- test means score of experimental group taught with flipped learning method and 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 method was rejected. It revealed that the flipped learning improved students' performance than the control group.

Hypothesis 3

There is no significant difference in the pretest means score of male and female students in the experimental group. Table 7 was used to test for this hypothesis 3 The table showed that, since t-calculated value of 0.040 is less than P-value 0.422 at 0.05 level of significance

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

($t\text{-cal} = 0.040 < P\text{-value } 0.422$), the null hypothesis was not rejected. Thus, the result revealed that there is no significance difference between male and female pretest means score 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 experimental group. Table 8 was used to test this hypothesis

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

The table indicates that the calculated t-value is 0.062, while the p-value is 0.951 ($t\text{-value} = 0.062 < p\text{-value} = 0.951$) 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.

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 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.

A difference in the post-test average scores between students in the control group and those exposed to the flipped learning instructional strategy (FLIS) was another important finding. 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, with a mean score of 20.17. This suggested that FLIS was more effective than the conventional approach at raising students' mathematics proficiency. This is consistent with the findings of Estestrebnsky (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 is also consistent with the research conducted by Bhagat, Chang, and Chang (2016). According to the research findings, male students in the experimental group had a higher average before the intervention. Performance score in relation to students who are female. 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 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 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 showed 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. When compared to traditional teaching methods, flipped learning was found to be more effective in improving students' mathematical performance.

2. Regardless of whether traditional teaching methods or flipped learning were employed, gender had no discernible effect on students' performance in mathematics.

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