

## **Effect of Flipped Learning on Academic Performance among Secondary School Mathematics Students in Trigonometry in Birnin Kebbi Metropolis**

**\*<sup>1</sup>Saratu Abdullahi Turaki, <sup>2</sup>Elizabeth Julius**

<sup>\*1</sup>Department of Science Education, Faculty of Education, Federal University Birnin Kebbi, Kebbi, Nigeria. **Email:** saroturaki55@gmail.com **Orcid ID:** 0009-0003-6077-2301

<sup>2</sup>Kebbi State University of Science and Technology Aliero, Kebbi, Nigeria. **Email:** mummybaffa2000@gmail.com,

---

### **Abstract**

*The study investigated the impact of flipped learning on academic performance among secondary school mathematics students in trigonometry in Birnin Kebbi metropolis. Two research objectives were set to guide the study. Additionally, two research questions and two research hypotheses were formulated to address the objectives. A quasi-experimental pre-test and post-test design was employed in this study. The population of the study consisted of all the three thousand and sixty two (3062) SSS1 students from the seventeen (17) Secondary Schools in Birnin Kebbi Metropolis. Purposive sampling technique was used to select 2 secondary schools. Two intact classes comprised of one hundred and five (105) students as sample were used for the study. They were assigned into an experimental group of 56 students (38 male, 18 female) and control group of 49 students (31 male, 18 female). The pilot sample consisted of 20 students (13 males, 7 female) was randomly selected from the population outside of the study sample. Structured Trigonometry Achievement Test (TAT) served as instrument used for data collection and hypotheses were analyzed using t-test at  $p \leq 0.05$  level of significance using Statistical Packages for Social Sciences. The results of this study revealed that, students taught trigonometry with flipped learning obtained higher achievement mean scores than those of their counterparts taught the same topics with traditional method in Birnin Kebbi metropolis and also shown that male students had slightly improved mean achievement scores than their female counterparts taught Trigonometry using flipped learning in Birnin Kebbi metropolis and the difference was significant.*

**Keywords:** Academic performance, Flipped learning, Mathematics student, Secondary school, Trigonometry

## Introduction

Mathematics is a fundamental discipline within the academic curriculum of educational institutions. In the current quantitatively complex society, an individual requires a functional comprehension of mathematical content for decision making as both a citizen and a worker. Mathematics researchers over the years have identified factors responsible for learners' poor performance in mathematics, some of which include; the poor foundation of students in mathematics, overcrowded mathematics classes and worn-out mathematics resources, anxiety towards mathematics, poor instructional strategies, lack of resources for teaching and learning mathematics, students and teachers unfavourable attitudes towards mathematics, students' laziness and disregard for mathematical discipline, teacher's abrasiveness when teaching mathematics, poor instructional approaches (Mosimege & Egara, 2022), and lack of learners' retention and interest in mathematics (Egara *et al.*, 2022). Implementing effective teaching strategies in mathematics by educators can increase students' motivation and eagerness to learn (Inweregbuh *et al.*, 2020). As a result, researchers in mathematics education have been investigating ways to boost both academic performance and engagement with mathematical concepts (Osakwe *et al.*, 2023). Among the recommended methods is the use of the flipped classroom model for mathematics instruction (Clark, 2015; Karadag & Keskin, 2017; Didem & Özdemir, 2018; Khadjieva & Khadjikhanova, 2019).

Flipped learning is an instructional strategy where traditional classroom activities are reorganized: direct instruction is moved outside the classroom using technology and online resources like videos, podcasts, blogs, or other digital tools, while in-class time is reserved for practical exercises and collaborative tasks that encourage active learning (Abeysekera & Dawson, 2015). In this model, students review textbooks and other materials before class, enabling class sessions to focus on problem-solving, hands-on exercises, and personalized teacher support (Cao & Grabchak, 2019). Additionally, it motivates students to learn more effectively, develops critical thinking skills, promotes collaborative learning, and supports diverse learning styles (Fetaji & Ebibi, 2019). The traditional method is a teacher-centered approach in which the instructor primarily delivers content through lectures or demonstrations, while students are expected to passively absorb the information. This model typically involves students listening to the teacher's explanations, observing

demonstrations, and completing assignments independently, with little emphasis on interaction or collaborative learning.

Trigonometry is widely regarded as a difficult subject by many students, who often struggle to comprehend its abstract concepts and principles (Tyata et al., 2021). It is essential for solving problems related to height and distance, analyzing right-angled triangles, understanding sine, cosine, and tangent functions, measuring angles in different units (degrees, gradians, and radians), and proving trigonometric identities, among other applications.

Ifeanyi (2022) carried out a study to assess the impact of the flipped classroom approach on student achievement, finding a significant positive influence on academic results. Likewise, Chung and Khe (2019) studied the effect of flipped classrooms on engineering students' performance, with their meta-analysis of 29 comparisons between traditional and flipped methods demonstrating a clear advantage for the flipped classroom over traditional lecture-based teaching. Egra and Mosimege (2023) examined the impact of the flipped classroom approach on mathematics achievement and interest among secondary school students. Their results showed that both male and female students taught using the flipped classroom method achieved comparable levels of performance and interest. According to Ifeanyi (2022), flipped learning is a form of blended learning in which students' access course content digitally at home and apply their knowledge during class. This method contrasts with traditional teaching, where new material is presented in class, and homework or projects requiring independent work are assigned for completion at home. This approach effectively integrates technology while offering a distinctive teaching and learning experience. Unlike conventional in-person instruction, the flipped classroom allows students to prepare for class at their own pace and from any location. Consequently, educators frequently use digital tools to develop and distribute course materials to students before class. This method has proven effective in enhancing students' performance and interest in subjects like mathematics, particularly in geometry (Felix & Mogege, 2023). When students attend trigonometry classes, they are better equipped to participate in the learning process, resulting in greater success.

Eze (2023) examined the impact of flipped learning on Nigeria Certificate in Education (NCE) mathematics students' interest and achievement in trigonometry in Kano State. The study revealed that the flipped learning

approach was more effective than traditional lecture methods in improving students' academic performance and interest in trigonometry. Furthermore, the findings showed no significant difference in achievement between male and female students in the experimental group, nor any notable interaction effects between teaching methods and gender on students' performance in trigonometry. Similarly, Betiang, Elizabeth, and Ubebe (2023) explored the effects of the flipped teaching approach on college students' interest and achievement in ordinary differential equations. Their results demonstrated that the flipped teaching method significantly improved students' interest and achievement compared to traditional teaching methods.

Researchers and educators have been investigating alternative strategies and methods to actively engage and motivate students in the learning process. One such innovative approach is the flipped learning model. Empirical studies have demonstrated the effectiveness of flipped learning across various disciplines, including statistics, chemistry, English, nursing, engineering, and pharmacy. However, research on its application in secondary school mathematics remains limited. To address this gap, this study investigates the impact of flipped learning on enhancing secondary school students' understanding of mathematical concepts.

### **Objectives of the Research**

1. To determine the difference between the academic performance of students taught trigonometry using flipped learning and traditional teaching method in Birnin Kebbi Metropolis.
2. To examine the difference between the academic performance of male students and female students taught trigonometry using flipped learning in Birnin Kebbi Metropolis.

### **Research Questions**

This research sought to find answers to the following questions

1. What is the difference in academic performance of students taught trigonometry using flipped learning and traditional teaching methods in Birnin Kebbi Metropolis?

2. What is the effect of the flipped learning on academic performance of male students and female students in trigonometry in Birnin Kebbi Metropolis?

### Research Hypotheses

**H<sub>01</sub>** There is no significant difference between the academic performance of students taught trigonometry using flipped learning and traditional teaching method in Birnin Kebbi Metropolis.

**H<sub>02</sub>** There is no significant difference between the academic performance of male students and female students taught trigonometry using flipped learning in Birnin Kebbi Metropolis.

### Research Methodology

A quasi-experimental pre-test and post-test design was employed in this study. The population of the study consists of all the three thousand and sixty-two (3062) SSS1 students from the seventeen (17) Secondary Schools in Birnin Kebbi Metropolis. Purposive sampling technique was used to select 7 secondary schools. Two intact classes were used, class A with 56 students (38 male, 18 female) assigned as experimental group and the class B with 49 students (31 male, 18 female). The pilot sample consisted of 20 students (13 males, 7 female) was randomly selected from the population outside of the study sample.

Structured Trigonometry Achievement Test (TAT) was adapted from instruments used in studies on flipped learning of Eze (2023) and Betiang *et al.* (2023) which served as instrument used for data collection containing 20 items of multiple choices. The validity of TAT and the lesson plans were subjected to face and content validation by four experts from department of Mathematics, Faculty of Science and Mathematics Education, Faculty of Education Federal University Birnin Kebbi. To ensure the reliability, the test was administered in a different school setting with different participants and

Cronbach Alpha  $\alpha$  reliability coefficient **0.78** was obtained, indicating acceptable internal consistency of the TAT for the study. Both descriptive statistical method which involves mean and standard deviation, and inferential statistical method for comparison which involves t-test were employed for data analysis in this study.

## Results

The data collected were analyzed using Statistical Packages for Social Sciences. Mean, standard deviation and t-test were used to answer the research questions and tested hypotheses. The result of the study are presented in the following tables:

### Research Question 1

What is the difference in academic performance of students taught trigonometry using flipped learning and traditional teaching methods counterpart in Birnin Kebbi Metropolis?

**Table 1:** Mean and Standard deviation (SD) of academic scores of Experimental group and Control groups

Group	Type of test	N	Mean	Standard deviation
Experimental	Pre-Test	56	9.286	3.802
	Post-Test		13.143	3.066
Control	Pre-Test	49	7.286	2.739
	Post-test		10.225	2.201

Table 1 shows that the pre-test mean academic scores of students in the experimental group and control group were 9.286 and 7.286 with standard deviation 3.802 and 2.739 respectively. Moreover, the post-test mean academic scores of students in both group increased with experimental group demonstrating greater improvement of mean and standard deviation of 13.143 and 3.066 respectively, and control group with mean and standard deviation of 10.225 2.201 respectively.

**Table 2:** t-test comparison of the post-test mean academic scores of students in experimental group and control group

Group	N	Mean	SD	Df	t-Value	P-Value	Remark
Experimental	56	13.143	3.066	103	5.53099	.00001	Significant
Control	49	10.225	2.201				

Table 2 shows a statistical analysis that revealed a significant difference in post-test scores ( $t(103) = 5.53, p < .001$ ), with the experimental group outperforming the control group. These results suggest that the flipped learning approach may be more effective than traditional instruction for

trigonometry learning, though further research is needed to account for potential confounding variables. Therefore, the null hypothesis  $H_{01}$  is rejected

### Research Question 2

What is the effect of the flipped learning on academic performance of male students and female students in trigonometry?

**Table 3:** Mean and Standard deviation of academic scores of Male students and Female students taught trigonometry using flipped learning

Gender	Type of test	N	Mean	Standard deviation
Male	Pre-Test	38	9.895	2.902
	Post-Test		13.790	2.858
Female	Pre-Test	18	7.778	2.580
	Post-test		9.611	1.540

The results in table 3 shows that the pre-test mean academic scores of both male and female students in the experimental group were 9.895 and 7.778 with standard deviation 2.902 and 2.580 respectively which indicate relatively same academic level before treatment. Moreover, the post-test mean academic scores of both male and female students in experimental group were 13.790 and 9.611 with standard deviations of 2.858 and 1.540.

**Table 4:** t-test comparison of the post-test mean academic scores of male students and female students taught trigonometry using flipped learning

Gender	N	Mean	SD	Df	t-Value	P-Value	Remark
Male	38	13.790	2.858	54	5.79759	.00001	Significant
Female	18	9.611	1.540				

Table 4 shows the t-value comparison of the post-test mean academic scores of male and female students taught trigonometry using flipped learning. The t-value calculated is 5.79759 with P-value of .00001 which is significant at

$P < 0.05$ . Therefore, the null hypothesis  $H_{02}$  is rejected.

## **Discussion**

The study revealed that students who were taught trigonometry using the flipped learning approach achieved higher mean scores than those taught with the traditional method in Birnin Kebbi metropolis. The results showed a significant difference in mean achievement scores between the two groups, with the flipped learning approach proving more effective. This improvement is linked to the personalized learning experiences enabled by online trigonometry instructional videos and the interactive classroom activities incorporated into the flipped learning model. These findings are consistent with prior research that underscores the positive effects of flipped learning on student success (Aydin, 2016; Sickle, 2016; Sun & Wu, 2016; Ibenegbu & Ugwu, 2022; Ezeudu & Gbendu, 2021; Choi, Kim, Bang, Park, Lee, & Kim, 2017; Duygu & Ali, 2018). These studies highlight the advantages of the flipped learning model, including flexibility in time and location, a student-centered approach, tailored learning experiences, self-paced study, access to diverse resources, an engaging learning environment, opportunities for self-assessment, and allowing students more time to prepare and develop questions before applying their knowledge in class.

Furthermore, the results indicated that male students slightly outperformed their female counterparts in the flipped learning group, with the difference being statistically significant. This suggests that male students derived greater benefits from the flipped learning approach in trigonometry. However, this finding contrasts with the results of Eze (2023), who found no significant difference in achievement between male and female students in the experimental group taught trigonometry using flipped learning. The discrepancy in this study may be due to the equal learning opportunities provided to all students, which could have influenced the outcomes in a distinct manner.

## **Conclusion**

In conclusion, the study revealed that flipped learning should be applied by mathematics teachers in improving students' academic performance. The study also revealed that male students' academic performance was better than female students' academic performance both taught trigonometry using flipped learning approach.

## Recommendations

The study recommended the following:

1. Mathematics teachers should adopt flipped learning for better understanding and improvement in academic performance of mathematics students in trigonometry in Birnin Kebbi metropolis.
2. Curriculum planners and educational policy makers should consider a review of the curriculum to incorporate flipped classroom strategy into the Secondary School Mathematics Curriculum. This could significantly improve students' academic performance in Mathematics concepts.
3. Federal and State Governments in collaboration with Ministries of Education should organize and sponsor regular training workshops and conferences to train teachers on how to promote Mathematics instruction through the use of innovative flipped classroom strategy.
4. The Federal and State governments through the Ministry of Education should provide ICT facilities and resources adequately to implement flipped learning strategy in all secondary schools in Nigeria.

## Reference

- Abeyssekera, L. & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research. *Higher Education Research & Development*, **34**(1), 1–14.
- Cao, L. & Grabchak, M. (2019). Interactive preparatory work in a flipped programming course. *ACM*, 229-23
- Choi, H., Kim, J., Bang, K., Park, Y., Lee, N., & Kim, C. (2017). Applying the flipped learning model to an English-medium nursing course. *Journal of Korean Academy of Nursing*, **45**(6), 939-948. <https://doi.org/10.4040/jkan.2015.45.6.939>
- Clark, K. (2015). The Effects of the flipped model of instruction on Student Engagement and Performance in the secondary Mathematics Classroom. *The Journal of Educators Online*, **12**(1), 91–115. <https://doi.org/10.9743/jeo.2015.1.5>.

- Didem, A. S. & 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), 76–91.
- Duygu, S. & Ali, A. (2018). The Effect of Flipped Classroom on the Academic Achievement and Attitude of Higher Education Students. *World Journal of Education* **8**(4); URL:<https://doi.org/10.5430/wje.v8n4p170>.
- Efiuvwere, R. A. & Fomsi, E. F. (2019). Flipping the mathematics classroom to enhance senior secondary students' interest. *International Journal of Mathematics Trends and Technology*, **65**(2), 95–101. <https://doi.org/10.14445/22315373/ijmtt-v65i2p516>
- Egara, F. O., Eseadi, C., & Nzeadibe, A. C. (2021). Effect of computer simulation on secondary school students' interest in algebra. *Education and Information Technologies*, *27*, 5457–5469.
- Elian, S. A. & Hamaidi, D. A. (2021). The effect of using flipped learning strategy on the academic achievement of eighth-grade students in Jordan. *International Journal of Advanced Computer Science and Applications*, **12**(8), 534–541. <https://doi.org/10.14569/IJACSA.2021.0120862>.
- Eze L. I. (2023) Effect of flipped learning on Nigeria Certificate in Education (NCE) Mathematics students' interest and achievement in trigonometry in Kano State, Nigeria, *British Journal of Education*, **11**(8), 76-91.
- Ezeudu, S.A & Gbendu, G. O. (2021). Effect of flipped classroom strategy on students' attitude towards secondary school geography: implications for entrepreneurship education in Nigeria. *International Journal of Studies in Education*, **16**(2), 38-51.
- Fetaji, M., Fetaji, B., & Ebibi, M. (2019). Analyses of possibilities of flipped classroom in teaching computer science courses. *IEEE*, 747-752
- Fraga, L. M. & Harmon, J. (2014). The flipped classroom model of learning in higher education: An investigation of preservice teachers' perspectives

and achievement. *Journal of Digital Learning in Teacher Education*, **31**(1), 18-27.

Ibenegbu, C.I. & Ugwu, K. (2022). Effects of Flipped Classroom Approach on Students Achievement in Government in Nsukka Education Zone, Nigeria. DOI: <https://doi.org/10.21203/rs.3.rs-1633688/v1>

Inweregbugh, O. C. Ugwuanyi, C. C., Nzeadibe, A. C., Egara, F. O. & Emeji, I. E. (2020). Teachers' practices of creativity in mathematics classroom in basic education. *International Journal of Research Publications*, **55**(1). <https://doi.org/10.47119/ijrp100551620201254>

Karadag, R., & Keskin, S. S. (2017). The effects of flipped learning approach on the academic achievement and attitudes of the students. *New Trends and Issues Proceedings on Humanities and Social Sciences*, **4**(6), 158–168. <https://doi.org/10.18844/prosoc.v4i6.2926>.

Khadjieva, I., & Khadjikhanova, S. (2019). Flipped classroom strategy effects on students' achievements and motivation: Evidence from CPFS level 2 students at Wiut. *European Journal of Research and Reflection in Educational Sciences*, **7**(12), 120–130. [www.idpublications.org](http://www.idpublications.org).

Sun, J. C. Y., & Wu, Y. T. (2016). Analysis of learning achievement and teacher–student interactions in flipped and conventional classrooms. *The International Review of Research in Open and Distributed Learning*, **17**(1), 79-99

Betieng, P., A., Elizabeth, I. and Ubebe, S., A. (2023). Effect of flip teaching approach on college of education students' interest and achievement in ordinary differential equation in south-south geopolitical zone, nigeria. *African Multidisciplinary Journal of Development (AMJD)*. **12**(2), 400-409. <https://doi.org/10.59568/AMJD-2023-12-3-30>

Tyata, R. K., Dahal, N., Pant, B. P. and Luitel, B. C. (2021). Exploring Project-Based Teaching for Engaging Students' Mathematical Learning. *Mathematics Education Forum Chitwan*, **6**(6), 30–49. <https://doi.org/10.3126/mefc.v6i6.42398>

- Chung, K., O., K. and Khe, H., F. (2018). Flipped classroom improves student learning in health professions education: a meta-analysis. *BMC Medical Education*, **18** (38). <https://doi.org/10.1186/s12909-018-1144-z>
- Egara, F. O., & Mosimege, M. D. (2023). Gender difference in secondary school students' retention in algebra: A computer simulation approach. *Eurasia Journal of Mathematics, Science and Technology Education*, **19**(7), em2290. <https://doi.org/10.29333/ejmste/13280>
- Ifeanyi, C., I. and Ugwu, K. (2022). Effects of Flipped Classroom Approach on Students Achievement in Government in Nsukka Education Zone. *Research Square*, PREPRINT (Version 1). <https://doi.org/10.21203/rs.3.rs-1633688/v1>