

Student Academic Performance and Engagement in Mathematics through Flipped Classroom in a Synchronous Learning Environment

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Abstract The flipped classroom approach allows students to watch teacher-made video lessons outside classes on an online platform called Edpuzzle, answer embedded questions, and perform tasks before synchronous class. The study assessed the academic performance and engagement in Mathematics of Grade 10 students through the flipped classroom (FC) in a synchronous learning environment. It aimed to a) ascertain students' academic performance in Mathematics, b). determine the level of students' engagement in Mathematics in terms of; cognitive, behavioral, emotional, and social engagement; c) determine if there is a significant difference between the academic performance of students in Mathematics; and d) examine the significant difference between the level of engagement of students in Mathematics. This study used the quasi-experimental research design. It was conducted at Valencia National High School with the Grade 10 students as participants. The student's academic performance and engagement in Mathematics were gathered using validated instruments to answer the research problems. Results showed that students' mean academic performance in both groups were very low in the pre-test. However, in the post-test, FC group showed an increase in performance, making to the high level, and non-FC group showed a slight increase making it to a low level. Although there has been a slight increase in the mean of the FC group in their engagement, both groups showed positive engagement toward Mathematics. Analysis of Covariance (ANCOVA) revealed a significant difference in students' academic performance in terms of post-test, while no significant difference was found in their engagement in Mathematics. Students in the FC group performed better in the post-test. However, both groups were comparably engaged in learning Mathematics.

Keywords: *academic performance, engagement, mathematics, flipped classroom, synchronous learning environment*

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1. Introduction

The Coronavirus Disease (COVID-19) pandemic at present continues to be a significant issue, threatening education in most parts of the world, especially the Philippines, one of the less developed countries economically [1]. Most educational institutions at any level stopped physical instruction and shifted to blended learning to contain the spread of COVID-19 [2]. Adopting distance learning has been one of the keys to ensuring the continuity of education following the physical closure of schools. On average, students are likely to experience a learning loss, and technology plays a vital role in this learning environment.

The shift from a classroom environment to a distance learning environment raises worries for students since they are to learn most concepts independently at home [3]. This concern adds to the existing concern of every mathematics educator facing the fact that the mathematics

skills of the learners are weakening, showing less academic performance and, most especially, the negative disposition perceiving the subject as the most difficult compared to the other learning areas. This challenge is even more evident, especially today when we teach Mathematics through blended learning instruction combining, modular instruction, and online learning instruction (synchronous and asynchronous).

The emergence of this event challenges mathematics educators to find alternative innovations and ways to engage learners in different activities that will aid them in learning Mathematics, help them enhance their mathematical achievement, and to help them have a cheerful disposition towards the subject. Teachers can no longer educate in classrooms only but can also utilize technology to conduct distance learning. Coping with today's situation, with the use of flipped classrooms in a distance learning environment, learners can enhance their mathematical learning abilities while at home, filling in the gap in education today.

In a flipped classroom, students watch video-recorded lectures outside of class. The 'flipped' part of the flipped classroom means students watch or listen to lessons at home and do their 'homework' in style. Flipping the classroom involves online learning through video lectures but is supported by face-to-face classroom discussions and individual help [4]. However, given the situation, the face-to-face classroom is impossible, so the researcher incorporated flipped classrooms in a synchronous learning environment. In this study, video lessons are given to the students, but instead of having face-to-face in class, instruction were done through a synchronous learning environment.

Flipped classroom mainly incorporates technology, which positively influences the learners' level of engagement [5]. Lin et al. [6] viewed motivation as one vital factor for every learner to perform and have lasting and continuing significant learning. At the same time, Francis [5] stated that technology integration significantly impacts engaging learners in meaningful learning activities.

A lot of researchers claim that flipped classroom has been found effective in improving students' academic performance and engagement in Mathematics. However, these limited studies need to give conclusive results on whether flipped classrooms will indeed enhance students' performance while delivering it in a synchronous learning environment.

With the previous statements, the researchers sought to examine the potential of the flipped classroom in enhancing students' academic performance and engagement in Mathematics in a synchronous learning environment.

2. Materials and Methods

The study assessed the academic performance and engagement in Mathematics through the flipped classroom in a Synchronous Learning Environment at Valencia National High School for SY 2021-2022. This study used the quasi-experimental research design with two different intact classes. One of the two intact classes was set as the experimental group, while the other was considered the controlled group. The two groups of students were given instruction with the same lessons.

Two (2) instruments were used to gather the data: the student engagement questionnaire and the Division-wide examination in Mathematics adopted from the Division of Valencia City. One instrument used in the study was a matrix-formed close-ended questionnaire that helped the researchers gather the students' engagement data in Mathematics. The questionnaire used was pilot tested in 2015 [15]. The questionnaire consisted of eight (8) cognitive engagement questions, eight (8) behavioral engagement questions, ten (10) emotional engagement questions, and seven (7) social engagement questions with scaling rating that ranges from 5 to 1. A validated Division-wide Mathematic test was used to measure the students' mathematics performance with 30 items covering the topics of Polynomial Function. Items were scored 1 for every correct response, and 0 if otherwise.

A reverse scoring procedure was done for a negative statement.

Before the study, an orientation to both groups was conducted separately via Google Meet. After the orientation, a pre-test on academic performance and engagement in Mathematics was administered to the students before using flipped classroom. The experiment was done in five (5) weeks during the second grading period. After the 5th week's session, the students took the same test, which served as the post-test. The result of the tests was to determine the difference in the student's academic performance and engagement in Mathematics of Grade 10 learners of Valencia National High School.

Analysis of Covariance (ANCOVA) was used to investigate the significant difference in the student's engagement and performance in Mathematics between the two groups. The data collected were tabulated and analyzed using appropriate statistical tools using the software. Descriptive statistics like mean, standard deviation, frequency, and percentage were used to answer the questions on the descriptive levels.

The following rating scale was used to understand the data better:

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive
4	3.51-4.50	Agree	Positive
3	2.51-3.50	Undecided	Fair
2	1.51-2.50	Disagree	Negative
1	1.00-1.50	Strongly Disagree	Highly Negative

Score	Percentage score	Descriptive rating	Interpretation
0 – 14	74% and below	Beginning	Very Low
15 – 17	75% - 79%	Developing	Low
18 – 20	80 – 85%	Approaching Proficiency	Moderate/Average
21 – 23	86 – 89%	Proficient	High
24 – 30	90% and above	Advance	Very High

3. Results and Discussions

The data obtained from the study were analyzed, interpreted, and presented in this chapter. The presentation was in the order of the objectives of the study. Tables and other figures were used to provide a straightforward data analysis.

3.1. Academic Performance of Students in Mathematics before and after Intervention

Table 1 shows students' academic performance in Mathematics of FC Group and Non-FC Group regarding their Pre-test. Among the twenty-nine (29) respondents in each group, twenty-two (22), which comprised 76% of the respondents from the FC group, and sixteen (16), which comprised 55% from the Non-FC group, got a deficient performance with scores lower than 14 out of 30. Four (4) students comprised 14% of the total respondents from the FC Group, and eleven (11) students from the Non-FC Group, which comprised 38% of the total respondents, got a low performance. One (1) student, which comprised 3%

of the FC Group, and two (2) students, which comprised 7% of the total number of respondents from the Non-FC Group, got a moderate performance. Two (2) students, which comprised 7% of the total respondents from the FC Group, got a high score, while no one from the Non-FC Group. Finally, nobody from both group got a very high performance. The overall mean performance of the FC Group on their pre-test is 12.59, which indicates a very low performance, while the overall mean academic performance of the Non-FC Group on their pre-test is 13.45, which shows a very low performance as well.

Table 1. Students' Academic Performance in Mathematics of FC and non-FC group in terms of their Pre-test

Range	FC GROUP			NON-FC GROUP		
	F	%	Interpretation	F	%	Interpretation
90% - 100%	0	0%	Very High	0	0%	Very High
86% - 89%	2	7%	High	0	0%	High
80% - 85%	1	3%	Moderate	2	7%	Moderate
75% - 79%	4	14%	Low	11	38%	Low
65% - 74%	22	76%	Very Low	16	55%	Very Low
Total	29	100%		29	100%	
	Mean =12.59 (Very Low)			Mean=13.45 (Very Low)		

The results in Table 1 show that the students' mean academic performance was very low before their exposure to flipped and non-flipped classrooms. In fact, only two (2) students from FC-Group had high performance, and the rest had low and very low performance in both groups. The result also displayed that despite having two (2) students from the FC Group who had high performance, we can observe that more students from the FC Group had a very low performance compared to the Non-FC Group. This result might be because they have yet to become familiar with the topic, and they found difficulty with the new terms and tasks related to the topic.

This result conforms to the study of Segumpan and Tan [7], where the results on the pre-test of the students exposed to the flipped and non-flipped classrooms were both very low. It also confirms the results of Gumban and Tan [8] when they found out that the students' pre-test scores before the flipped classroom intervention were very low. They stated that it was because the students needed to learn the lesson.

The student's academic performance in Mathematics of the FC Group and Non- FC Group in terms of their post-test is shown in Table 2. The overall mean score of the FC Group on their post-test is twenty-three (23), which indicates a high performance, while the Non-FC Group had an overall mean of 15.59 which indicates a low performance. Among the twenty-nine (29) respondents from the FC Group, eighteen (18) of them, which comprises 62% of the total respondents, got very high performance with a score greater than 24 out of 30, and only two (2) which shall consist of 7% of the total respondents of the group got a very low performance with scores lower than 14. Four (4) of them, which comprises 14% of the total respondents, got a high performance, two (2) of them, which comprises 7% of the total number of respondents, got a moderate performance, and three (3) of them which comprises 10% of the total number of respondents got a low performance. On the other hand,

among the twenty-nine (29) respondents from the Non-FC Group, only one (1), which comprises 3% of the total respondents go, a very high performance, and thirteen (13) of them, which comprises 45% of the total number of respondents got a very low performance. Two (2) respondents, comprising 7% of the total respondents, got a high performance, and two (2) got a moderate performance. Eleven (11) comprised 38% of the total number of respondents who got a low performance.

Table 2. Students' Academic Performance in Mathematics of FC and non-FC groups in terms of their Post-test

Range	FC GROUP			NON-FC GROUP		
	F	%	Interpretation	F	%	Interpretation
90% - 100%	18	62%	Very High	1	3%	Very High
86% - 89%	4	14%	High	2	7%	High
80% - 85%	2	7%	Moderate	2	7%	Moderate
75% - 79%	3	10%	Low	11	38%	Low
65% - 74%	2	7%	Very Low	13	45%	Very Low
Total	29	100%		29	100%	
	Mean=23 (High)			Mean=12.59 (Low)		

The results in Table 2 show a big difference in students' mean academic performance of the FC Group and Non-FC Group. The FC Group showed a high performance, while the Non-FC Group showed a low performance. This result might be because the FC Group has mastered the topic covered since they first watched the video discussion before having the synchronous class. All their questions regarding the topic were entertained because it was written on their note-taking form, and they had a higher task on the lesson compared to the Non-FC group, which only learned the topic during the synchronous class.

The result in Table 2 agrees with the study of Lin et al. [6] that learners who watch pre-recorded video lessons gain higher academic performance than those who don't. It has also been supported by the results of Unakorn, et al. [4], who found that flipped classroom greatly helps students' performance. However, the result contradicts the result of Segumpan and Tan [7], who found that the flipped group in the study had low performance on the post-test.

3.2. Students' Engagement in Mathematics before and after the Intervention

3.2.1. Level of Students' Cognitive Engagement in Mathematics

Table 3 shows students' cognitive engagement in Mathematics exposed to flipped classrooms before and after the intervention. It has an overall mean of 3.88 before and 3.92 after the intervention, both interpreted as "Positive." Among the eight (8) Cognitive Engagement items, one (1) of the statements which is, "I try to understand my mistakes when I get something wrong," had the highest means before and after the intervention, which is interpreted as "Highly Positive" while the statement "I do just enough to get by" had the lowest means which is interpreted as "Fair" both before and after the intervention. Four (4) items have the same rating even after the intervention, which rated "Positive." Two (2)

items that were rated "Fair" before the intervention had a constant rating of "Fair" even after the treatment. One (1) of the items, which is "When work is hard, I only study the easy parts," rated "Positive" (3.52) before the intervention because "Fair" (3.41) after the intervention. Although the statement, "I try to understand my mistakes when I get something wrong," rated Highly positive on both Pre-Test and Post-Test, we can see on the table that there was a slight decrease in its mean after the intervention, from 4.59 to 4.55. The same was reflected in the statement, "When work is hard, I only study the easy parts," where its mean was slightly decreased, from 3.52 to 3.41, after the intervention.

Results in Table 3 show the students' positive cognitive engagement in the FC Group before and after the intervention. It also reveals a slight increase in the students' mean cognitive engagement toward Mathematics after the intervention. Although both means are interpreted to be "Positive," we can see that there has been a slight increase after the intervention. The results also revealed that all of the means in all items on cognitive engagement have increased except on two (2) items which are, "I try to understand my mistakes when I get something wrong" and "When work is hard, I only study the easy parts." This might be because students are in a synchronous learning environment, and sometimes, they need help to focus entirely during the class because of an unstable internet connection. Although they watched the video lesson before the synchronous class, some students might watch it for their attendance while not trying to understand what it was all about and missing out on the important parts of the lesson.

The increase in the mean of cognitive engagement of the students in FC Group aligns with the results of Lo and Hew [9], who found that students in flipped classrooms displayed higher Mathematical performance and cognitive achievement. Moreover, it also aligns with the statement of Mamolo [10], who stated that there was a decrease in students' motivation and self-efficacy when he incorporated

learning Mathematics in a synchronous learning environment.

Table 4 shows students' cognitive engagement in Mathematics exposed to a non-flipped classroom before and after the intervention. It has an overall mean of 3.64 before and 3.73 after the intervention, which both rated "Positive." This result reflects that students' mental activity upon learning Mathematics is "Positive" when exposed to flipped classrooms, where they enjoy learning the subject. None of the eight (8) items rated "Highly Positive" before and after the intervention. Four (4) items rated "Positive" before and after the intervention. Two (2) items rated "Fair" before and after the intervention. Two (2) items which are "I would rather be told the answer than have to do the work" and "I don't think that hard when I am doing work for class," both rated "Fair" before the intervention and rated "Positive" after the intervention. The table also shows that two (2) items on cognitive engagement had a slight increase after, and these are the statements, "I try to connect what I am learning to things I have learned before" and "When work is hard, I only study the easy parts."

The result in Table 4 displays the positive cognitive engagement of the students in the Non-FC Group before and after the intervention. There is also a slight increase in the overall means of cognitive engagement in Mathematics of the students in the Non-FC Group. This might be because students in the Non-flipped group are still exposed to technology while in a synchronous learning environment. Technology helps the learners get motivated to learn the subject.

This finding is supported by the study of Francis [5], which stated that technology greatly impacts engaging learners in meaningful activities. That, the use of technology increases the students' level of motivation and engagement. Moreover, Etcuba, et al. [11] follows this result stating that technology in teaching Mathematics strongly motivates and engages learners in learning.

Table 3. Cognitive Engagement in Mathematics of students exposed to flipped classroom before and after the intervention

Cognitive Engagement in Mathematics	Flipped Classroom Group			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I go through the work for math class and make sure that it's right.	4.34	Positive	4.34	Positive
I think about different ways to solve a problem.	4.21	Positive	4.34	Positive
I try to connect what I am learning to things I have learned before.	4.24	Positive	4.45	Positive
I try to understand my mistakes when I get something wrong.	4.59	Highly Positive	4.55	Highly Positive
*I would rather be told the answer than have to do the work.	3.34	Fair	3.34	Fair
*I don't think that hard when I am doing work for class	3.72	Positive	3.72	Positive
*When work is hard, I only study the easy parts.	3.52	Positive	3.41	Fair
*I do just enough to get by.	3.10	Fair	3.21	Fair
Overall Mean Interpretation	3.88	Positive	3.92	Positive

Legend: (*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

Table 4. Cognitive Engagement in Mathematics of students exposed to non-flipped classrooms before and after the intervention.

Cognitive Engagement in Mathematics	Non-Flipped Classroom Group			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I go through the work for math class and make sure that it's right.	3.76	Positive	3.93	Positive
I think about different ways to solve a problem.	3.83	Positive	3.90	Positive
I try to connect what I am learning to things I have learned before.	4.24	Positive	4.10	Positive
I try to understand my mistakes when I get something wrong.	4.28	Positive	4.38	Positive
*I would rather be told the answer than have to do the work.	3.48	Fair	3.66	Positive
*I don't think that hard when I am doing work for class	3.41	Fair	3.69	Positive
*When work is hard, I only study the easy parts.	3.28	Fair	3.14	Fair
*I do just enough to get by.	2.83	Fair	3.04	Fair
Overall Mean Interpretation	3.64	Positive	3.73	Positive

Legend: (*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

Table 5. Behavioral Engagement in Mathematics of students exposed to flipped classroom before and after intervention

Behavioral Engagement in Mathematics	Flipped Classroom			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I stay focused.	4.03	Positive	3.93	Positive
I put effort into learning math.	4.21	Positive	4.03	Positive
I keep trying even if something is hard.	4.17	Positive	4.34	Positive
I complete my homework on time.	3.93	Positive	3.76	Positive
I talk about math outside of class.	3.24	Fair	3.07	Fair
*I don't participate in class.	3.97	Positive	3.93	Positive
*I do other things when I am supposed to be paying attention.	3.97	Positive	3.79	Positive
*If I don't understand, I give up right away.	4.10	Positive	3.97	Positive
Overall Mean Interpretation	3.95	Positive	3.85	Positive

Legend: (*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

3.2.2. Level of Students' Behavioral Engagement in Mathematics

Table 5 shows the Behavioral Engagement in Mathematics of students exposed to flipped classrooms before and after the intervention. The table shows that the overall mean of the FC group is 3.95 before intervention and 3.85 after intervention which are both interpreted as "Positive". Among the eight (8) statements, seven of which rated "Positive" both before and after the intervention. Only (1) one of the items which is "I talk about math outside of class" rated "Fair" both on its pre-test with a mean of 3.24 and post-test with a mean of 3.07.

The results on Table 5 shows a positive behavioral engagement of the students in the FC Group before and after the intervention. It also shows that there is a minimal decrease on the overall means of behavioral engagement towards Mathematics. Six (6) items out of the eight (8) items on behavioral engagement had a slight decrease after the exposure to flipped classroom. This might be because students are still adjusting to synchronous learning. They might still find difficulty in participating in the class while being in a synchronous environment. One

of the great factors that might explain the results obtained is because of their internet connections. Some of the students might not have a strong internet connection at home finding it hard to participate in the class.

The result agrees with Mamolo [10] where he explained that students found it hard to participate and asks questions to their teacher and classmates when having difficulty in the lesson because they are in the virtual environment. But this result disagrees with Divakaran [12] where he stated that learning Mathematics at home encourages learners to give active participation, learning together, promoting students' engagement in real-time.

Table 6 shows the Behavioral Engagement in Mathematics of students exposed to non-flipped classroom before and after intervention. Among the eight (8) statements, seven (7) of which rated "Positive" both before and after the intervention. One (1) item which is "I talk about math outside of class" rated "Fair" both on its pre-test with a mean of 3.17 and post-test with a mean of 3.31. It has an overall mean of 3.75 before the intervention and 3.90 after the intervention which are both interpreted to be "Positive".

Table 6. Behavioral Engagement in Mathematics of students exposed to non-flipped classroom before and after intervention

Behavioral Engagement in Mathematics	Non-Flipped Classroom Group			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I stay focused.	3.66	Positive	4.07	Positive
I put effort into learning math.	3.97	Positive	4.21	Positive
I keep trying even if something is hard.	4.17	Positive	4.17	Positive
I complete my homework on time.	3.83	Positive	3.86	Positive
I talk about math outside of class.	3.17	Positive	3.31	Fair
*I don't participate in class.	3.90	Positive	4.03	Positive
*I do other things when I am supposed to be paying attention.	3.62	Positive	3.72	Positive
*If I don't understand, I give up right away.	3.69	Positive	3.83	Positive
Overall Mean Interpretation	3.75	Positive	3.90	Positive

Legend: (*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

Results in Table 6 show the students' positive behavioral engagement in the Non-FC Group before and after the intervention. It also reveals that students showed a slight increase in the overall mean of the student's behavioral engagement in the Non-FC Group before and after the intervention. This result might be because although the non-FC group does not watch the video lesson before the in-class discussion, they are still instructed through synchronous class with a lesser task to accomplish than those who are in the FC Group, creating greater time to collaborate with their peers and participate in class.

This finding is supported by Laiet al. [13], who revealed that peer interaction could lead to higher learning engagement. Also, Sangcap [14] believed that students' effort in solving mathematical problems and their attitude dramatically affects their performance.

3.2.3. Level of Students' Emotional Engagement in Mathematics

Table 7 shows students' emotional engagement in Mathematics exposed to flipped classrooms before and after the intervention. It has a mean of 3.77 (Positive) before the intervention and 3.62 (Positive) after the intervention. Among the ten (10) statements, one (1) of which, "I often feel frustrated in math class," rated "Negative" (2.41) before the intervention and still "Negative" (2.31) after the intervention. One (1) item, which is "I feel good when I am in math class," rated "Fair" both before (3.48) and after (3.34) after the intervention. One (1) of the items, which is "I get worried when I learn new things about math," rated "Positive" (3.69) but turned "Fair" (3.07) after the intervention. Seven of the remaining items had a consistent "Positive" rating before and after the intervention.

Table 7. Emotional Engagement in Mathematics of students exposed to flipped classroom before and after the intervention.

Emotional Engagement in Mathematics	Flipped Classroom Group			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I look forward to math class.	3.76	Positive	3.72	Positive
I enjoy learning new things about math.	3.86	Positive	3.72	Positive
I want to understand what is learned in math class.	4.41	Positive	4.34	Positive
I feel good when I am in math class.	3.48	Fair	3.34	Fair
*I often feel frustrated in math class.	2.41	Negative	2.31	Negative
*I think that math class is boring.	3.96	Positive	3.86	Positive
*I don't want to be in math class.	4.07	Positive	3.93	Positive
*I don't care about learning math.	4.48	Positive	4.14	Positive
*I often feel down when I am in math class.	3.55	Positive	3.72	Positive
*I get worried when I learn new things about math.	3.69	Positive	3.07	Fair
Overall Mean Interpretation	3.77	Positive	3.62	Positive

Legend: (*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

The results in Table 7 display a positive emotional engagement of students before and after exposure to flipped classrooms. Table 7 also shows a slight decrease in the overall means of students' emotional engagement in the FC group before and after the intervention. This result was observed because synchronous learning requires a strong internet connection to focus on the discussion. With a stable connection, students might feel satisfied to interact with the teacher and their peers. Because of this, students did not engage wholly and emotionally in the flipped classroom.

This result is supported by that of Yu et al.'s [15] study, where they concluded that there is a significant relationship between online interaction and emotional engagement. Moreover, they explained that emotional engagement is positively affected by peer interaction and student-teacher interaction. Contrary to this, Jamaludin and Osman [16] said that their students were more emotionally engaged and interested in the flipped classroom class and therefore concluded that it helps promote active learning inside and outside the class.

Table 8 shows students' emotional engagement in Mathematics exposed to a non-flipped classroom before and after the intervention. Among the ten (10) items, two (2) items, namely, "I feel good when I am in math class" and "I often feel frustrated in math class," rated "Negative" for both groups before the intervention and rated "Fair" after the intervention. One (1) item, which is "I often feel down when I am in math class," rated "Fair" (3.41) before the intervention and placed "Positive" (3.52) after the intervention. One (1) of the items, which is "I get worried when I learn new things about math," rated "Positive" (3.86) before the intervention and rated "Fair" (3.17) after the intervention. The remaining six (6) items have a constant "Positive" rating both before and after the intervention. It has a mean score of 3.67 before the

intervention and 3.69 after the intervention, which both rated "Positive."

In Table 8, we can see that the students in the non-FC group displayed positive emotional engagement before and after the intervention. It also shows a slight increase in the students' level of emotional engagement in the Non-FC Group after the intervention. Students in the non-FC group show that they are positively engaged emotionally in the class. This finding was observed because despite being in distance learning, they enjoy learning Mathematics with the teacher's assistance in a synchronous learning environment.

This result conforms to Divakaran's [12] findings that synchronous class encourages learners to engage in active participation, learning together, promoting students' engagement in real-time.

3.2.4. Level of Students' Social Engagement in Mathematics

Table 9 shows students' social engagement in Mathematics exposed to flipped classrooms before and after the intervention. It has an overall mean score of 4.14 (Positive) before the intervention and also 4.14 (Positive) after the intervention. All seven (7) items on social engagement rated "Positive" both before and after the intervention.

The results in Table 9 show the students' positive social engagement in the FC Group toward learning Mathematics before and after the intervention. It also showed that there had been constant social engagement because the overall means before and after the intervention had been the same. This observation might be because students became quite acquainted with synchronous classes since they were exposed to this during the pandemic. They have a lot of online platforms where they can communicate with one another.

Table 8. Emotional Engagement in Mathematics of students exposed to non-flipped classroom before and after the intervention.

Emotional Engagement in Mathematics	Non-Flipped Classroom Group			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I look forward to math class.	3.66	Positive	3.69	Positive
I enjoy learning new things about math.	3.69	Positive	3.90	Positive
I want to understand what is learned in math class.	4.14	Positive	4.31	Positive
I feel good when I am in math class.	3.34	Negative	3.41	Fair
*I often feel frustrated in math class.	2.38	Negative	2.45	Fair
*I think that math class is boring.	3.66	Positive	4.10	Positive
*I don't want to be in math class.	4.07	Positive	4.00	Positive
*I don't care about learning math.	4.45	Positive	4.31	Positive
*I often feel down when I am in math class.	3.41	Fair	3.52	Positive
*I get worried when I learn new things about math.	3.86	Positive	3.17	Fair
Overall Mean Interpretation	3.67	Positive	3.69	Positive

Legend: (*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

Table 9. Social Engagement in Mathematics of students exposed to flipped classroom before and after the intervention

Social Engagement in Mathematics	Flipped Classroom Group			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I build on others' ideas	3.86	Positive	3.86	Positive
I try to understand other people's ideas in math class.	4.24	Positive	4.31	Positive
I try to work with others who can help me in math.	4.38	Positive	4.45	Positive
I try to help others who are struggling in math.	3.93	Positive	3.79	Positive
*I don't care about other people's ideas.	4.28	Positive	4.34	Positive
*When working with others, I don't share ideas.	4.21	Positive	4.17	Positive
*I don't like working with classmates.	4.10	Positive	4.07	Positive
Overall Mean Interpretation	4.14	Positive	4.14	Positive

Legend: (*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

This finding is supported by Hinampas et al.'s [17] results that the students are highly engaged when they feel safe and secure, enjoy collaborating with their peers, and are willing to help one another in learning Mathematics. The result disagrees with Mamolo [10], who stated that students found it hard to ask questions to their teacher and classmates when having difficulty in the lesson because they were in the virtual environment.

Table 10 shows students' social engagement in Mathematics exposed to a non-flipped classroom before and after the intervention. All seven (7) items on social engagement in Mathematics shows a "Positive" rating both before and after the intervention. It has an overall mean score of 3.99 (Positive) before the intervention and 4.05 (Positive) after the intervention. The statement "I like working with my classmates" had the highest mean before the intervention, and "I Try to understand other people's ideas in math class" had the highest mean after the intervention.

Table 10. Social Engagement in Mathematics of students exposed to non-flipped classroom before and after the intervention.

Social Engagement in Mathematics	Non-Flipped Classroom Group			
	Before		After	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I build on others' ideas	3.76	Positive	3.76	Positive
I try to understand other people's ideas in math class.	4.07	Positive	4.17	Positive
I try to work with others who can help me in math.	3.93	Positive	4.07	Positive
I try to help others who are struggling in math.	3.72	Positive	3.83	Positive
*I don't care about other people's ideas.	4.14	Positive	4.31	Positive
*When working with others, I don't share ideas.	4.07	Positive	4.10	Positive
*I don't like working with classmates.	4.21	Positive	4.10	Positive
Overall Mean Interpretation	3.99	Positive	4.05	Positive

Legend:(*) means scoring is reversed

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Highly Positive (HP)
4	3.51-4.50	Agree	Positive (P)
3	2.51-3.50	Undecided	Fair (F)
2	1.51-2.50	Disagree	Negative (N)
1	1.00-1.50	Strongly Disagree	Highly Negative (HP)

Table 10 reveals the positive social engagement of the students in the Non-FC Group before and after the intervention. All behavioral items show a slight increase in their mean after the intervention except the statement, "I like working with my classmates." They might have needed help constantly communicating with their classmates in the virtual world.

The result is supported by Mamolo [10] when he emphasized that students find it hard to ask questions in the virtual setting. The slow internet connection might have been the problem for the decrease in motivation and self-efficacy, needing to maintain stable communication.

3.3. ANCOVA on Students' Academic Performance in Mathematics

Table 11 shows the ANCOVA result of the academic performance of the students. As shown in the table, it has an F-value of 81.434, with a probability value of 0.000 ($P < 0.01$), indicating a highly significant difference, thus, rejecting the null hypothesis. This means a highly significant difference exists between the academic performance of the students exposed to FC and non-FC after the intervention. We can also see on their means that there is a big difference in their means. The FC Group had a group mean of 22.97, while the non-FC had a group

mean of 15.57. Therefore, after the intervention, the FC group performed better than the non-FC group.

Table 11. Comparison of students' performance between FC and non-FC Group

GROUP	N	MEAN	SD
Performance Non-FC Group	29	15.57	3.21
FC Group	29	22.97	5.15

Source	SS	Df	MS	F-value	Sig.
Group	1527.446	1	1527.446	81.434	.000**
Pre-test (Covariate)	0.372	1	0.372	0.020	.889
Error	1031.628	55	18.757		
Total	23372.000	58			

**P< Highly Significant at 0.01 level.

The results in Table 11 show that flipped classroom in a synchronous learning environment significantly impacts students' academic performance. Students exposed to flipped classrooms performed better compared to those who were not. This might be because students in the flipped classroom gained more mastery of the concept being discussed after the intervention. After all, they watched the discussion first before having the synchronous class. They were given more opportunities to ask questions because it was embedded in their note-taking form. More importantly, they dealt with higher activity compared to the Non-FC Group.

This result agrees with the findings of Bhagat et al. [18] when they found that learners had improved learning achievement in a flipped classroom, resulting in greater learning motivation.

Similarly, the results of Ramakrishnan [19] also displayed that flipped classroom has positively affected the students' performance. It also conforms to the statement of Unakorn et al. [4], who emphasized that video lectures are much more effective if they contain not only the concept discussion but also supplemental activities where they can immediately apply what they have learned from the discussion.

However, the result contradicts that of Gumban and Tan's [8] when they found out that the intervention had less impact on student's performance in Mathematics. Correspondingly, Segumpan and Tan [7] also found that the student's performance in Mathematics is similar between FC and non-FC Groups. This finding may be due to less exposure of students to technology, and hence, they felt anxious about using them.

3.4. ANCOVA on Students' Engagement in Mathematics

Table 12 shows the ANCOVA results of students' engagement in Mathematics between FC and Non-FC Groups. As shown in Table 12, it has an F-value of 0.653 with a probability value of 0.422 ($P>0.05$), indicating no significant difference, thus, accepting the null hypothesis stating that there is no significant difference between the level of engagement in Mathematics of the students exposed to FC and non-FC after the intervention. This indicates that the student's performance in the two groups is similar. Their means are shown in the table; the FC

Group had a mean of 3.83, and the non-FC group had a mean of 3.86, which only implies that both groups showed the same level of engagement after the intervention.

Table 12. Comparison of students' engagement between FC and non-FC Group

GROUP	N	MEAN	SD
Performance Non-FC Group	29	3.86	0.49
FC Group	29	3.83	0.43

Source	SS	Df	MS	F-value	Sig.
Group	0.021	1	0.021	0.653	0.422*
Pre-test (Covariate)	11.316	1	11.316	353.713	0.000
Error	2.016	63	10.932		
Total	982.755	66			

*P > Not Significant at 0.05 level.

The result in Table 12 revealed no significant difference in the engagement in Mathematics between students in the FC and Non-FC Groups after being exposed to the flipped classroom. This result might be because the two groups are in the science class. Moreover, this is likely because of the time restrained on the exposure to the intervention since engagement requires a longer period to see its enhancement clearly.

This result aligns with the result of Gumban and Tan [8], that students showed positive engagement towards Mathematics before and after the intervention of flipped classrooms.

4. Conclusions and Recommendations

Based on the findings of the study, the following conclusions were drawn:

The level of student academic performance of Grade 10 students exposed to FC and non-FC in terms of Pre-test both showed very low performance. After the intervention, the non-FC group showed a slight increase in the low level and a significant increase in the FC group, which is on the high level.

The students showed "Positive" cognitive, behavioral, emotional, and social engagement in Mathematics before and after the FC and Non-FC Group intervention.

The student's academic performance in the FC and non-FC group is the same before the intervention. But, after the intervention, there is a highly significant difference in the student's academic performance between the FC and the non-FC groups. Hence, flipped classroom in a synchronous learning environment has been found effective in enhancing the student's academic performance in Mathematics.

Students who watched the teacher-made video lessons before the synchronous class performed the activity on the video lesson, answered the note-taking form, and accomplished tasks in the synchronous class performed better than those who only had the synchronous class.

The student's engagement in Mathematics before and after the intervention between the FC and non-FC group is the same. Both groups of students had a Positive Engagement in Mathematics before and after the intervention. Even after using flipped classrooms, it did

not show any difference in the student's level of engagement in Mathematics.

In this pandemic, where technology plays a vital role in teaching-learning, one of the best ways to deliver learning is through the Flipped classroom in a synchronous learning environment. Students can learn the lesson at their own pace and ask for assistance from their guardians while learning the lesson. They can develop critical thinking skills by answering activities embedded in the teacher-made video lessons and independently and freely asking questions about the lesson.

It is a time-saving technique to deliver learning and promote communication between teacher and learner.

Based on the summary of findings and conclusion of the study, the following recommendations are put forward:

The Flipped classroom in a synchronous learning environment helps increase the student's academic performance in Mathematics. This strategy is recommended to mathematics educators, especially in this pandemic, where students need constant communication and feel that their teachers are with them. If the resources are ready and accessible, this is a very time-saving and effective method.

If resources are available, researchers may use respondents outside the science class to see if there would be an effect on the student's engagement level in Mathematics.

Before utilizing this strategy, it is also suitable for mathematics teachers to be more equipped with techniques for handling classes in a synchronous learning environment. Mathematics teachers are advised to utilize teacher-made video lessons to contextualize the video lessons for the learners.

For future researchers, it is suggested to increase the number of respondents since those capable of being in a synchronous environment are being considered in this study.

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