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Conventional versus Peer Teaching in Flipped Classroom: Which is Better at Increasing Students' Conceptual Understanding and Self-Efficacy?

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ABSTRACT

Calculus is one of the branches of mathematics which is often deemed difficult by students, indicated by students' weak conceptual understanding and low self-efficacy in calculus-related courses. Thus, innovative learning needs to be encouraged to overcome this problem. This study compares the effectiveness of whether a conventional or peer-teaching method is better at increasing students' conceptual understanding and self-efficacy in flipped classroom teaching practices. A descriptive quantitative method was used in this study. This research was conducted in two classes in the calculus course at a teacher education program at a university in West Sumatra. The first class was taught in a Conventional Flipped Classroom (CFC) with 34 students. The second class took place in a Peer Teaching Flipped Classroom (PTFC) with 36 students. Pre-test, post-test, self-efficacy questionnaires, and field notes were used for data collection. Data analysis techniques were performed using graphs. Results indicate that students' conceptual understanding and self-efficacy by peer teaching were better in the flipped classroom than in the conventional flipped classroom. Also, students' academic background was found to be influential to students' conceptual understanding and self-efficacy. We reveal that the student's previous level of achievement in a peer-teaching flipped classroom influences their conceptual understanding and self-efficacy. This study suggests that future researchers and practitioners may implement peer-teaching flipped classrooms in advanced calculus. It is recommended that the group division should also consider the students' prior achievement level.

Keywords: *Conceptual Understanding; Self-Efficacy; Flipped Classroom; Peer Teaching Flipped Classroom*

Pengajaran Konvensional dan Pengajaran dengan Tutor Sebaya dalam *Flipped Classroom*: Mana yang Lebih Baik dalam Meningkatkan Pemahaman Konseptual dan Self Efikasi Siswa?

ABSTRAK

Kalkulus merupakan salah satu cabang dalam matematika yang diketahui sering dianggap sulit oleh siswa, yang terbukti dari pemahaman konseptual dan self-efficacy siswa yang rendah pada kelas-kelas kalkulus. Kalkulus merupakan salah satu cabang matematika yang sering dianggap sulit oleh mahasiswa, ditunjukkan dengan lemahnya pemahaman konseptual mahasiswa dan self-efficacy yang rendah dalam mata kuliah yang berhubungan dengan kalkulus. Dengan demikian, pembelajaran inovatif perlu didorong untuk mengatasi masalah ini. Penelitian ini membandingkan keefektifan metode konvensional atau *peer-teaching* yang lebih baik dalam meningkatkan pemahaman konseptual

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dan self-efficacy siswa dalam praktik *flipped classroom* teaching. Metode kuantitatif deskriptif digunakan dalam penelitian ini. Penelitian ini dilakukan di dua kelas pada mata kuliah kalkulus pada program pendidikan guru di sebuah universitas di Sumatera Barat. Kelas pertama diajarkan di *Conventional Flipped Classroom (CFC)* dengan jumlah siswa 34 orang. Kelas kedua berlangsung di *Peer Teaching Flipped Classroom (PTFC)* dengan jumlah siswa 36 orang. Kuesioner pre-test, post-test, *self-efficacy*, dan catatan lapangan digunakan untuk pengumpulan data. Teknik analisis data dilakukan dengan menggunakan grafik. Hasil menunjukkan bahwa pemahaman konseptual dan *self-efficacy* siswa dengan peer teaching lebih baik di flipped classroom daripada di flipped classroom konvensional. Juga, latar belakang akademik siswa ditemukan berpengaruh terhadap pemahaman konseptual dan *self-efficacy* siswa. Kami mengungkapkan bahwa tingkat prestasi siswa sebelumnya dalam kelas membalik peer-teaching memengaruhi pemahaman konseptual dan self efikasi mereka. Studi ini menunjukkan bahwa peneliti dan praktisi selanjutnya dapat mengimplementasikan kelas terbalik peer-teaching dalam kuliah kalkulus. Disarankan bahwa pembagian kelompok juga harus mempertimbangkan tingkat prestasi siswa sebelumnya.

Kata kunci**:** *Pemahaman konseptual; Self efikasi siswa; Flipped Classroom; Pengajaran dengan tutor sebaya pada flipped classroom.*

1. Introduction

Calculus is one of the branches of mathematics, which is usually taught at the university level, especially in the mathematics education department. However, research found that students have low conceptual understanding and self-efficacy in calculus courses [1], [2], [3]. Although the number of studies on flipped classrooms is increasing, they are primarily focused on home videos through design heuristics that enable students to think critically about individual math problems before engaging in learning. and the curricular components of the flipped classroom have addressed the effectiveness of such approaches on student outcomes. in tasks in a collective school environment [4]. Researchers discuss implications and recommendations for mathematics education, especially calculus [5]. The researchers concluded that the video-assisted flipped classroom learning model was effectively applied to mathematics learning [6].

Recently, many researchers have implemented flipped classrooms and peer teaching flipped classrooms in an effort to improve students' conceptual understanding and self-efficacy. In the flipped classroom students read and view important lecture material before class so that more time can be spent using engaging, interactive learning techniques in the classroom. Hence, students come to class prepared and can engage students more actively and understand concepts well [7]. Flipped classroom is a technology-based approach to student center learning [8], [9], [10], [11], [12], [13]. This approach is considered capable of improving students' conceptual and students' self-efficacy. [14] contends that peer teaching in flipped classrooms influenced conceptual understanding. In line, [15] stated that peer teaching flipped classrooms can increase students' conceptual understanding and self-efficacy.

Peer teaching in cooperative learning teams includes the following activities: (1) Assigning each student to a separate team to design a class teaching session on chosen subject matter and giving them the task of creating cases and questions to inspire class discussion. (2) Planning: Give your teaching session preparation team a week to work on it. (3) Team teaching of chosen material in each class, using situations to stimulate discussion, and teacher mentoring by going over any details that were missed. (4) Evaluation: Encourage students to stay informed, provide comments on their development, and evaluate team-teaching sessions from the perspective of the teacher [16]. The goal of peer teaching in a flipped classroom is to incorporate peer teaching [17]. The flipped classroom learning model affects conceptual understanding [18], [19], [20]. Self-efficacy in addition to affecting students' achievement also affects interest and intention [21]. Student background influences student self-efficacy [22].

Previous researchers have attempted to compare traditional flipped classrooms and peer-teaching flipped classrooms using statistical methods and have found that peer-teaching flipped classrooms are superior to traditional flipped classrooms. [23], [24]. However, this study was not tested using a statistical approach but was analyzed based on descriptive analysis.

In this study, research would be conducted using flipped classrooms and peer-teaching flipped classrooms in improving students' conceptual understanding and self-efficacy. This research also investigates the correlation between conceptual understanding and self-efficacy in the categories of students' prior knowledge (high, medium, and low).

2. Methods

This research used a descriptive quantitative method. This research was conducted on calculus courses in two classes at an educational college in West Sumatra. The first class was taught using a conventional flipped classroom (CFC) with 34 students. The second class was conducted using a peer teaching flipped classroom (PTFC) with 36 students. In line with our department's goal of training mathematics teachers in secondary schools. By gender, the number of female students in the conventional flipped classroom was 25 females and 9 males. On the other hand, there were 30 female and 6 male students in the Peer Teaching Flipped Classroom.

The instruments used in this study were pretests and posttests to learn more about the students' conceptual understanding in learning calculus. Questions were used in the form of essays validated by two experts. Self-efficacy was also assessed using student-filled questionnaires and self-efficacy sheets. Data analysis techniques have been carried out using graphs. Data were analyzed descriptively with a quantitative approach.

A pretest was a test conducted before giving treatment to students. And post-test was a test run after providing treatment to students. Both tests contained ten questions to test students' conceptual understanding. The procedure that the researcher did to compile the initial proficiency test was: a) made a question grid for each ability according to indicators, b) made questions that fit the grid, and c) content validation through two experts using a validation sheet. The results of the test validation given by the expert can be seen in Table 1.

TABLE 1 The results of test questions validation for conceptual understanding.

Unit	No. of Days Taught	Weight	Keywords	% of the Topic	No. of Items per Topic	Item Placement
Unit 1: The real number system and functions; natural numbers, rational numbers, integers, and irrational numbers.	1	20%	Explain	20%	2	1a-1b

Unit	No. of Days	Weight	Keywords	% of the	No. of Items	Item Placement
Unit 2: The real number system and functions; inequality, absolute value, and square root.	1	20%	Prove	20%	2	2a-2b
Unit 3: The real number system and functions; coordinate systems, straight line, equation graph, distance, circle and line equation formula, understanding function, range and domain.	1	20%	Determine	20%	2	3a-3b
Unit 4: The real number system and functions; type of function, functional function and trigonometric function.	1	20%	Apply	20%	2	4a-4b
Unit 5: Limit and Continuity; introduction of limit, definition of limit and in-depth study of limit.	1	10%	Estimating	10%	1	5a
Unit 6: Limit and Continuity; properties of limit, continuity of function, limit at infinity and infinite limit.	1	10%	Estimating	10%	1	5b
Total	6	100%		100%		

TABLE 2 The validation results of test.

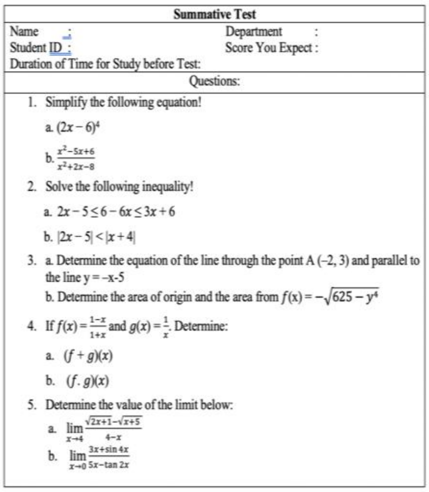
Validation Unit	Expert 1	Expert 2	Average	Criteria
Unit 1	4	4	4	Very Valid
Unit 2	4	3	3,5	Very Valid
Unit 3	3	3	3	Valid
Unit 4	3	3	3	Valid
Unit 5-6	4	3	3,5	Very Valid

After validating the test questions with the expert and making revisions according to the suggestions, a valid test question is obtained as indicated by the result of validation in Table 2. The revision of test questions has been carried out based on the expert's advice, and the following changes have been made to the test questions.

TABLE 3 The questions for the conceptual understanding test.

	Before Validation	After Validation
Questions	(see below)	(see below)

Before Validation



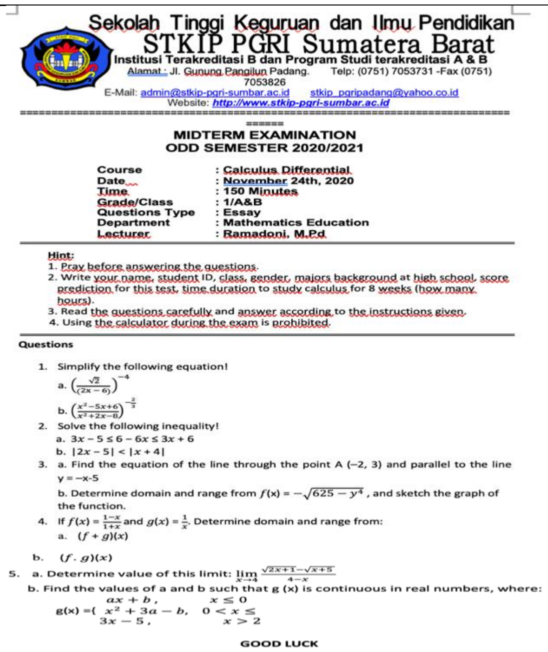
Summative Test

Name :
Department :
Student ID :
Score You Expect :
Duration of Time for Study before Test:

Questions:

1. Simplify the following equation!
   a. $(2x-6)^4$
   b. $\frac{x^2-5x+6}{x^2+2x-8}$
2. Solve the following inequality!
   a. $2x-5 \leq 6-6x \leq 3x+6$
   b. $|2x-5| < |x+4|$
3. a. Determine the equation of the line through the point A (–2, 3) and parallel to the line y = –x-5
   b. Determine the area of origin and the area from $f(x) = -\sqrt{625-y^4}$
4. If $f(x) = \frac{1-x}{1+x}$ and $g(x) = \frac{1}{x}$. Determine:
   a. $(f+g)(x)$
   b. $(f.g)(x)$
5. Determine the value of the limit below:
   a. $\lim_{x\to 4} \frac{\sqrt{2x+1}-\sqrt{x+5}}{4-x}$
   b. $\lim_{x\to 0} \frac{3x+\sin 4x}{5x-\tan 2x}$

After Validation



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MIDTERM EXAMINATION
ODD SEMESTER 2020/2021

Course : Calculus Differential
Date : November 24th, 2020
Time : 150 Minutes
Grade/Class : 1/A&B
Questions Type : Essay
Department : Mathematics Education
Lecturer : Ramadoni, M.Pd

Hint:
1. Pray before answering the questions.
2. Write your name, student ID, class, gender, majors background at high school, score prediction for this test, time duration to study calculus for 8 weeks (how many hours).
3. Read the questions carefully and answer according to the instructions given.
4. Using the calculator during the exam is prohibited.

Questions

1. Simplify the following equation!
   a. $\left(\frac{\sqrt{2}}{(2x-6)}\right)^{-4}$
   b. $\left(\frac{x^2-5x+6}{x^2+2x-8}\right)^{-\frac{2}{3}}$
2. Solve the following inequality!
   a. $3x-5 \leq 6-6x \leq 3x+6$
   b. $|2x-5| < |x+4|$
3. a. Find the equation of the line through the point A (–2, 3) and parallel to the line y = –x-5
   b. Determine domain and range from $f(x) = -\sqrt{625-y^4}$, and sketch the graph of the function.
4. If $f(x) = \frac{1-x}{1+x}$ and $g(x) = \frac{1}{x}$. Determine domain and range from:
   a. $(f+g)(x)$
   b. $(f.g)(x)$
5. a. Determine value of this limit: $\lim_{x\to 4} \frac{\sqrt{2x+1}-\sqrt{x+5}}{4-x}$
   b. Find the values of a and b such that g (x) is continuous in real numbers, where:
   $$g(x) = \begin{cases} ax+b, & x \leq 0 \\ x^2+3a-b, & 0 < x \leq \\ 3x-5, & x > 2 \end{cases}$$

GOOD LUCK

Table 4 presents the question items from the distributed questionnaire for self-efficacy.

TABLE 4 The Questionnaire for self-efficacy.

No	Items
1	Do you often miss the excitement?
2	Do you often need an understanding friend to cheer you up?
3	Are you the typical carefree person?
4	Do you find it very difficult to take no for an answer from other people?
5	Do you think everything through before doing anything?
7	If you say you're going to do something, do you always keep your word, no matter how uncomfortable doing it is?
8	Does your mood fluctuate?
9	Do you usually do and say things quickly without stopping to think?
10	Have you ever felt 'unhappy/depressed' for no apparent reason?
11	Would you do almost anything for a challenge?
12	Do you suddenly feel shy when you want to talk to an attractive stranger?
13	Do you occasionally lose your temper and get angry?
14	Do you often do things on the spur of the moment?
15	Do you often worry about the things you do or say?
16	Do you prefer reading to meeting people?
17	Are you the type who is easily hurt/offended?
18	Do you like traveling?
19	Do you sometimes have thoughts that you don't want others to know about?
20	Are you sometimes very excited and sometimes very sluggish?
21	Would you prefer to have few but special friends?
22	Do you daydream a lot?
23	When people yell at you, do you yell back?
24	Do you often have feelings of guilt?
25	Are all your habits classified as good and much desired by others?

26	Can you like go and have fun at a merry party?
27	Are you the type who is often nervous about doing something?
28	Do other people find you very passionate?
29	After you do something important, do you walk away feeling that you could have done it better?
30	Are you mostly quiet when you are with other people?
31	Do you like to gossip?
32	Do you like to think so you can't sleep?
33	If there's something you want to know, would you rather look it up in a book than talk about it with someone?
34	Are you one of those people who often get excited when doing something?
35	Do you like the types of activities that require your attention?
36	Are you one of those people who often shake?
37	Will you always report your obligations, even though you know you'll never be caught?
38	Don't you like being with a crowd of people joking around?
39	Are you an easily offended person?
40	Do you like to do things where you have to act quickly?
41	Are you worried about bad things that might happen?
42	Are you slow and unhurried in your actions?
43	Have you ever been late for an appointment?
44	Do you often have nightmares?
45	Do you really like talking to people, including talking to people you don't know?
46	Are you bothered by any illness?
47	Would you be very unhappy if you couldn't see many people throughout the day?
48	Are you a nervous person?
49	Of all the people you know, are there some people you don't like?
50	Are you a fairly confident person?
51	Are you easily hurt when others blame you for your work?
52	Do you find it difficult to enjoy a lively party?
53	Are you bothered by feelings of inferiority?
54	Are you having trouble enjoying a party?
55	Do you sometimes talk about things you know nothing about?
56	Are you worried about your health?
57	Do you like pranking other people?
58	Do you suffer from sleeplessness?

3. Results and Discussions

The purpose of this research is to examine the effect of flipped classroom methods in calculus courses on college students. This research compares conventional flipped classrooms and peer-teaching flipped classrooms.

3.1 Comparison between PTFC and CFC Methods

In this section, we will discuss in more detail the students' conceptual understanding and self-efficacy, which is carried out every week (self-formative test).

TABLE 5 All of the students in PTFC method.

Average PTFC	**Pretest**	**Week**						**Posttest**
		1	**2**	**3**	**4**	**5**	**6**	
SBC	39.17	76.96	58.57	90.90	62.86	79.38	92.12	
PBC	64.39	65.00	66.29	76.36	63.42	71.26	72.50	
PTBC	48.60	32.25	32.55	55.05	36.75	29.70	28.65	
SIC		87.78	80.29	96.66	69.14	93.94	95.00	80.11
PIC		80.00	78.48	74.82	75.00	85.80	84.38	76.57

SBC= Score Before Class,
PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),
SQIC= Score In-Class,
PIC= Prediction In-Class.

TABLE 6. All of Students in CFC Method.

Average CFC	Pretest	Week						Posttest
		1	2	3	4	5	6	
SBC	41.76	88.82	87.35	92.36	46.66	69.70	84.38	
PBC	79.32	82.22	82.26	80.00	77.50	78.76	78.70	
PTBC	40.20	14.10	24.15	32.55	35.10	28.35	29.55	
SIC		91.34	73.44	79.38	83.76	95.62	97.24	75.68
PIC		81.30	80.00	76.12	73.76	78.12	80.68	85.71

SBC= Score Before Class,
PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),
SIC= Score In-Class,
PIC= Prediction In-Class.

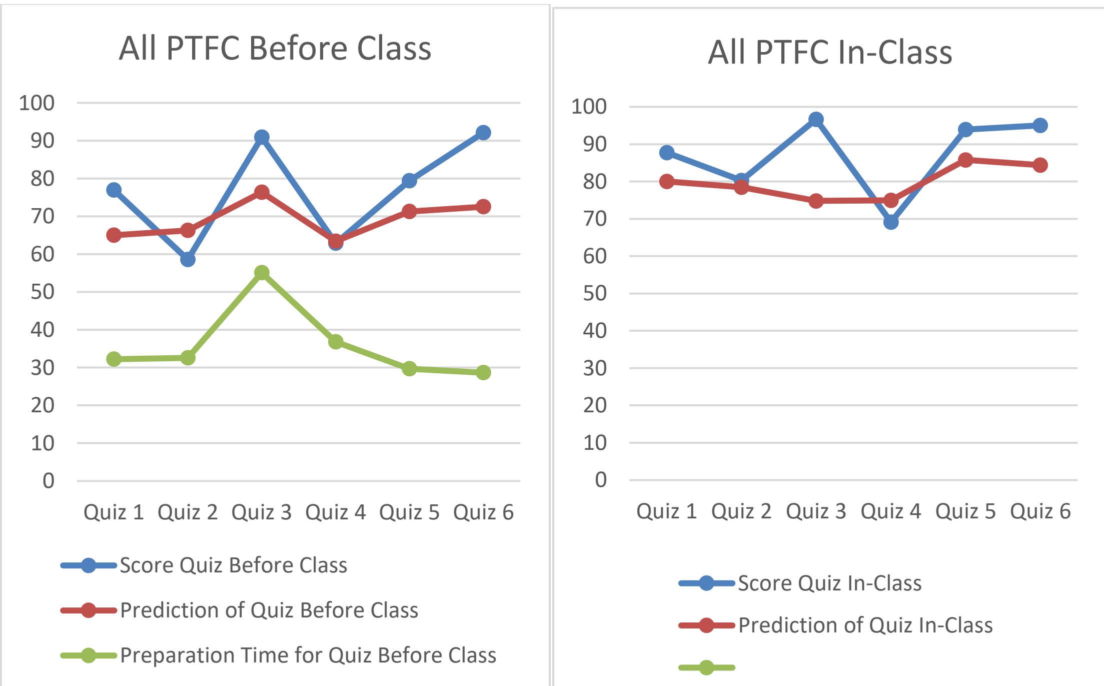


Figure 1 All Students in Conventional Flipped Classroom

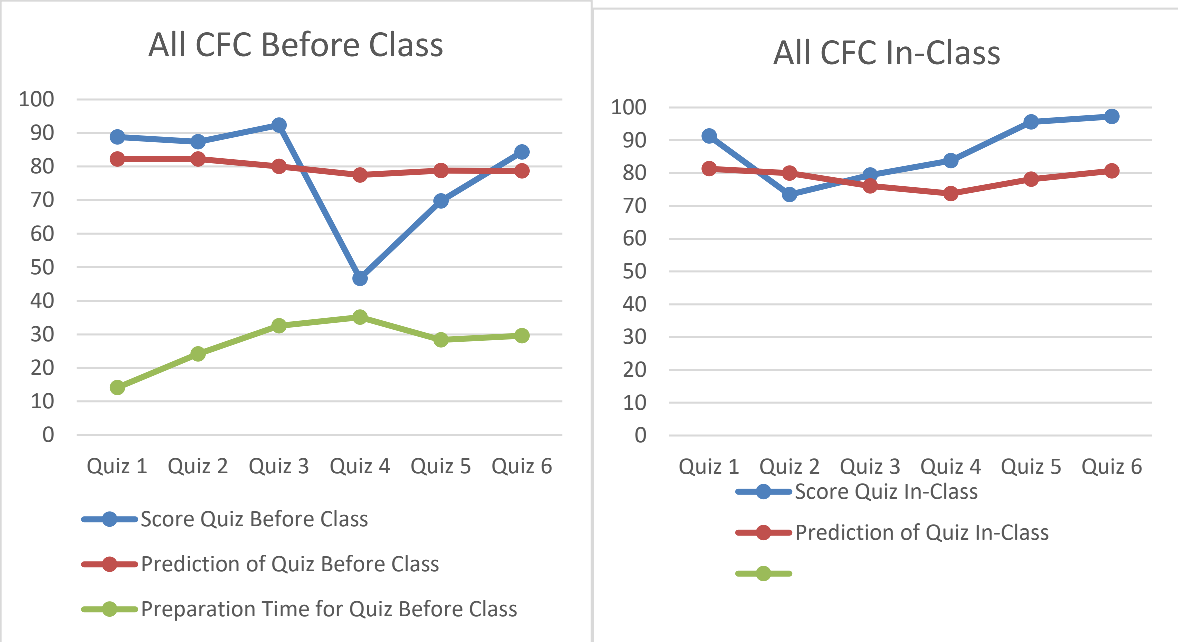


Figure 2 All students in peer teaching flipped classroom.

Using the PTFC method shows that students' quiz scores after applying the PTFC method in class always experienced an increase from the quizzes held before class. Although it appeared that there was an increase and decrease in student scores every week because the level of difficulty of the material in learning calculus every week was different. Moreover, this is in line with the consistency of students' self-efficacy, which always increases. This means that students still had more predictions about the after-class quiz than before class. Based on the analysis carried out, this was caused by an increase in student's conceptual understanding of several wrong things in the previous quiz to evaluate themselves and improve their answers. Referring to the time and student scores always followed the same pattern from quiz to quiz 4, for quizzes 5 and 6 they still experienced an increase in scores even though students experienced a reduction in learning time. In the early meets, the more time students spent, the higher the score obtained, and different from the time at the end, they managed themselves well and made the best use of their time. So that with less time they were able to maximize their learning.

In this PTFC method, we see a consistent increase between the before-class quizzes and in-class quizzes. It means that the process of in-class learning activities provides a deeper understanding of student understanding. It also happens with student self-efficacy. If we compare students' predictions before class and in-class, we see that it is always a constant increase. The results are in line with hypotheses 1 and 2 results, and there is a significant increase in conceptual understanding and self-efficacy with students in the PTFC method.

One argument is that students using the PTFC approach put more mental effort into their studies. The students' feedback and video explanations before class helped them absorb the material more thoroughly than just by viewing videos and taking notes. In comparison to the CFC technique, the PTFC method gave students more opportunities to participate in class discussions, was more dynamic, and allowed for peer teaching. This helped students learn concepts more thoroughly.

If we look at the relationship between the score (conceptual understanding) and the students' prediction (self-efficacy), we see that the students' ability to predict their scores during the pretest fluctuates. Simultaneously, in-class, there is only one intersection of results because the material at the meeting was indeed tricky for students to understand. It can be seen from the students' comments when they made conclusions on the Mentimeter application. In addition, almost all the students' scores during the quiz in-class exceeded their predictions. It means that the results they got exceed their expectations.

Whereas in the CFC method, based on the graph above, the student's score from pretest to posttest does not always increase. It happened at weeks 2 and 3 where students experienced a decrease in their score. It happened because students were not careful in answering questions in the classroom. Due to the similarity between the quiz questions given before class and after applying the CFC method, they always used the same answers and were reluctant to answer again. Judging from the time they spent each week was relatively the same, and time did not reflect the student score. Students spent a lot of time on difficult material, however the extra time they use has not been able to make their score better than easy material. The students' predictions were relatively the same every week. Moreover, students' quiz predictions before class and in class were almost the same.

This data shows that there was an inconsistency in the students' scores before class and in-class. Sometimes the student's score at the pretest was better than the in-class score. There was a big gap between the students' scores before class and in-class. This means that by using the CFC method, in-class learning is essential for students to improve their conceptual understanding. Meanwhile, if we monitor students' self-efficacy, they continuously provided predictions before class and in-class. This is inversely proportional to their conceptual understanding, which experienced a very drastic increase and decreases.

3.1 Comparison between PTFC and CFC Methods in Self-Efficacy in Term of High Ability

Table 7 All of Students with High Ability in PTFC Method.

Average High Ability of PTFC	Pretest	Week						Posttest
		1	2	3	4	5	6	
SBC	53.33	78.18	66.36	90.00	63.34	80.00	91.66	
PBC	70.33	81.80	80.83	76.00	73.34	86.66	88.34	
PTBC	38.10	31.35	34.35	60.00	31.95	30.60	28.80	
SIC		95.00	85.00	98.34	73.34	98.34	95.00	86.50
PIC		65.00	63.64	76.00	68.34	78.18	81.66	82.50

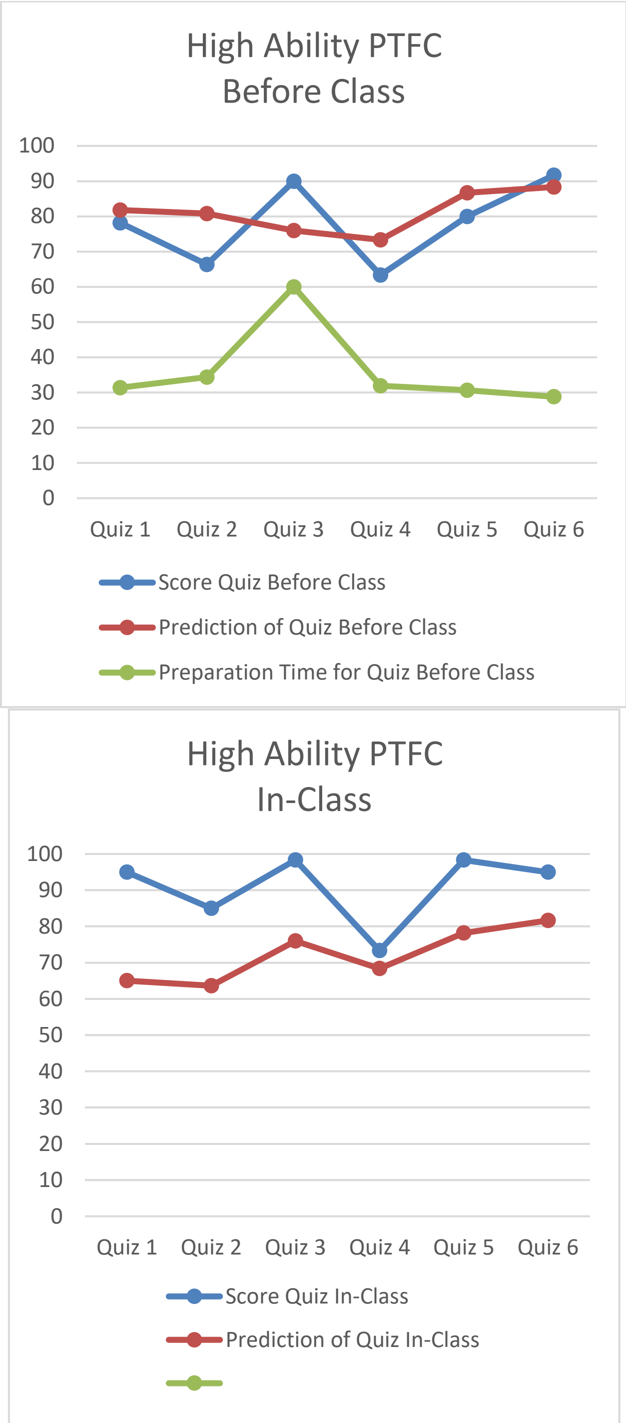
SBC= Score Before Class,
PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),
SIC= Score In-Class,
PIC= Prediction In-Class.

Table 8 All of students with high ability in CFC method.

Average High Abillity of CFC	Pretest	Week						Posttest
		1	2	3	4	5	6	
SBC	54.16	93.34	90.00	90.00	56.66	68.34	91.66	
PBC	79.75	83.34	82.00	80.00	81.66	80.00	81.80	
PTBC	56.85	12.45	21.75	28.65	38.1	31.95	31.35	
SIC		96.36	76.36	85.46	89.10	100.00	100.00	80.58

PIC	81.80	80.00	80.00	74.54	81.82	82.00	87.50

SBC= Score Before Class, PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),
SIC= Score In-Class,
PIC= Prediction n-Class.



Picture 3 All of the high ability peer teaching flipped classroom

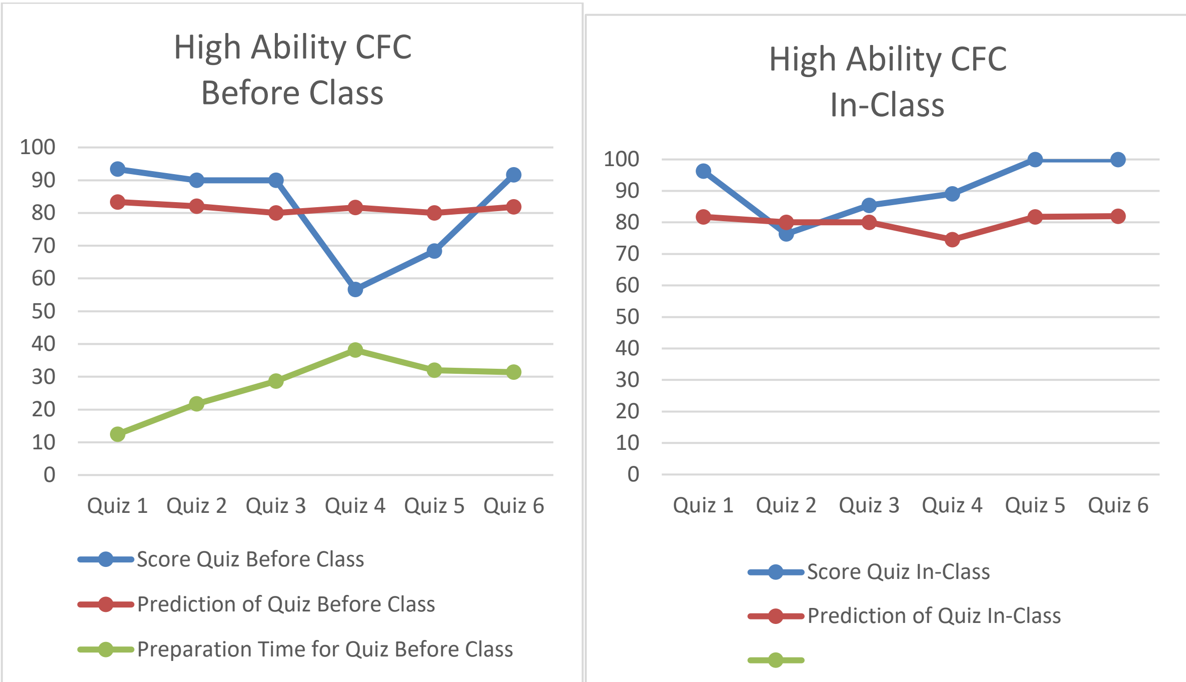


Figure 4 All of high ability conventional flipped classroom.

Examining in-depth about students who had high abilities in the PTFC method, this was almost the same as the whole class. After class, the students' quiz scores after applying the PTFC method always increased from quiz before class. The student prediction who increased after class always decreased from the quizzes held before class. Referring to the time, it appears that time did not represent the student score. In the beginning of meets, the more time students spent, the higher the score obtained, and different from the time at the end, they have managed themselves well and made the best use of their time. So that with less time they were able to maximize their learned.

For high ability students in the PTFC method, there was an increase in student scores from before class to in-class. This is inversely proportional to their self-efficacy, which has decreased from before class to in-class. If we look at it, almost all the students' predictions before class were higher than their scores. As for in-class, their score exceeded the predictions they gave. This happened because students had high confidence in the mastery they got before class. After they learn in-class, they knew that there were some things wrong with the concept, so they could improve the concept and reduce their predictions.

Whereas in the CFC method with high abilities, it is almost the same as the total, based on the graph above, the student's score from pretest to posttest does not always increase. The classrooms are practically the same. Judging from the time they spent each week is relatively the same, and time did not reflect the student score. Students spent a lot of time on difficult material, however the extra time they use has not been able to make their score better than easy material.

Students' understanding of concepts did not always increase by using the CFC method from before class to in-class. Meanwhile, their self-efficacy remained the same. If we look at the students' predictions before class and in-class, the scores they got tend to fluctuate.

The results provided a clear explanation for why students using the PTFC approach required greater mental effort because receiving feedback during the flipped classroom increased their involvement and engagement. Additionally, this method allowed students to assess their comprehension before to class. Students also had the chance to teach other students, participate more actively in class, and speak up for themselves, all of which allowed them to play a part in evaluating other students and gauge their own progress. As a result, individuals could predict themselves using the PTFC method and had high levels of self-efficacy.

One explanation is that students felt they could learn well in class because the use of PTFC made learning more interactive and active for them. As a result, they had many opportunities to discuss and inquire about many topics, and they were also very involved in the learning process. Peer teaching had been done by students, so they were confident that they could use what they had learned outside of the classroom and in the future and did not hesitate to put it into practice again.

The findings revealed no statistically significant difference between the two classes' student assignment dimensions. This was made possible because students in the traditional flipped classroom also received control before class by creating a summary of the videos they watched, allowing for continued supervision and control. Their worry about the grade they would receive was also affected, and it decreased as a result. Students were urged to participate in group problem-solving exercises in the in-class component as well, giving those who were taught in the traditional flipped classroom the impression that they could learn effectively there as well.

3.2 Comparison between PTFC and CFC Methods in Self-Efficacy in Term of Medium Ability

Table 9 All of students with medium ability in PTFC method.

Average Medium Ability of PTFC	Pretest	Week						Posttest
		1	2	3	4	5	6	
SBC	39.39	75.00	56.67	90.90	78.34	72.72	96.00	
PBC	64.09	63.34	65.83	76.36	63.34	70.90	70.00	
PTBC	85.95	37.50	32.70	60.00	43.65	29.25	27.90	
SIC		86.66	76.67	93.34	41.18	92.72	96.36	78.25
PIC		80.00	78.18	74.00	74.54	89.10	85.46	74.55

SBC= Score Before Class,
PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),
SIC= Score In-Class,
PIC= Prediction In-Class.

Table 10 All of students with medium ability in CFC method.

Average Medium Ability of CFC	Pretest	Week						Post-test
		1	2	3	4	5	6	
SBC	40.28	90.00	91.67	98.34	41.82	80.00	76.36	
PBC	85.83	92.72	83.64	80.00	74.54	76.36	72.72	
PTBC	25.95	16.05	23.85	33.75	36.15	28.65	28.65	
SIC		92.72	71.67	81.80	83.64	96.36	94.54	73.92
PIC		80.00	80.00	76.36	70.90	76.36	78.18	84.17

SBC= Score Before Class,
PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),

SIC= Score In-Class,
PIC= Prediction In-Class.

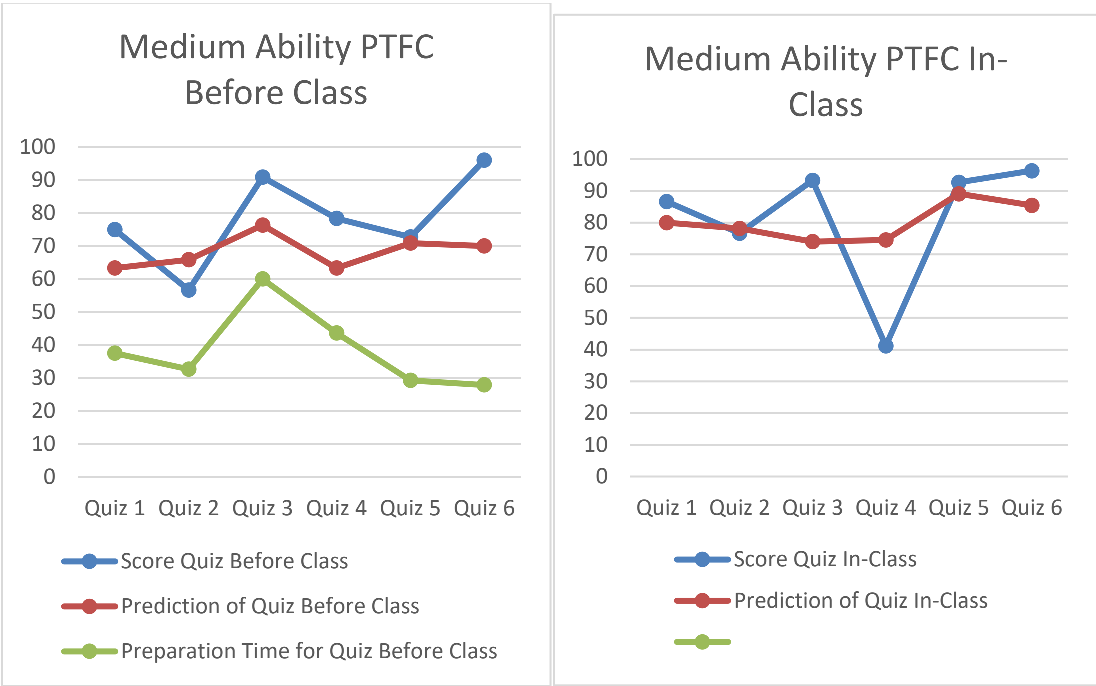


Figure 5 All of High Ability Peer Teaching Flipped Classroom.

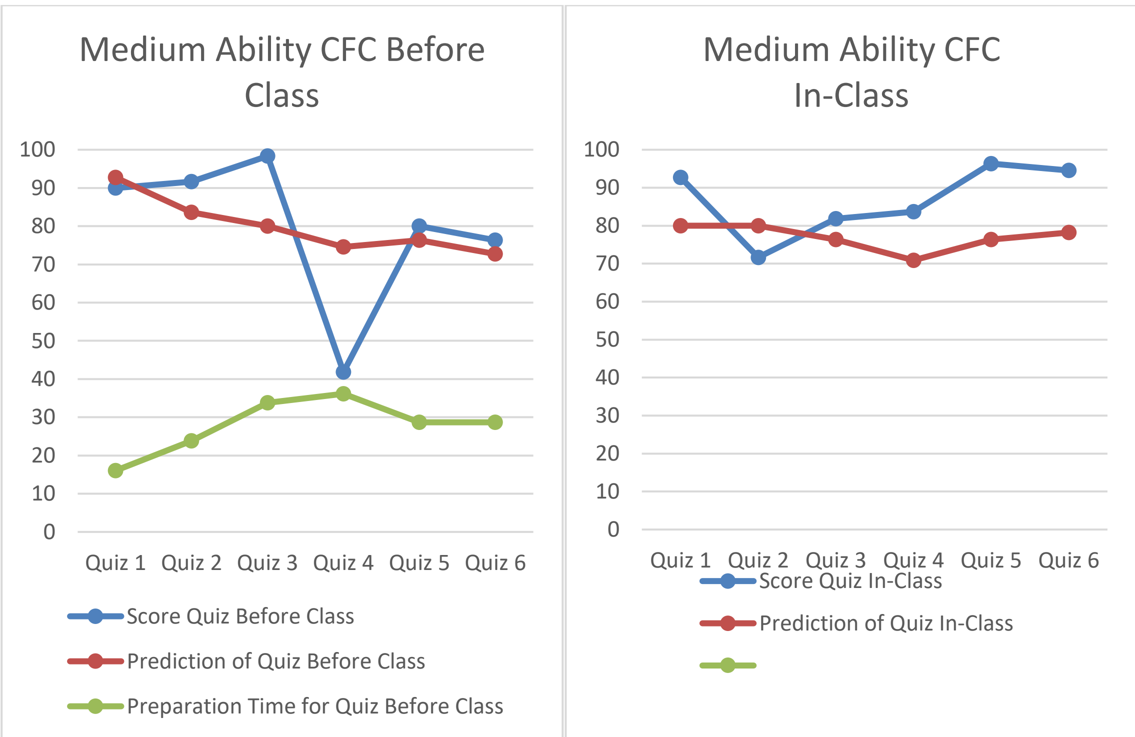


Figure 6 All of Medium Ability Conventional Flipped Classroom.

In detail, for students who had medium abilities in the PTFC method, the student's quiz score after applying the PTFC method after class had increased from the quiz held before class, but not in quiz 4. Indeed, students admitted that the material about determining domain and codomain. This meeting was material that was difficult for students to understand. Even though it had been taught in class and in discussions, students still experienced difficulties in some concepts. The researcher reviewed several essential things at the beginning of the meeting afterward. For student prediction, the students mostly increased after class, continuously rising from the quizzes held before class. Referring to the time, it appears that time did not represent the student score. At the beginning of meets, the more time students spent, the higher the score obtained, and different from the time at the end, they managed themselves well and made the best use of their time. So that with less time they were able to maximize their learning.

Students' understanding of concepts almost always increases by using the PTFC method from before class to in class. Likewise, their self-efficacy tends to increase. But in contrast, the relationship between the predictions and the score they get tends to fluctuate.

Whereas in the CFC method, the medium ability is almost the same as the total CFC method, based on the graphic above, this can be seen that the student's score from pretest to posttest does not always increase, namely at the beginning of the meeting until the 4th meeting. In terms of students' predictions, every week is relatively the same. Also, students' predictions of quizzes before class and after class are almost the same. Judging from the time they spent each week is relatively the same, and time did not reflect the students' scores. Students spent a lot of time on difficult topics, however, the extra time they use has not been able to make their scores better than easy topics.

Students' understanding of concepts was not always improved by using the CFC method from before class to in class. In contrast to their self-efficacy, which tended to be constant. There was also a big gap between the scores before class and in class. Using the CFC method, the in-class activity provided a significant effect on students' conceptual understanding.

3.3 Comparison between PTFC and CFC Methods in Self-Efficacy in Term of Low Ability

TABLE 11 All of students with low ability in PTFC method.

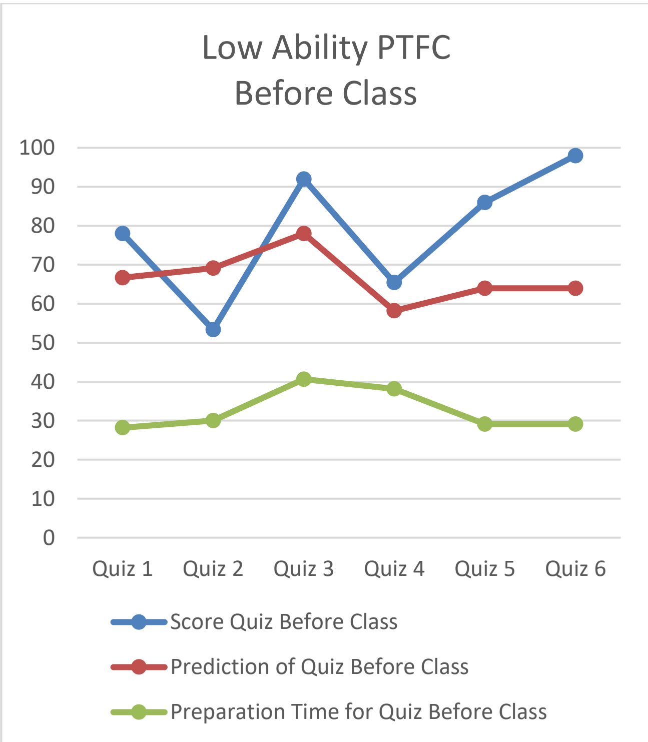
Average Low Ability of PTFC	Pretest	Week						Posttest
		1	2	3	4	5	6	
SBC	34.72	78.00	53.33	92.00	65.44	86.00	98.00	
PBC	59.08	66.66	69.17	78.00	58.18	64.00	64.00	
PTBC	26.55	28.20	30.00	40.65	38.20	29.10	29.10	
SIC		81.66	79.09	98.34	54.54	90.00	84.00	75.58
PIC		78.34	76.00	74.28	77.78	80.00	77.78	71.38

SBC= Score Before Class,
PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),
SIC= Score In-Class,
PIC= Prediction In-Class.

TABLE 12. All of students with low ability in CFC method.

Average Low Ability of CFC	Pretest	Week						Posttest
		1	2	3	4	5	6	
SBC	28.67	81.82	78.18	87.28	40.00	58.18	84.00	
PBC	71.00	80.00	80.91	80.00	74.00	80.00	82.00	
PTBC	36.20	13.80	25.95	33.75	28.50	22.50	27.00	
SIC		84.44	73.00	69.00	80.00	90.90	97.78	71.80
PIC		82.22	80.00	72.72	74.54	76.36	82.22	85.40

SBC= Score Before Class,
PBC= Prediction Before Class,
PTBC= Preparation Time Before Class (units in 4 minutes),
SIC= Score In-Class,
PIC= Prediction In-Class.



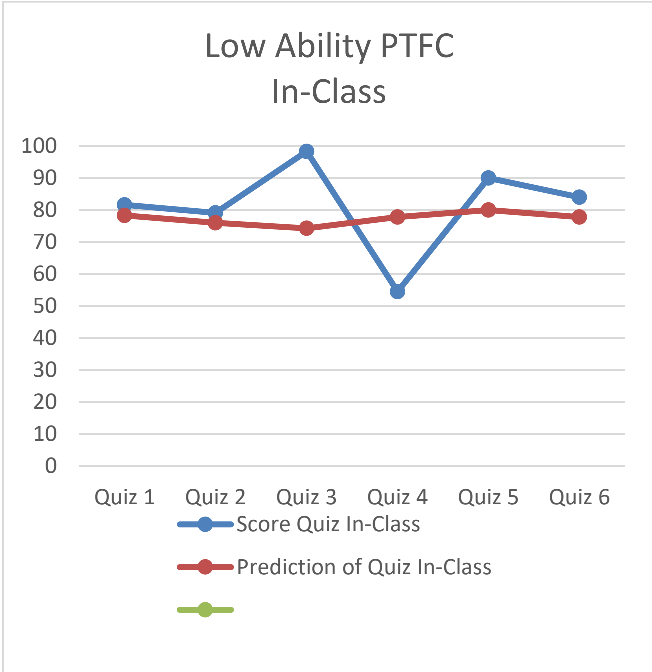


Figure 7 All of the low ability peer teaching flipped classroom

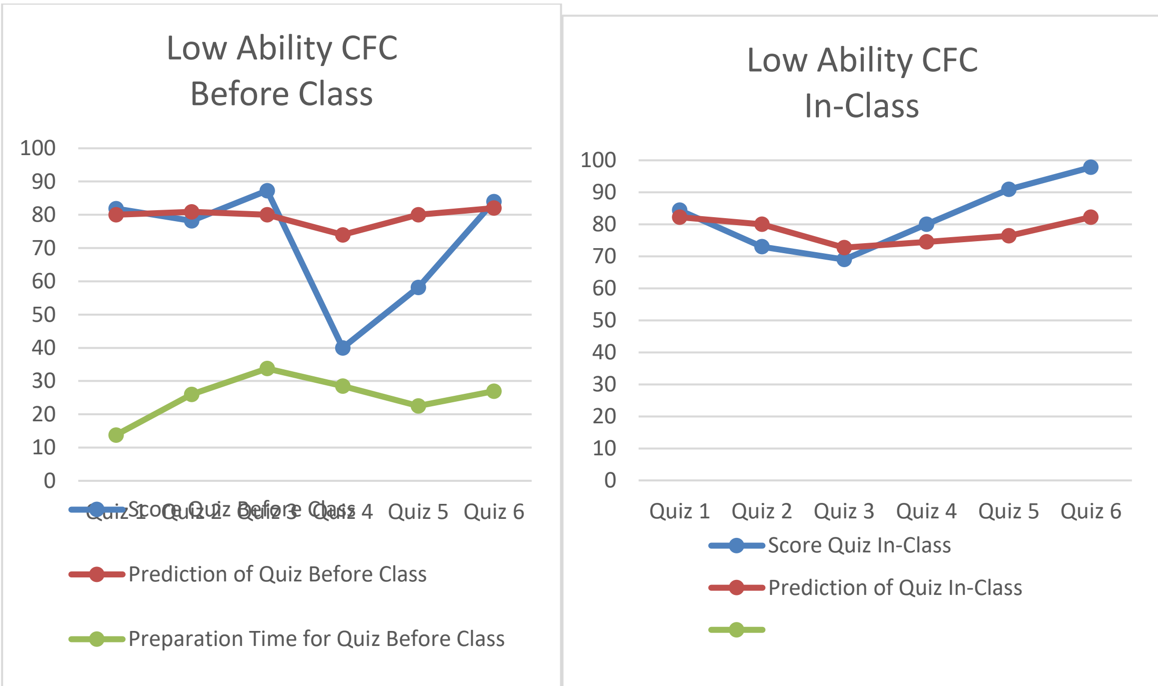


Figure 8 All of low-ability conventional flipped classroom

In detail, for students who had low abilities in the PTFC method, the quiz scores of students after applying the PTFC method after class had increased from the quizzes held before class at meetings 2, 3, 4, and 6, but not at meetings 5 and 7. Indeed, students admitted that the material on determining domain and codomain at this meeting was difficult for students to understand. Whereas at the 7th meeting about the limit theorem, students tried to answer the questions quickly and carelessness occurred in answering the questions. Students always experienced an increase in after-class for student prediction, continuously increasing from the quizzes held before class. Referring to the time, it appears that time did not represent the student's score. At the beginning of meets, the more time students spent, the higher the score obtained, and different from the time at the end, they managed themselves well and made the best use of their time. So that with less time they were able to maximize their learning.

Students' understanding of concepts almost always increases by using the PTFC method from before class to in class, in line with their self-efficacy, which increases. However, the gap in the scores of students before class and in class was not too big. This indicates the importance of before-class learning for low-ability students in the PTFC method. The relationship between students' conceptual understanding was almost always above their predictions for low-ability students in the PTFC method.

Whereas in the CFC class with low abilities, it is almost the same as the total CFC method, based on the graph above, the student's score from the pretest to the post-test does not always increase, namely at the 1st meeting to the 4th meeting. In terms of students' predictions, every week was relatively the same. The students' predictions before class and after class were almost relatively the same. Judging from the time they spent each week was relatively the same, and time did not represent the student's scores. The more time students spent, the higher the score obtained.

Students' understanding of concepts was not always increased by using the CFC method from before class to in class contradicted their almost constant self-efficacy. However, there was a big gap between the scores of the students before class and in class. This indicated the magnitude of the effect of in-class learning for low-ability students in the CFC method. Students could not predict their conceptual understanding well because it always tended to be constant while their scores experience a drastic increase and decrease.

Calculus self-efficacy assesses a student's ability to understand concepts and solve problems [25]. What students experience each time they perform a calculus task influences their calculus self-efficacy [26], [27]. Moreover, self-efficacy provides positive messages about student performance and assessment feedback [28]. In addition, calculus self-efficacy was a predictor of achievement and enhanced students' conceptual understanding [29].

Another thing that is essential to increasing the success of a peer-teaching flipped classroom is the student background. It is important to think about this in order to make the group/class students more developed and more active. Students help each other understand the material and solve math problems. Peer teaching helps foster diversity of student backgrounds and prior knowledge, making them easier to integrate [30]. Furthermore, Students' background influences student self-efficacy [31]. Additionally, self-efficacy and its impact on student performance also influence interests and intentions [32], [33].

4 Conclusion

The results showed that students' conceptual understanding and self-efficacy using peer-teaching flipped classrooms perform better than in conventional flipped classrooms. Students' background affects conceptual understanding and self-efficacy. The results showed that the student's prior achievement level in peer-teaching flipped classrooms influenced students' conceptual understanding and self-efficacy. Based on the conclusions and research implications above, the authors provide the following suggestions: the implementation of a peer-teaching flipped classroom in advanced calculus. Mathematics teachers can practice it in learning. Where to provide concepts through videos before class and provide practice questions according to the level of student ability and background in class. It is recommended that the group division must consider the students' prior achievement level.

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