**Research Article**

# Flipped Classroom in Post-Pandemic: Evaluating Gender Divide and Impact on the Student's Achievement in Mathematics

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**ABSTRACT**

Flipped classroom in mathematics is gaining momentum even in post-pandemic. This innovative pedagogy is beneficial in delivering mathematics content even when the number of learning sessions is reduced due to the restrictions of holding in-person classes. This study explores the effect of flipping mathematics classroom on the achievement of high school students and if a gender divide exists. One-Group Pre-test and Post-test Design was employed. Fifty-seven (57) Grade 10 students were the respondents of this study of which there were twenty-five (25) male and thirty-two (32) female students. Findings revealed that students improved their scores in the given mathematics assessment after being exposed to the flipped classroom. Consequently, the Mean Percentage Scores increased significantly from Low Mastery to Average Near Mastery. However, no gender divide was found in a flipped classroom. Overall, the flipped classroom can potentially increase students' achievement in mathematics.

*Keywords: Flipped Classroom, Gender Divide, Mathematics Achievement, Mean Percentage Score*

## Introduction

Mathematics is one of the challenging subjects most high school students considered before the pandemic happens, even more so during this tumultuous time. Students who were exposed to Modular Distance Learning (MDL) claimed to have developed anxiety in learning mathematics (Capinding, 2022). Additionally, students perceived that learning mathematics became challenging in distance learning since they have less interaction with their teacher and classmates (Almarashdi & Jarrah, 2021).

Educators across the globe employed viable learning strategies to lessen the struggles of students in learning mathematics amidst the pandemic. One of the emerging educational practices to support Modular Distance Learning (MDL) is Flipped Classroom (Asad et al., 2022). Ramakrishnan & Priya (2016) argue that a "flipped classroom is suitable for

mathematics teaching" since some parents have no proper training to teach their children at home and solve some mathematical problems.

A flipped classroom is an innovative pedagogy that reverses conventional teaching and learning activities by delivering the learning competencies outside the classroom (Ramakrishnan & Priya, 2016; Fernandez-Martin et al., 2020; Asad et al., 2022). In a mathematics flipped classroom, the teacher provides video lessons for students to watch at home and then do some math exercises after viewing the material. It transformed the traditional classroom into an active learning setting since students will come to school ready and more time will be allotted for discussion of math concepts, problem-solving, and giving of feedback.

Several studies revealed promising benefits of flipping classroom in teaching and learning mathematics. Flipped classroom not only increase students' engagement and interaction but also improves the academic achievements of low-performing students (Unakorn & Klongkratoke, 2015; Bhagat et al., 2016; Ramakrishnan & Priya, 2016; Albalawi, 2018 Algarni, 2018; Shukla & Mcinnis, 2021). Moreover, students who were exposed to the flipped classroom performed significantly higher in mathematics assessment than those students who attended traditional classes (Graziano & Hall, 2017; Albalawi, 2018; Algarni, 2018; Youssef & Al-Shahrani, 2021).

Fung et al. (2021) highlighted that flipped classroom enables learners to learn at their own pace and convenience, and re-watched video lessons anywhere at any time. It also increases opportunities for discussion, clarification of conceptual and procedural misconceptions, and feedback. More importantly, low achievers get more attention from the teacher.

Minaz et al. (2018) and Kutigi et al. (2022) explored if a gender divide in flipped classroom exists. Researchers found no significant difference in the performance of male and female students after the treatment. It is also noteworthy to point out that both test scores of students increased from pre-test to post-test.

On the other hand, "both male and female students who were exposed to flipped classroom performed better on the assessment compared to those male and female students in the traditional classes" (Minaz et al., 2018).

In the Philippines, in-person classes are in place after almost two years of hiatus. This school year 2022-2023, the Department of Education (DepEd) allowed the schools to implement viable learning modalities for the First Quarter either "full face-to-face classes, blended learning modality, or full distance learning" (DepEd Order No. 34, 2022). Most of the schools across the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) implemented a blended learning modality with 3-day of in-person classes and 2-day of modular distance learning.

Najmi (2020) emphasized that a "flipped classroom can be used as an alternative way of delivering instructions even in a multi-shift school system." With the present shift of classes, the flipped classroom can help develop the mathematics skills of students even when school time is reduced (Najmi, 2020). Similarly, Batilantes (2022) accentuated that flipped classroom can cover untaught learning competencies even without the presence and supervision of the teacher due to school activities and ancillary workloads.

Mathematics teachers of Tairan National High School in Basilan Schools Division developed video lessons in School Year 2020-2021 that is based on the Most Essential Learning Competencies (MELC) as a supplement to modular distance learning. In the post-pandemic, the same video lessons were given to the students to help them learn and practice mathematics concepts at home. These video lessons were shared with the students. Teachers implemented flipped classroom since most of the students own mobile devices.

This study evaluates the effect of the flipped classroom on the achievement of students in mathematics in post-pandemic and determines if a gender divide in flipped classroom exists since less is known about this trend.

Specifically, the study sought to answer the following:

1. Is there a significant difference between the Pre-test results of the male and female students?
2. Is there a significant difference between the Pre-test and Post-test results of students exposed to the flipped classroom when analyzed by gender?
3. Is there a significant difference between the Post-test results of the male and female students exposed to the flipped classroom?
4. What is the level of achievement of the male and female students exposed to the flipped classroom in the Post-Test?

## Methods
### *Research Design*
This study made use of the One-Group Pre-Test-Post-Test Design since it can be used to evaluate the effectiveness of an intervention (Stratton, 2019). Male and female students were given pre-test before the start of the school year to assess their prior knowledge of the course materials in mathematics. Students were exposed to the flipped classroom in learning mathematics. The researchers gave the video lessons to the students for them to watch at home. Students were required to answer the exercises given at the end of the video lessons since they will be having board work when they come back to school. The teacher explains the concepts and then discusses the exercises with the students. Post-test was given five (5) weeks after the students were exposed to the flipped classroom.

### *Respondents*
The fifty-seven (57) Grade 10 students of Tairan National High School enrolled in the School Year 2022-2023 were conveniently chosen to be the samples for this study. There were twenty-five (25) male and thirty-two (32) female students who were exposed to the flipped classroom.

### *Data Gathering Procedure*
The researchers prepared and secured the pertinent documents including the permit to conduct the study and the assessment tool that will be used for this study. Upon approval, the researchers administered the pre-test to the Grade 10 students at the beginning of the school year 2022-2023. Pre-test scores were recorded.

After the pre-test was administered, students were oriented that they will be given video lessons to view at home. The researchers developed the video lessons anchored on the Most Essential Learning Competencies (MELC) for Mathematics 10 and this is similar to the content of the Adaptive Learning Materials (ALM), a self-learning module, being used in the Bangsamoro region. These video lessons contain concept notes, examples, and exercises for students to acquire learning competencies while learning at home. Also, students were required to accomplish the exercises at the end of each video lesson. These exercises will be discussed through board work when students come back to school.

In this flipped classroom setup, the teacher will explain the concepts and then call students randomly to solve the problem on the board and feedback follows. This set-up lasted for five (5) weeks covering the learning competencies for Sequences under Patterns and Algebra.

The researchers gave the post-test to the students to determine the flipped classroom's impact on the achievement of the students in mathematics and if a gender divide exists.

The pre-test and post-test results were analyzed using suitable statistical tests through the R Statistical package.

### *Research Instrument*
The *Mathematics Achievement Test for Sequences (MATS)* is a 50-item multiple-choice researcher–made assessment for Mathematics 10 covering the Most Essential Learning Competencies (MELC) for Arithmetic sequence, Geometric Sequence, and other types of sequences. Three mathematics teachers from Basilan Division validated the MATS. The instrument was pilot tested and tested its reliability through R with a Cronbach's Alpha coefficient of .73 (Institute for Digital Research and Education Statistical Consulting, 2020). In addition, the difficulty and discrimination index of the MATS was .511 and .287 respectively, showing that the MATS can be classified as average and good.

## Data Analysis

The test results of the male and female students were tested for normality and homogeneity through the R Statistical Package. The Shapiro-Wilk tests and Levene's *F* tests on the pre-test results of male and female students showed no significant departure from normality and no violation of equal variances assumptions. Hence, a parametric test, specifically, an independent *t*-test was employed to determine if there is a difference between the prior knowledge of male and female students.

To compare the pre-test and post-test results of the male and female students, a nonparametric test was carried out since the post-test results of both male and female groups showed a violation of the assumptions of normality; $W$ (25) = 0.76548, $p$ = .00006365 for male group and $W$ (32) = 0.91496, $p$ = .01521 for the female group. Similarly, a Mann Witney U test was carried out to compare the post-test results of male and female students to determine if there is a gender divide in the flipped classroom in post-pandemic.

The researchers calculated the achievement levels through Mean Percentage Score (MPS). It can be derived by getting the quotient of the mean score and total number of items then multiplied it by 100. The achievement level is interpreted using these ratings: "Mastery (96-100), Closely Approximating Mastery (86-95), Moving Towards Mastery (66-85), Average Near Mastery (35-65), Low Mastery (15-34), and Very Low Mastery (5-14), and Absolutely No Mastery (0-4)" (DepEd Memorandum no. 160 series of 2012).

# Result and Discussion
## Comparison of the Pre-Test Results by Gender

To determine if the male and female students have the same prior knowledge before the conduct of the study, the pre-test results were compared. Table 1 presents the summary statistics of the Pre-test results by Gender.

*Table 1. Summary Statistics of the Pre-Test Results by Gender*

| Groups | N | Min | Max | Mean Score | SD |
|--------|---|-----|-----|-----------|-----|
| Male | 25 | 5 | 20 | 13.04 | 4.02 |
| Female | 32 | 5 | 24 | 14.94 | 4.21 |

Pre-test results of the male group ($M$ = 13.04, $SD$ = 4.02) and the female group ($M$ = 14.94, $SD$ = 4.21) are relatively close, showing that both groups obtained approximately the same scores.

The researchers made use of a *t*-test to determine if the mean difference in the pre-test results of students is statistically significant. Table 2 shows that no significant difference was found in the pre-test results: $t$ (55) = 1.7298, $p$ = .0893 (two-tailed). Thus, both groups are of equal prior knowledge before being exposed to the flipped classroom in mathematics.

*Table 2. Comparison of Pre-Test Results by Gender using independent t-test*

| N | Mean Score | Std. Deviation |
|---|-----------|----------------|
| 25 | 13.04 | 4.02 |
| 32 | 14.94 | 4.21 |

*\*Significant at p < 0.05 (two-tailed).*

## Comparison of the Pre-Test and Post-Tests Results by Gender

The researchers compared the pre-and post-test results to test the effect of the flipped classroom on students' achievement in mathematics. Table 3 presents the summary statistics of the pre-test and post-test results.

*Table 3. Summary Statistics of the Pre-test and Post-test results of Male and Female Students*

| Group | N | Pre-Test | | | Post-Test | | | Mean Gain |
|---|---|---|---|---|---|---|---|---|
| | | *M* | MPS | *SD* | *M* | MPS | *SD* | |
| Male | 25 | 13.04 | 26.08 | 4.02 | 18.64 | 37.28 | 6.79 | 5.6 |
| Female | 32 | 14.94 | 29.88 | 4.21 | 19.78 | 39.56 | 6.30 | 4.84 |
| Overall | 57 | 14 | 28 | 4.21 | 19 | 38 | 6.48 | 5 |

Comparing the results of the pre-test ($M$ = 13.04, $SD$ = 4.02) and the post-test ($M$ = 18.64, $SD$ = 6.79) of male students, the mean scores increased by 5.6, indicating that male students got more correct answers in the post-test after being exposed to the flipped classroom in learning mathematics. Consequently, the Mean Percentage Scores (MPS) of male students increased from 26.08 (Low Mastery) to 37.28 (Average Near Mastery).

Similarly, female students gained a significant increase of 4.84 in the mean scores of their post-test results ($M$ = 19.78, $SD$ = 6.30) compared to their pre-test results ($M$ = 14.94, $SD$ = 4.21). This indicates that female students improved their scores in the post-test after exposure to flipped classes in mathematics. As a result, the MPS of female students increased from 29.88 (Low Mastery) to 39.56 (Average Near Mastery).

Overall, the students who were exposed to the flipped classroom increased their mean scores from the pre-test ($M$ = 14, $SD$ = 4.21) to the post-test test ($M$ = 19, $SD$ = 6.48) with a mean gain of 5. In addition, students demonstrated Average Near Mastery with an MPS of 38 in the post-test compared to the pre-test where students demonstrated Low Mastery with an MPS of 28. Generally, flipping mathematics classroom can improve the achievement or mastery level of students.

The pre-test and post-test results of male and female students were compared and analyzed through Wilcoxon Paired Samples Signed Rank Test to determine whether the increase is significant. Table 4 shows the analyses using Wilcoxon Paired Samples Signed Rank Test.

Results show that male students performed significantly better in the post-test compared to the pre-test; z = 3.04, $p$ = .002. Likewise, female students gained a statistically significant increase in their mathematics achievement when the pre-test and post-test results were compared; z = 3.91, $p$ < .001. These findings show that male and female students significantly increased their performance in mathematics when the flipped classroom was used. Overall, students significantly increased their academic achievement in mathematics. These findings coincide with Unakorn & Klongkratoke (2015); Ramakrishnan & Priya (2016); McNaughton (2017); Albalawi (2018); Shukla & Mcinnis (2021); Batilantes (2022) and Kutigi, et al. (2022).

*Table 4. Comparison of Pre-Test and Post-Test Results by Gender using Wilcoxon Signed Rank Test*

| Group | Post-Test – Pre-Test | N | Rank Average | Rank Total | z | p | Interpretation |
|---|---|---|---|---|---|---|---|
| Male | Negative Rank | 7 | 7.07 | 49.5 | 3.04 | .002* | Significant |
| | Positive Rank | 18 | 15.31 | 275.5 | | | |
| | Equal | 0 | | | | | |
| Female | Negative Rank | 6 | 9.17 | 55 | 3.91 | .001* | Significant |
| | Positive Rank | 26 | 18.19 | 473 | | | |
| | Equal | 0 | | | | | |
| Overall | Negative Rank | 13 | 15.69 | 204 | 4.95 | .001* | Significant |
| | Positive Rank | 44 | 32.93 | 1449 | | | |
| | Equal | 0 | | | | | |

*Significant at $p$ < 0.05 (two-tailed).*

*Table 5. Comparison of Post-Test Results by Gender using Mann-Whitney U Test*

| Group | n | Rank Average | Rank Total | W | P | Interpretation |
|---|---|---|---|---|---|---|
| Male | 25 | 26.72 | 668 | 342.5 | .3579 | **Not Significant** |
| Female | 32 | 30.81 | 986 | | | |

*\*Significant at p < 0.05 (two-tailed).*

### Comparison of the Post-Test Results by Gender

The researchers compared the post-test results of male and female students to determine if a gender divide exists in a flipped classroom. Table 5 shows that no significant difference was found between the post-test results of male and female students; $W = 342.5$, $p = .3579$. This indicates that the performance of the male and female students is equally the same when the flipped classroom was used in mathematics. This finding corroborates with Minaz et al. (2018) and Kutigi, et al. (2022).

### Comparison of the MPS of the Post-Test Results by Gender

The researchers computed the Mean Percentage Scores (MPS) per learning competency of the post-test results of the male and female students.

As shown in Table 6, out of sixteen (16) learning competencies in the MELC for Mathematics 10, the Male students demonstrated one (1) Moving Towards Mastery (MTM), seven (7) Average Near Mastery (AVR), and eight (8) Low Mastery (L). The overall MPS of the Male students in the Post-test is 37.28%, indicating that the male students demonstrated Average Near Mastery (AVR) in the Post-Test. On the other hand, female students demonstrated (2) Moving Towards Mastery (MTM), eight (8) Average Near Mastery (AVR), and six (6) Low Mastery (L). The achievement level of female students in the Post-Test is 39.56%, indicating an Average Near Mastery (AVR). Overall, the achievement index through the MPS of the male and female students in the post-test revealed that there is no difference in the level of achievement. However, if we compare the MPS of Pre-Test and Post-Tests results the students' academic achievement in mathematics improved positively when exposed to the flipped classroom. Hence, the flipped classroom can enhance the academic achievement of students in learning mathematics.

*Table 6. Achievement Index per Competency of the Post-Test Results by Gender*

| CONTENT | LEARNING COMPETENCIES | MALE MPS (%) | FEMALE MPS (%) |
|---|---|---|---|
| ARITHMETIC SEQUENCE | 1. Generate and describe patterns | 76 (MTM) | 72.92 (MTM) |
| | 2. Find the next few terms of a sequence | 57.33 (AVR) | 41.67 (AVR) |
| | 3. Find the nth term of a sequence | 35.2 (AVR) | 45.2 (AVR) |
| | 4. Illustrate an arithmetic sequence | 48 (AVR) | 54.69 (AVR) |
| | 5. Determine the nth term of a given arithmetic sequence | 40 (AVR) | 43.75 (AVR) |
| | 6. Find the arithmetic means of an arithmetic sequence | 30 (L) | 37.5 (AVR) |
| | 7. Determine the sum of the first *n* terms of a given arithmetic sequence | 28.8 (L) | 29.38 (L) |

| CONTENT | LEARNING COMPETENCIES | MALE MPS (%) | FEMALE MPS (%) |
|---|---|---|---|
| | 8. Solve problems involving arithmetic sequence | 32.8 (L) | 31.88 (L) |
| | 9. Illustrate a geometric sequence | 62 (AVR) | 73.44 (MTM) |
| | 10. Differentiate a geometric sequence from an arithmetic Sequence | 36 (AVR) | 35.94 (AVR) |
| | 11. Determine the $n$th term of a given geometric sequence | 14 (L) | 29.69 (L) |
| GEOMETRIC SEQUENCE | 12. Find the geometric means of a geometric sequence | 24 (L) | 39.06 (AVR) |
| | 13. Determine the sum of the first $n$ terms of a geometric sequence. | 28 (L) | 29.69 (L) |
| | 14. Determine the sum of the first $n$ terms of an infinite geometric sequence. | 30 (L) | 25 (L) |
| | 15. Solve real-life problems involving geometric sequences | 23 (L) | 27.34 (L) |
| OTHER SE-QUENCES | 16. Illustrate other types of sequences like harmonic sequence and Fibonacci sequence | 40 (AVR) | 39.06 (AVR) |
| **Overall Mean Percentage Score (MPS)** | | **37.28 (AVR)** | **39.56 (AVR)** |

*Note.* MTM – Moving Towards Mastery, AVR – Average Near Mastery, L- Low

## Conclusion

Based on the results above, researchers concluded that:

1. Male and female students have the same prior knowledge of the learning competencies under sequences before the implementation of the flipped classroom.
2. Both male and female students showed a significant increase in their scores from pre-test to post-test, showing that flipped classroom can potentially improve the academic achievement of students in learning mathematics.
3. There is no gender divide in a flipped classroom in mathematics.
4. The use of the flipped classroom in mathematics can improve the academic achievement or mastery level of the students.

## Recommendations

The use of the flipped classroom in post-pandemic enhanced students' mathematics achievement. Hence, the researchers recommend the following:

1. Conduct a further study on the effectiveness of the flipped classroom in post-pandemic by comparing a flipped classroom with traditional classes.
2. Explore whether flipped classroom can increase knowledge retention in mathematics.
3. Conduct an In-Service Training or workshop for teachers in the MBHTE-Basilan Schools Division on how to use flipped classroom not just in mathematics but in other learning areas as well.

## Acknowledgement

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