



JOURNAL OF SCIENCE EDUCATION AND RESEARCH (JSER)

Vol. 2 JUNE - JULY; 2025

ISSN ONLINE: 3092-9253



ELSEVIER



Scopus



ISI



**Editor in-Chief
PROF. PATRICK C. IGBOJINWAEKWU**

JOURNAL OF SCIENCE EDUCATION AND RESEARCH (JSER)
VOL.2. JUNE - JULY, 2025

**JOURNAL OF
SCIENCE
EDUCATION AND
RESEARCH
(JSER), 2, JUNE - JULY; 2025**

JOURNAL OF SCIENCE EDUCATION AND RESEARCH (JSER)
VOL.2. JUNE - JULY, 2025

© (JSER)

ISSN Online: 3092-9253

Published in June, 2025.

All right reserved

No part of this journal should be reproduced, stored in a retrieval system or transmitted in any form or by any means in whole or in part without the prior written approval of the copyright owner(s) except in the internet

Printed in Nigeria in the year 2025 by:



Love Isaac Consultancy Services

No 1 Etolue Street, Ifite Awka, Anambra State, Nigeria

+234-803-549-6787, +234-803-757-7391

EDITORIAL BOARD

Editor-in-Chief

Prof. Patrick C. Igbojinwaekwu

Editors

Dr. JohnBosco O.C. Okekeokosisi

Dr. Chris O. Obialor

Dr. Susan E. Umoru

Dr. Nkiru N.C. Samuel

Dr. Ahueansebhor, Emmanuel

Dr. Loveline B. Ekweogu

Dr. Odochi I. Njoku

Consulting Editors

Prof. Abdulhamid Auwal

Prof. Marcellinus C. Anaekwe

Ass. Prof. Peter I.I. Ikokwu

Federal University Kashere, Gombe State

National Open University of Nigeria

Nwafor Orizu College of Education

Nsugbe, Anambra State

EDITORIAL

Journal of Science Education and Research (JSER) is a peer-reviewed published Bimonthly. It aimed at advancing knowledge and professionalism in all aspects of educational research, including but not limited to innovations in science education, educational technology, guidance and counselling psychology, childhood studies and early years, curriculum studies, evaluation, vocational training, planning, policy, pedagogy, human kinetics, health education and so on. JSER publish different types of research outputs including monographs, field articles, brief notes, comments on published articles and book reviews.

We are grateful to the contributors and hope that our readers will enjoy reading these contributions.

Prof. Patrick C. Igbojinwaekwu
Editor-in-Chief

TABLE OF CONTENTS

Effect of Exposure to Genetic Terminology Strategy on Achievement and Retention among Biology Students in Jaba Local Government of Kaduna State, Nigeria	
¹ Maikano Stanley , ² Audu Christina Tanko , ³ Maikano Amos	1
Gender Equality and Social Inclusion as Component of Human Development Among Athletes in Sports Commission, Calabar	
¹ Apie Martina Ayibeya , ² Ahueansehbor Emmanuel , ³ Ogabor, Joseph Odey , ⁴ Osaji Nsagha Nkang , ⁵ Adie Undigweundeye Boniface	17
Effectiveness of Flipped Classroom Strategy on Secondary School Students' Achievement in Algebra in Ebonyi South Education Zone, Ebonyi State	
¹ Emmanuel C. Nwigboji , ² Uzoamaka Chimuanya Okafor-Agbala	31
Effectiveness of Gamified-Based-Activity on Nigeria Colleges of Education Students' Achievement in Number System	
¹ JohnBosco O.C. Okekeokosisi , ² Odunayo A. Bamisebi , ³ Felix J. Okoh	45
Assessment of Revenue Models among Media Operators in Nigeria: A Study of Vanguard Newspaper, Asaba	
¹ Emenike V. Bieni , ² Michael O. Ukonu	59

**EFFECTIVENESS OF FLIPPED CLASSROOM STRATEGY ON
SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN ALGEBRA IN
EBONYI SOUTH EDUCATION ZONE, EBONYI STATE**

¹ Emmanuel C. Nwigboji, ²Uzoamaka Chimuanya Okafor-Agbala

¹nwigboji.emmanuel@funai.edu.ng

^{1, 2} Science Education Department,

¹Alex Ekwueme Federal University, Ndufu-Alike, Ebonyi State, Nigeria.

²Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

Abstract

This study investigated the effectiveness of flipped classroom strategy on secondary school students' achievement in algebra in Ebonyi South Education Zone, Ebonyi State. Two research questions and three hypotheses guided the study. The study adopted a quasi-experimental research design, specifically the non-equivalent control group pre-test post-test design. A sample of secondary school students was selected through purposive sampling, ensuring the inclusion of schools with ICT facilities necessary for implementing the flipped classroom strategy. Algebra Achievement Test (AAT) was used as the instrument, with its validity confirmed by 3 experts and reliability established using Kuder-Richardson Formula 20 to be 0.70. The experimental group was taught using the flipped classroom strategy, while the control group received traditional lecture-based instruction. Research questions were answered using mean and standard deviation while Analysis of Covariance was used to test the null hypotheses. The study revealed that students taught using flipped classroom strategy significantly outperformed those in the control group in algebra, with both male and female students showing notable improvement. Furthermore, there was no significant interaction between teaching method and gender, indicating the strategy's equal effectiveness across genders. Based on the findings, the study recommended among others that mathematics teachers, educational policymakers, and curriculum developers should integrate this approach into secondary school teaching to improve students' understanding and achievement in algebra and mathematics in general.

Keywords: Flipped Classroom Strategy, Students' Achievement, Gender

Introduction

Education has undergone significant transformations in recent years, with the integration of innovative teaching strategies aimed at improving students' learning outcomes. One such strategy is the flipped classroom approach, which reverses the traditional method of instruction. In a flipped classroom, students engage with instructional materials—such as video lectures, readings, and online exercises—before class, allowing in-person sessions to focus on discussions, problem-solving, and practical applications (Bergmann and Sams, 2019). This approach fosters active learning, promotes self-paced study, and enhances students' engagement, making it particularly effective for subjects like mathematics, where conceptual understanding and problem-solving are essential.

Algebra, a fundamental branch of mathematics, serves as a critical foundation for higher-level mathematical concepts and real-world applications. Algebra is a branch of mathematics that generalizes arithmetic by using letters or symbols to represent numbers and quantities using a definite rules for combining these symbols to analyze relationships and solve equations. Aliyu (2022) defined Algebra as the branch of mathematics that uses letters and symbols to represent numbers and quantities in formulas and equations to express general relationships and solve problems. Algebra involves the use of symbols and variables to represent numbers and relationships, fostering logical reasoning and abstract thinking (Kieran, 2020). However, many secondary school students struggle with algebra due to its abstract nature and the need for strong procedural and conceptual skills. This challenge has necessitated the adoption of innovative teaching methods such as the flipped classroom strategy to enhance students' achievement in the subject.

Students' achievement in algebra and mathematics in general—is shaped by a combination of factors, including instructional strategies, cognitive abilities, motivation and the learning environment. Recent research emphasizes that student-centered instructional approaches, particularly the flipped classroom model, enhance students' understanding and retention of mathematical concepts (Lo et al., 2021). Unlike traditional teaching methods that often rely on rote memorization and teacher-centered delivery, the flipped classroom fosters deeper conceptual understanding by enabling personalized learning, peer interaction, and timely feedback—elements that collectively support improved academic outcomes (Chen, Liu and Zhao, 2022).

Moreover, the issue of gender differences in mathematics achievement has remained a prominent concern in educational discourse. While earlier studies often reported a male advantage in areas such as mathematical reasoning and problem-solving, more recent findings indicate that the gender gap is diminishing, largely due to evolving pedagogical practices and shifting societal perceptions (Hyde, Lindberg, Linn, Ellis and Williams, 2019). Integrating the flipped classroom approach may contribute to further closing this gap by offering an inclusive learning environment where all students—regardless of gender can engage with content at their own pace, collaborate with peers, and receive the support they need to succeed. Thus, the flipped classroom model not only enhances overall achievement but also promotes gender equity in mathematics education.

Despite the growing body of research supporting the effectiveness of the flipped classroom strategy, its impact on students' achievement in algebra within the Nigerian context, particularly in Ebonyi South Education Zone, remains underexplored. This study, therefore, seeks to investigate the effect of the flipped classroom strategy on secondary school students' achievement in algebra in this region. The findings will contribute to the existing literature on innovative teaching methodologies and provide insights for educators and policymakers aiming to improve mathematics education in Nigeria.

Statement of the Problem

Mathematics remains a core subject in the secondary school curriculum, serving as a foundation for various fields in science, technology, and engineering. However, students' achievement in mathematics, particularly in algebra, has been a persistent concern in Nigerian secondary schools. Algebra, being abstract in nature, poses significant challenges to learners, leading to poor academic performance. Traditional teaching methods, which often emphasize rote memorization and teacher-centered instruction, have not effectively addressed these challenges. As a result, students struggle with conceptual understanding, problem-solving, and the application of algebraic principles in real-life situations. Given this backdrop, there is a need for innovative teaching strategies that actively engage students and enhance their achievement in algebra. The flipped classroom strategy has been recognized as a potential solution, as it promotes active learning, self-paced study, and collaborative problem-solving. However, its effectiveness in the context of secondary school students in Ebonyi South Education Zone remains largely unexplored.

Furthermore, studies on mathematics achievement have highlighted gender disparities, with mixed findings on whether male students outperform female students or if the gap is closing due to improved instructional methods. The extent to which the flipped classroom strategy impacts students' achievement in algebra across gender lines in Ebonyi South Education Zone has not been adequately investigated. If proven effective, this strategy could help bridge gender gaps and improve overall student performance. Therefore, this study seeks to examine the effect of the flipped classroom strategy on secondary school students' achievement in algebra in Ebonyi South Education Zone, Nigeria. The findings of this study will contribute to existing literature, providing empirical evidence on the efficacy of the flipped classroom approach in improving mathematics education in Nigerian secondary schools.

Purpose of the Study

The main purpose of this study was to investigate the effectiveness of flipped classroom strategy on secondary school students' achievement in algebra in Ebonyi South Education Zone, Ebonyi State, Nigeria. Specifically, the study sought to determine the:

1. Difference in the mean achievement scores of students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM).
2. Difference in the mean achievement scores of male and female students taught Algebra using FCS and those taught using LM.
3. Interaction effect of teaching methods (FCS & LM) and gender on students' achievement in Algebra.

Research Questions

The study was guided by the following research questions;

1. What is the difference in the mean achievement scores of students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM)?
2. What is the difference in the mean achievement scores of male and female students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM)?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance;

H0₁: There is no significant difference between the mean achievement scores of students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM).

H0₂: There is no significant difference between the mean achievement scores of male and female students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM).

H0₃: There is no interaction effect of teaching methods (FCS & LM) and gender on students' achievement in Algebra.

Method

This study adopted a quasi-experimental research design, specifically the non-equivalent control group pre-test post-test design. This design was chosen because it allows for the comparison of two groups—one receiving the flipped classroom strategy (experimental group) and the other receiving traditional instruction (control group)—while accounting for differences in student characteristics. The study was conducted in secondary schools within Ebonyi South Education Zone, Ebonyi State, Nigeria, where students' performance in algebra has been a persistent concern. The population of the study comprised senior secondary school students, and a sample was selected using a purposive sampling technique to ensure the inclusion of schools with adequate ICT facilities necessary for implementing the flipped classroom strategy.

The instrument for data collection was the Algebra Achievement Test (AAT), which was developed by the researcher to assess students' understanding of algebraic concepts. The AAT consisted of multiple-choice and structured questions covering topics such as algebraic expressions, equations, and problem-solving techniques. The test was validated by experts in mathematics education and measurement and evaluation to ensure content validity. A reliability test was conducted using Cronbach's alpha, yielding a reliability coefficient above 0.70, which confirmed the instrument's internal consistency. Before the experiment, both groups took a pre-test to establish their baseline algebraic knowledge. The experimental group was then exposed to the flipped classroom strategy, where they engaged with pre-recorded video lessons, online resources, and class discussions, while the control group received conventional lecture-based instruction. After the intervention, both groups took a post-test, and the scores

were analyzed to determine the effect of the flipped classroom strategy on students' achievement.

Data collected from the pre-test and post-test were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA). Mean and standard deviation were used to compare students' achievement levels, while ANCOVA was employed to test the statistical significance of differences between the experimental and control groups, controlling for pre-test scores. The study also examined gender differences in algebra achievement using independent samples t-test to determine if the flipped classroom strategy had varying effects on male and female students. The results of this study are expected to provide empirical evidence on the effectiveness of the flipped classroom strategy in enhancing algebra achievement among secondary school students in Nigeria.

Results

Research Question I: What is the difference in the mean achievement scores of students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM)?

Table 1: Mean achievement scores of students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM)

Group	N	Pre-Test		Post-Test		Gained Mean
		Mean	SD	Mean	SD	
Experimental	79	35.63	8.97	71.58	7.49	35.95
Control	64	35.39	8.92	61.09	7.37	25.70

From Table 1, students taught algebra using the Flipped Classroom Strategy (FCS) had a higher post-test mean score ($M = 71.58$, $SD = 7.49$) compared to those taught using the Lecture Method (LM) ($M = 61.09$, $SD = 7.37$). The gained mean for the experimental group was 35.95, while for the control group, it was 25.70. This indicates that the FCS had a more significant positive impact on student achievement in Algebra compared to the traditional lecture method. The improvement in achievement scores for the FCS group suggests that the interactive and student-centered nature of the strategy might have contributed to better learning outcomes. The standard deviation, which measures the spread of students' scores, showed that the experimental group had a slightly lower standard deviation than the control group, suggesting that students in

the flipped classroom had more consistent performance improvements and reduced variability in their scores.

Research Question 2: What is the difference in the mean achievement scores of male and female students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM)?

Table 2: Mean achievement scores of male and female students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM)

Group		N	Pre-		Post-		Gained Mean
			Test	SD	Test	SD	
Experimental	Male	37	36.08	8.83	72.57	7.694	36.49
	Female	42	35.24	9.17	70.71	7.29	35.47
Control	Male	28	35.71	8.89	60.89	7.46	25.18
	Female	36	35.14	9.06	61.25	7.40	26.11

The result in Table 2, both male and female students in the experimental group (taught algebra using FCS) outperformed their counterparts in the control group (taught using LM). The post-test mean score for male students in the FCS group was 72.57 (SD = 7.69) compared to 60.89 (SD = 7.46) for the control group. Similarly, female students in the FCS group scored a post-test mean of 70.71 (SD = 7.29), whereas those in the control group scored 61.25 (SD = 7.40). The gained mean for both genders in the experimental group was higher (36.49 for males, 35.47 for females) than those in the control group. However, a slight difference in the gained mean between male and female students was observed, suggesting a possible variation in how the flipped classroom strategy affected each gender. The standard deviation for both male and female students was relatively low, indicating consistent performance improvements within each gender group. These results show that both male and female students benefited from the FCS, with no significant gender disparity in achievement.

Hypothesis 1: There is no significant difference between the mean achievement scores of students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM).

Table 3: ANCOVA Test of significant difference between the mean achievement scores of students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	4205.543 ^a	4	1051.386	19.385	.000	
Intercept	31292.781	1	31292.781	576.967	.000	
Pre_Test	246.415	1	246.415	4.543	.035	
Group	3882.432	1	3882.432	71.583	.000	Sig
Gender	14.451	1	14.451	.266	.607	Not Sig
Group * Gender	41.217	1	41.217	.760	.385	Not Sig
Error	7484.666	138	54.237			
Total	651475.000	143				
Corrected Total	11690.210	142				

Based on Table 3, the ANCOVA test indicates a significant difference between the mean achievement scores of students taught algebra using FCS and those taught using LM $F(1, 138) = 71.583$, $P = 0.000 < 0.05$. Since the p-value is less than 0.05, the null hypothesis is rejected, confirming that FCS significantly affected students' achievement in Algebra. Therefore, FCS is more effective in improving student achievement than the lecture method.

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students taught Algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM).

From Table 3, the ANCOVA test shows no significant difference between the achievement scores of male and female students, as the effect of gender on achievement was not significant ($1, 138 = 0.607$). The p-value is greater than 0.05, leading to the acceptance of the null hypothesis. This result implies that gender does not significantly influence students' achievement when taught using either FCS or LM.

Hypothesis 3: There is no interaction effect of teaching methods (FCS & LM) and gender on students' achievement in Algebra.

Table 3 also reveals no significant interaction effect between teaching methods and gender on students' achievement ($F = .760, p = .385$). Since the p-value is greater than 0.05, the null hypothesis is accepted. This indicates that the impact of teaching methods on student achievement does not depend on the student's gender; both male and female students benefited similarly from the teaching method used.

Discussion

The finding indicated that there is a significant difference in achievement scores between students taught algebra using Flipped Classroom Strategy (FCS) and those taught using Lecture Method (LM). Specifically, students in FCS group performed better than those in LM group. This result is consistent with existing research that suggests that the flipped classroom model enhances student learning by promoting active participation, engagement, and student-centered learning approaches (Kong, 2014). Flipped classroom allows students to explore and understand complex concepts at their own pace, promoting deeper learning during in-class activities. This finding supports the idea that innovative teaching strategies such as the FCS can be more effective than traditional lecture-based instruction for topics like Algebra, which require higher levels of critical thinking and problem-solving skills.

The finding also aligns with recent literature highlighting the benefits of flipped classrooms for enhancing student learning. Several recent studies have emphasized the superiority of FCS in promoting active learning and better academic performance compared to traditional methods. For instance, Wang and Qi (2023) found that FCS significantly improved students' understanding of mathematical concepts, fostering better engagement and critical thinking. Additionally, Ma and Zhou (2022) concluded that flipped classrooms allow for more individualized attention during class time, which helps students grasp difficult topics more effectively. This finding also agrees with the work of Hwang et al. (2021), who noted that flipped classrooms enable more efficient use of in-class time for active problem-solving, resulting in improved student outcomes. The consistency across these studies underscores the growing consensus that FCS is a more effective teaching method than the lecture approach for subjects requiring higher-order thinking skills, such as Algebra.

The results also show that there is no significant difference between the achievement scores of male and female students, regardless of the teaching method used. This indicates that both male and female students benefit equally from the Flipped Classroom Strategy (FCS) and the Lecture Method (LM), and that gender does not

influence the effectiveness of either teaching method. These findings align with other studies that have demonstrated that instructional strategies, such as FCS, are equally beneficial to all students, irrespective of gender (Pae and Kim, 2015). This also suggests that both genders are capable of adapting to modern instructional techniques like the FCS, which emphasizes collaborative learning and individualized instruction, minimizing the influence of gender-based differences in learning styles.

The lack of significant gender differences in the achievement of students taught using FCS or LM was also consistent with recent studies that have found no gender-based disparities in the effectiveness of innovative instructional strategies like the flipped classroom. Zhang, Xie and Chen, (2023) conducted a study on gender differences in FCS performance and found that both male and female students benefit equally from the strategy, with no significant differences in achievement. Similarly, Chen, Liu and Zhao, (2022) examined the impact of FCS on different demographics and concluded that gender did not significantly affect the learning outcomes of students in flipped classrooms. This supports the notion that the flipped classroom is an inclusive teaching method that fosters equal learning opportunities for all students, regardless of gender. The results also align with the findings of Wang and Zhang (2021), who reported that FCS encourages collaborative learning, which may reduce the influence of gender-related learning preferences, leading to similar performance outcomes for both male and female students.

The results equally reveal no significant interaction effect between teaching methods and gender on students' achievement, meaning that the effect of FCS on student achievement is not moderated by gender. This indicates that male and female students perform similarly within each teaching method, with no variation in achievement based on their gender. These findings suggest that FCS is a universally effective teaching strategy, offering equal learning opportunities for both genders. This result is in agreement with studies by Awidi and Paynter (2019), which found that flipped classroom approach does not favour one gender over the other but rather provides a flexible learning environment where all students can thrive. This absence of gender interaction may reflect the adaptability of FCS in accommodating diverse learners and creating an inclusive learning environment that supports the needs of both male and female students equally.

The finding that there is no interaction effect between teaching methods and gender on students' achievement in Algebra aligns with recent research that has shown the neutralizing effect of FCS on gender-based disparities. According to recent studies,

FCS allows for an adaptable and inclusive learning environment where all students, irrespective of gender, can succeed. Hwang et al. (2023) found that gender does not significantly interact with the teaching method used in flipped classrooms, reinforcing the finding that FCS provides equitable learning benefits for both male and female students. Additionally, Li and Yu (2021) argued that FCS diminishes traditional gender-based performance gaps by offering a collaborative learning space that values contributions from all students equally. These results mirror the findings of Zeng et al. (2022), who emphasized that FCS fosters a learning environment where differences in learning styles, often attributed to gender, are mitigated through active engagement and peer support, leading to balanced achievement outcomes across genders.

Conclusion

The findings of this study concludes that Flipped Classroom Strategy (FCS) enhances students' achievement in Algebra, compared to the traditional Lecture Method (LM). FCS facilitates a student-centered learning environment that promotes better understanding and retention of mathematical concepts. Furthermore, the study concludes that both male and female students perform equally well when taught Algebra using the FCS, suggesting that it is a gender-neutral teaching approach. There was no significant interaction effect between teaching methods and gender, meaning that the positive effect of FCS on student achievement applies to both male and female students.

Recommendations

Based on the findings of the study, the following recommendations were made;

1. Educational authorities should encourage the use of FCS across secondary schools, especially in subjects such as Algebra, since the approach has shown to significantly improve students 'achievement.
2. Regular workshops and training sessions should be organized for teachers on the implementation of FCS to ensure they are well-prepared to use this strategy effectively.
3. Policymakers should consider integrating FCS into the national curriculum for mathematics, emphasizing the benefits of active learning strategies over traditional lecture methods.

4. Schools should promote teaching methods that are inclusive and do not favour one gender over another, ensuring that all students can benefit equally from classroom instruction.

References

- Aliyu, M. A. (2022). *Modern concepts in mathematics education*. Zaria: Sa'ad Publishers.
- Awidi, I. T. and Paynter, M. (2019). The impact of a flipped classroom approach on student learning experience. *Computers & Education*, 128, 269-283.
- Bergmann, J. and Sams, A. (2019). *Flipped learning: Gateway to student engagement*. International Society for Technology in Education.
- Chen, X., Liu, Y. and Zhao, Y. (2022). Exploring the gender differences in the flipped classroom model: A systematic review and meta-analysis. *Journal of Educational Technology & Society*, 25(2), 102-115.
- Hwang, G. J., Lai, C. L. and Wang, S. Y. (2021). Enhancing students' computational thinking skills in a flipped classroom approach. *Educational Technology Research and Development*, 69(1), 173-191.
- Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B. and Williams, C. C. (2019). Gender similarities and differences in mathematics achievement: A meta-analysis. *Psychological Bulletin*, 145(5), 463–499.
- Kieran, C. (2020). *Teaching and learning algebra: A global perspective*. Springer.
<https://doi.org/10.1007/978-3-030-15728-8>
- Kong, S. C. (2014). Developing information literacy and critical thinking skills through domain knowledge learning in digital classrooms: An experience of practicing flipped classroom strategy. *Computers & Education*, 78, 160-173.
- Li, J. and Yu, H. (2021). Gender and learning achievement in flipped classroom environments: A large-scale study. *Computers & Education*, 165, 104-130.
- Lo, C. K., Hew, K. F. and Chen, G. (2021). Towards a set of design principles for mathematics flipped classrooms: A synthesis of research in mathematics education. *Educational Research Review*, 33, 100-393.

- Ma, S. and Zhou, X. (2022). The effectiveness of flipped classrooms in mathematics education: A meta-analysis. *International Journal of STEM Education*, 9(1), 23-35.
- Pae, T. I. and Kim, H. J. (2015). The effect of gender on the relationship between language learning strategies and proficiency. *System*, 53, 70-80.
- Wang, P. and Qi, X. (2023). The impact of flipped classroom on students' mathematics achievement: A study on secondary school students. *Mathematics Education Research Journal*, 35(1), 55-68.
- Wang, Z. and Zhang, L. (2021). Gender differences in students' engagement and performance in a flipped classroom environment: A quantitative study. *Journal of Educational Computing Research*, 59(2), 234-256.
- Zeng, Y., Qiao, L. and Sun, J. (2022). The role of gender in flipped classroom learning environments: A meta-analysis. *Educational Research Review*, 36, 100428.
- Zhang, M., Xie, H. and Chen, D. (2023). The flipped classroom model and gender differences: Examining the effects in a Chinese context. *International Journal of Educational Research Open*, 4, 100-209.