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Enhancing Flipped Classroom with Peer Teaching to Promote Students' Conceptual Understanding and Self-Efficacy in Calculus Courses

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Abstract

Calculus differential is the basis of mathematics before entering the level of further mathematics, which has a high analysis level. Students have difficulty understanding concepts and have not been able to analyze/predict/realize (self-efficacy) that impact challenges in working on calculus problems. On the other hand, technology has been developed in education. This research compared conventional flipped classrooms and peer teaching flipped classrooms. This research investigated the differences in students' conceptual understanding and self-efficacy in both classes in terms of majors' background and prior achievement level. This research used a nonequivalent-groups pretest and posttest design. The data was collected using test and questionnaire. The ANCOVA results showed that peer teaching flipped method was better than the conventional flipped classroom method in terms of students' conceptual understanding and self-efficacy. Moreover, self-efficacy had a positive correlation with conceptual understanding in both methods. Furthermore, the students' prior achievement level influenced students' conceptual understanding and self-efficacy, while students' majors background influenced students' self-efficacy only

Keywords: Calculus, Conventional Flipped Classroom, Peer Teaching Flipped Classroom, Conceptual Understanding, Self-Efficacy

Introduction

Calculus is one of mathematics branches. It is usually taught at the university level, especially in the mathematics education department. Calculus theory is as basis of mathematic before entering the level of further mathematics, which requires a high level of analysis. Learning calculus is important and has its benefits. However, students still have some problems such as 1) conventional learning processes that cannot prepare students well before learning (Scott, 2016), 2) lack of students' involvement in learning (Cronhjort, 2017), 3) many students as passive recipients (Cornehl, 2019), 4) students' low ability to understand concepts and learning outcomes (Kashefi, 2012), 5) students have low self-efficacy (Oldham, 2018).

A plethora of previous studies has examined the effect of flipped classroom (i.e., the conventional flipped classroom in this study) on students' outcome. They found that flipped classroom effectively improve students' achievement and recommended this strategy to solve the students' problem in calculus (Lo, 2017; Debbag, 2020; Srikaya, 2018). The flipped classroom is defined as a teaching method that reverses the learning ritual between in-class and before-class. In flipped classroom, students will meet concepts before class through short videos and more practice to solve math problems in-class activities (Lai, 2016).

However, there are also many researchers encounter challenges by using this teaching method. They found that it still failed to improve students' conceptual understanding (Albalawi, 2018; Kadry, 2014; Willis, 2014) as well as students' self-efficacy (Adediwura, 2012; Croy, 2020). Therefore, new strategies need to be used to improve the conventional one. This study tried to integrate the peer-teaching strategy into the conventional flipped classroom method (i.e., the peer-teaching flipped classroom) to improve students' conceptual understanding and self-efficacy.

What is the Conventional Flipped Classroom?

The flipped classroom encourages students to read and watch important lecture material before class and engaging students and interactive learning techniques in-class. So, students come to class prepared, students more actively and understand concepts well (Bequette, 2018). The flipped classroom offers the concept before class and in-class learning to students, which begins with the transition stage before class methods are done through video and online discussions, while in-class

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activities focusing on the higher cognition and evaluation for the students' abilities (Anderson, 2001).

Challenges of Conventional Flipped Classroom

Previous researchers put forward several reasons who have failed in their teaching practice by applying the flipped classroom method. For example, students who do not watch videos before class will become unprepared to receive knowledge, which have an impact on the lack of accountability of students to complete learning in class (O'Flaherty and Phillips, 2015; Gaughan, 2014). Students cannot get immediate answers to their questions at home (Arnold-Garza, 2014). Students might not be able to manage their time and work (Ash, 2012). Moreover, Gaughan (2014) argues that students do not watch teachers' videos due to the lack of students' accountability for completing instruction before class. Another obstacle is students are not actively involved in group discussions and collaborative work in class (Benjes-Small & Tucker, 2013; Edudemics' Guide to Flipped Classrooms, 2015). The essential of controlling students before class, and then involving students to learn actively and collaboratively in class is paramount in increasing students' conceptual understanding and self-efficacy. By integrating peer teaching technique into flipped classroom, all of this could be realized.

The Peer Teaching Flipped Classroom

The peer teaching flipped classroom is an integration of peer teaching into flipped classroom. Topping (2013) defined peer teaching as students learning from and with each other in a structured way, supervised by a professional researcher or practitioner. Peer teaching flipped classroom is an interactive teaching method that involves students before class and student interactivity in-class. Students essential to be setting in before class and in class (Sun, 2020). Before class and in class engagement has a significant effect on student achievement.

Peer teaching flipped classroom is an excellent way to improve student conceptual understanding because students are well controlled before class by making video explanations, online discussions, giving feedback, and doing a quiz. Moreover, students are also actively involved in solving calculus questions and explaining them to classmates in class. In addition to students' conceptual understanding, it is suggested to consider students' self-efficacy also in learning success. Self-efficacy is an individual's belief in his ability to succeed in doing something. Students must have clear expectations (Arnold-Garza, 2014). Students' expectations are part of students' self-efficacy. Self-efficacy is useful for students to manage themselves, believe in their abilities, can increase self-confidence so they are not afraid of failure. By implementing peer teaching flipped classroom, it is expected that students can control/predict/realize/manage themselves before class and in class activities. Sun (2020) revealed that, student self-efficacy positively impacts student learning outcomes and is positively related to academic achievement in both before class and in class learning environments. Students' self-efficacy in collaborative learning also has a positive impact on students' conceptual understanding.

Based on the phenomenon and the empirical finding above, this study attempted to integrate peer teaching technique into flipped classroom to improve students' conceptual understanding and self-efficacy. This research also was conducted to investigate the effect of gender (male and female), senior high school major (natural science, social science and vocational), and students' prior achievement level (high, medium, and low).

Literature Review

The Peer Teaching Flipped Classroom

Based on this study, the researcher looked at the effect of learning outcomes on student involvement in making videos. Students who teach and explain concepts to their classmates will understand more than just receiving information. Students who teach others will have a higher understanding (Letrud, 2012). A peer teaching flipped classroom learning model that takes part in students teaching their peers makes learning more interactive, fun, productive, and enthusiastic (Graziano, 2017).

Topping et al. (2013) defined peer teaching as students learning from and with each other in a structured way, supervised by a professional researcher or practitioner. Topping et al. (2017) defined two different tutoring types based on the participants' ages: same-age and cross-age tutoring.

Peer teaching flipped classroom requires students to make a concept explanation video to their classmates. Moreover, peer teaching flipped classroom conducted using pre-recordings, online quizzes, and group learning in class can increase student satisfaction and better learning experiences (Awidi, 2019). Furthermore, flipped classroom learning that involves students in editing videos both individually and in groups can positively impact first-year students. Students who make videos must understand before explaining (Eugenia, 2018). It is more comfortable for students to understand the language of their classmates and more attractive to them. That studied compares pre-test student learning outcomes before learning (where students watch the video provided) with post-test student learning outcomes after learning (where students do image editing into a video). The results show that students who create or edit videos are better than students just watching videos.

Sampson (2001) confirms the fundamental principles that have emerged from his study for successful implementation of peer learning are: (1) Attending to the context in which the peer learning strategy is to be introduced. (2) Focusing on learning outcomes and objectives and matching these to peer learning strategies. (3) Ensuring congruence between the

peer learning strategies and assessment tasks. (4) Preparing staff and students for different learning approaches, roles, and responsibilities. (5) Introducing peer learning strategies and managing the process. (6) Creating favorable conditions for learning. Thus, several preliminary activities that must be carried out are introducing a learning strategy and conveying objectives to match the strategy, and assessment.

Weerasinghe (2013) stated design principles of peer teaching: (1) Select a section of a topic out of the lesson sections that should be covered according to the online courses' schedules. (2) Start a discussion thread with a meaningful subject title and an interesting question and provide students' background information. (3) Adhere to the netiquettes. (4) Encourage peers to explore information related to students' questions. (5) Acknowledge others' inputs. (6) Integrate information and encourage peers to integrate information provided by students and others. (7) Motivate peers to judge and evaluate peers' responses. (8) Support students' peers to resolve the problem. (9) Bring in examples and experience of practical applications. (10) Try to achieve learning objectives. Thus, several crucial in the peer teaching flipped classroom stage are content selection, providing questions and exploring information, managing time and conducting peer evaluations.

Ramaswamy (2001) maintains that students peer teaching in cooperative learning teams are: (1) Assignments: assign each student to different teams to plan a class teaching session of selected content areas, charge to develop cases and questions to stimulate class discussion. (2) Preparation: allow a time for peer week for team preparation of their teaching session. (3) Each class session: team teaching of selected content, using cases to involve class discussion and teacher mentoring by discussing detail left out. (4) Evaluation: stimulate the student to keep up-to-date and feedback for their progress and teacher evaluation of team-teaching sessions. Thus, several essential activities that must be included in a peer teaching flipped classroom are giving assignments to students at each meeting, giving students time to prepare for peer teaching, selecting content to be taught, and providing feedback/evaluation.

Based on peer learning principles above, the need to prepare students, and the learning strategies that students use in conveying context to peers, here flipped classroom is the right strategy in calculus learning. Students can use videos to explain concepts to their classmates before class and teach classmates in small groups.

Research Questions

This research compared the effects of conventional flipped classroom method with peer teaching flipped classroom method in conceptual understanding and self-efficacy. The research questions are:

Would students' conceptual understanding in peer-teaching flipped classrooms perform better than students in conventional flipped classrooms?

Would students' self-efficacy in peer-teaching flipped classroom perform better than students in conventional flipped classrooms?

Would students' self-efficacy influence students' conceptual understanding in peer-teaching flipped classrooms and students in conventional flipped classrooms?

Would learners' variables, including senior high school major and prior achievement level, influence students' conceptual understanding and self-efficacy?

Research Design

This research used a nonequivalent-groups pretest and post-test experimental design based on research questions.

Research Participants and Setting

This research was conducted on calculus courses in two freshman classes at one of university in west Sumatra, Indonesia. In this study, two groups of samples were performed. The first class was taught using a conventional flipped classroom (CFC). The second class was conducted using peer teaching flipped classroom (PTFC). Students who continue their education in tertiary institutions have different backgrounds from senior high school majors such as natural science, social science, and vocational majors. Meanwhile, information about students' prior achievement levels was obtained from the pretest given at the beginning of the meeting. The distribution of students in the two methods can be seen in the table 1:

Instruments

The instruments used in this research were pretest and posttest to know about students' conceptual understanding in calculus learning. The questions were used in the form of essays. Moreover, self-efficacy was measured by using questionnaires.

Research Procedures

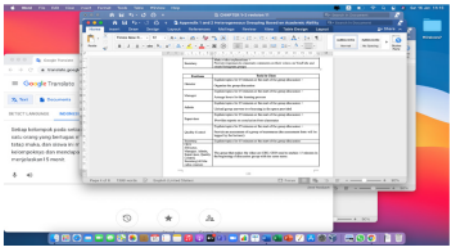
In this research, the research procedure will be presented during eight weeks. There are eight necessary activities in both learning methods, where two before-class activities and six in-class activities.

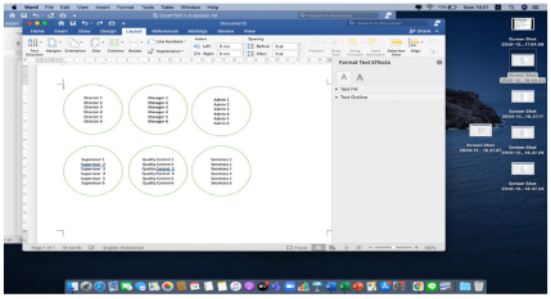
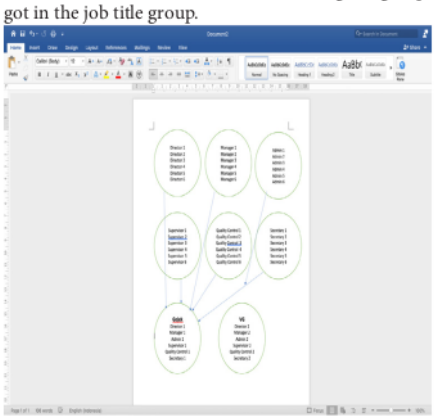
Please embed tables and figures in appropriate areas within the document and center them horizontally. Tables and figures should not exceed the given page margins. Provide captions (maximum length: 6 to 8 words) for each table or figure. Centre the caption above the table and below the figure. Please reference the table or figure in the text (see Table 1). Please do not use vertical lines in tables. For figures, GIF and JPEG (JPG) are the preferred formats.

Table 1: Distribution of Students based on the Students' Background

	Achievement Level		
PTFC Method	*High*	*Medium*	*Low*
Prior Major			
Natural Science	12	5	4
Social Science	0	3	3
Vocational	0	4	5
Total	12	12	12
	Achievement Level		
CFC Method	*High*	*High*	*High*
Prior Major			
Natural Science	11	5	5
Social Science	0	5	3
Vocational	1	2	2
Total	12	12	10

Table 2: Comparison of Two Method of Activity 2

Before Class	*Conventional Flipped Classroom Method*	*Peer Teaching Flipped Classroom Method*
Videos	Students watch videos: Each student watches a video provided by the teacher on YouTube.	Students make teaching videos: The duty group make a short teaching video, where each group member must get a part to explain the material. Furthermore, the duty group sent it to the teacher, and the teacher uploads it on YouTube.
Feedback	Teacher Feedback: Each student makes notes from the teachers' video, and the teacher assesses the notes made by students. Moreover, students' practice answering the 5 questions given by the teacher and upload them on the e-learning (as a quiz before class).	Students Feedback: Each student in the other group watching the video must make an essential point in their notes. Students give comments (feedback) to the video explanation and raise questions after watch the video, and the group that makes the video will answer that question. The teacher must make sure each student gives comments and questions after watching the video. Moreover, students' practice answering the 5 questions given by the teacher and upload them on the e-learning (as a quiz before class).
In Class		
Numbering	In-class learning used 14 m. Students were divided into groups and given a head number.	In-class learning used 14 m. Students were divided into groups and given a head name. Each student had their respective roles as Director, Manager, Admin, Supervisor and Quality Control, Secretary. Here are the roles of students in detail: 

Before Class	*Conventional Flipped Classroom Method*	*Peer Teaching Flipped Classroom Method*
Submitting	All groups get the same questions from the teacher.	Students with the same name will discuss in the same group.  Each group has one person in charge of making a video before class face-to-face, and this student becomes the CEO in his group and gets an assignment to explain 15 minutes. Each group gets different questions from the teacher.
Thinking	Students discuss and exchange information in small groups to answer questions from the teacher.	The group answers different questions given by the teacher. After that, each student returns to the original group with the solutions of questions, they got in the job title group.  Every student explains their solutions of the questions. And then, the manager arranges who explain first and so on. Students who act as admin arrange the grouping answers and upload them on e-learning.
Answering	Students whose numbers are randomly selected from the teacher must present in front of the class.	Students whose names are selected from Random Generator Application must present in front of the class.
Evaluation	Students answer multiple-choice questions using paper pencils.	Students answer questions by using Kahoot. Students who act as quality control at this stage function to provide a recap of the report the number of correct answers from each group member by ranking based on the results of Kahoot. The teacher will ask students who answer correctly to explain to their peers.
Conclusion	The teacher concludes the lesson and gives a glimpse of the lesson plan for the next meeting.	Students conclude the lesson using the Mentimeter application. The supervisor of each group that appears is tasked with delivering the overall conclusions based on what their classmates write in the Mentimeter application.

Results and Discussions

The purpose of this research 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. This section will explain the results and hypothesis testing of the study. This study's results will be described based on the research questions and hypotheses made, along with their descriptions:

Comparison between PTFC and CFC Methods in Conceptual Understanding

The data of conceptual understanding shows that PTFC (M=78.89, SD=7.07) higher than CFC (M=73.44, SD=11.14). Next, the heterogeneity of slopes is not statistically significant with F(1,67) =.27, p=.606 >.05. Next, the researcher employed the homogeneity test. The data is homogeneous with F(1,68) = 3.93, p=.052>.05. Therefore, the data is further analyzed using the ANCOVA test (Table 3).

Based on the result of the ANCOVA test, it is concluded that there is a significant effect of method on posttest after controlling for pretest, F (1,67) = 6.51, p=.013<.05. The method used is a factor that increases conceptual understanding significantly. The data in the table above reveals that the mean of PTFC is higher than the mean of CFC, and the method provides a significant effect. Thus, it can be concluded that the PTFC method is better than the CFC method in increasing students' conceptual understanding.

The possible explanations is that students with the PTFC method had more mental effort. During before the class, the students provided video explanations and feedback that made them learn more deeply than just capturing the concept from watching videos and taking notes. The PTFC method offered students' opportunities to speak up in class, more interactive, and had the chance to peer-teaching to other students, making them learn more deeply to understand concepts more than the CFC method.

Comparison between PTFC and CFC Methods in Self-Efficacy

The data of self-efficacy shows that PTFC (M=84.64, SD=7.33) higher than CFC (M=81.15, SD=6.12). Next, we will carry out the test of heterogeneity of slopes. the heterogeneity of slopes is not statistically significant with F(1,67) = 10.36, p>.05. Next, the researcher employed the homogeneity test. The data is homogeneous with F(1,68) = .26, p=.615> .05. Then it can be further analyzed using the ANCOVA test (Table 4).

Based on the table above, it can be shown that there is a significant effect of method on the post-test after controlling for pretest, F(1,67) =5.99, p=.017 <.05. The method used is a factor that increases self-efficacy significantly. The data in the table above reveals that the mean of PTFC is higher than the mean of CFC, and the method provides a significant effect. So, it can be concluded that the PTFC method is better than the CFC method in increasing students' self-efficacy.

The finding gave a clear explanation that students with the PTFC method had more mental effort due to the provided feedback during the flipped classroom made them more involved and engaged. Furthermore, using this approach enabled students to evaluate their understanding before class. Students also had the opportunity to speak in class, be more interactive, and had the chance to teach other students, which made them also have a role in evaluating other students so that they can assessed themselves and measured the extent. Thus, they had good self-efficacy abilities and could predict themselves in the PTFC method. An in-depth analysis is carried out with the dimensions of self-efficacy. The obtained is shown in the table 5:

The table shows that the method has a great influence on the general of self-efficacy dimension with F(1,67) = 6.62, p<.05. And also, future dimension with F(1,67) = 5.00, p<.05. This means that the factors between the two methods for self-efficacy are general self-efficacy and future factors are significantly different between both methods. On the other hand, the grade, in class and assignment factor for increasing self-efficacy in the two methods were not significantly different.

One possible explanation is that during the class, students believed that they can learn well because used PTFC made them more active and interactive in learning, so they had many opportunities to discuss and ask many things they did

Table 3: Tests of Between-Subjects Effects

Source	*df*	*Type III SS*	*MS*	*F*	*p*
Corrected Model	2	595.43a	297.72	3.45*	.037
Pretest of CU	1	76.50	76.50	.89	.350
Method	1	561.67	561.67	6.51*	.013
Error	67	5777.44	86.23		

[a] R2= .0493 (Adjusted R2= .066)

Table 4: Tests of Between-Subjects Effects

Source		*df*	*Type III SS*	*MS*	*F*	*p*
Corrected Model	2	1351.7		675.87	22.94**	.000
Pretest of SE	1	1138.53		1138.53	38.64**	.000
Method		1	176.59			
Error		67	1974.04			

[a]R2= .406 (Adjusted R2= .389)

not know, and they were also much involved in the learning process. Students were sure that they could carry out the learning they got outside of the classroom and in the future because students had implemented peer-teaching, so they did not hesitate to enforce it at a later date.

The results showed that there was an insignificant difference for the assignment dimension of students in the two classes, this was possible because students used the conventional flipped classroom were also given control before class by made a summary of the videos they did, so that they could still be supervised and still under control. This also had an impact on their anxiety about the grade they would get to be reduced. This also occurred in the in-class dimension, students were asked to do group problem solving activities, so that those who were taught in the conventional flipped classroom also still believed that they would be able to learn well in-class.

Correlation between Conceptual Understanding and Self-Efficacy in CFC and PTFC Methods

The data is analyzed using the Pearson product-moment correlation. The data were obtained from the post-test conceptual understanding and self-efficacy questionnaire that the students filled out before the post-test in calculus learning. The following results of data analysis in the table 6:

Table 5: Descriptive Statistics

Dimension of SE	*Method*	*n*	*M*	*F*	*p*
General SE	PTFC	36	23.33	6.62*	.012
	CFC	34	22.03		
Grade no Anxiety	PTFC	36	23.81	1.19	.280
	CFC	34	23.26		
Future	PTFC	36	22.61	5.00*	.029
	CFC	34	21.35		
In-Class	PTFC	36	8.56	.013	.908
	CFC	34	8.59		
Assignment	PTFC	36	6.44	3.42	.069
	CFC	34	5.91		

The CFC method's data in the table above reveal that the conceptual understanding has a positive correlation with self-efficacy with r=.362* (p<.05). If examined more deeply, the five dimensions that exist in self-efficacy that have a positive correlation with conceptual understanding students are general self-efficacy and assignment with r respectively .357* and 364* (p<.05). Self-efficacy has a strong correlation with all dimensions (general self-efficacy, grade on test, future, in-class, and assignment factor) with r respectively .850**, 590**, .685**, .557**, and 582** (p<.01). General self-efficacy dimension has correlation with grade on test, future and assignment dimensions with r respectively .356*, 461**, and 464** (p<.05). Grade on test dimension has a strong correlation with in-class dimension with r=.497** (p<.01). Future dimension has correlation with assignment dimension with r=.361* (p<.05).

Several conclusions can be obtained from looking at the correlation using the CFC method: 1). The higher the student's conceptual understanding, the higher the student's self-efficacy. 2). The higher the student's conceptual understanding, the higher the student's general self-efficacy and the student's confidence in doing the assignment. 3). The higher the student's self-efficacy, the higher the students' general self-efficacy, students with no anxiety about grade, students could implement to future, students could learn well in-class, and students could do assignments well. 4). The higher the students' general self-efficacy, the higher the students with no anxiety about grade, students could implement to future, and students could do assignments well. 5). The higher the students with no anxiety about grade, the higher the students could learn well in-class. 6). The higher the student could implement to future, the higher the student's ability to do assignments well.

The PTFC method in the table above reveals that the conceptual understanding positively correlates with self-efficacy with r=.394* (p<.05). If examined more deeply, the five dimensions that exist in self-efficacy that have a positive correlation with conceptual understanding students are general self-efficacy dimension and assignment dimension with the r respectively .479** and 354* (p<.05). Self-efficacy has a strong correlation with all dimensions (general self-efficacy, grade on test, future, in-class, and assignment factor) with r

Table 6: Intercorrelations Between the Conceptual Understanding and Self-Efficacy

Pearson Correlation	*1*	*2*	*2.1*	*2.2*	*2.3*	*2.4*	*2.5*	
1. Post-test of CU		--	.362*	.357*	.241	.081	.242	.364*
2. Post-test of SE			--	.850**	.590**	.685**	.557**	.582**
2.1. Post-test of General SE	--	.356*	.461**	.314	.464**			
2.2. Post-test of Grade no Anxiety		--	.061	.497**	.121			
2.3. Post-test Future				--	.173	.361*		
2.4. Post-test In-Class					--	.232		
2.5. Post-test Assignment						--		

* p< .05. ** p< .01.

respectively .882**, 856**, .632**, .648**, and 789** (p<.01). General self-efficacy dimension has correlation with grade on test, future, in-class and assignment dimensions with r respectively .685**, 404*, 523** and 715** (p<.05). Grade on test dimension has correlation with future dimension, in-class and assignment dimensions with r respectively .356*, .600** and .560** (p<.01). Future dimension has a strong correlation with assignment dimension with r=.487** (p<.01). In-class dimension has a strong correlation with dimension assignment dimension with r=.427** (p<.01). (Table 7)

Several conclusions can be obtained by looking at the correlation using the PTFC method: 1). The higher the student's conceptual understanding, the higher the student's self-efficacy. 2). The higher the student's conceptual understanding, the higher the student's general self-efficacy and the student's confidence in doing the assignment. 3). The higher the student's self-efficacy, the higher the students' general self-efficacy, students with no anxiety about grade, students could implement to future, students could learn well in-class, and students could do assignments well. 4). The higher the students' general self-efficacy, the higher the students had no anxiety about grade. Students could implement to the future, learn well in class, and do assignments well. 5). The more students have no anxiety about grade, the higher the student's ability to implement to future, the greater the student's ability to learn well in-class, and the more stable the student's ability to do assignments. 6). The higher the student's ability to implement to the future, the higher the student's ability to do assignments well. 7) The higher the students 'ability in-class, the higher the students' ability to do assignments well. If we look more deeply at the PTFC method, each dimension has more correlation than the CFC method.

Comparison between Conceptual Understanding in CFC and PTFC Methods in Term of Majors' Background

The data in the PTFC method shows that natural science (M=82.52, SD=6.01) higher than social science (M=71.77, SD=3.44) and vocational (M=75.22, SD=5.67). The data in the CFC method also shows that natural science (M=75.52, SD=10.83) higher than social science (M=67.88, SD=11.87) and vocational (M=73.44, SD=10.38). Next, the test of heterogeneity of slopes is not statistically significant. The data is homogeneous with F(5,64)= 1.88 and P-Value = .111> 05. Therefore, it is further analyzed using the Two-Way ANCOVA test (Table 8).

Based on the data presented, it is confirmed that there is no statistically significant method with F(1, 63)=2.77, p=.101, partial η2=.042. The mean of PTFC in terms of the mean of all majors' background is 78.89, and the mean of CFC is 73.44. Although the mean of PTFC is higher than the mean of CFC, but not a significant difference. Moreover, the data also shows that there was statistically significant majors' background with F(2, 63)=5.77, p=.005, partial η2=.155. The mean of natural science in both methods is 79.02, the mean of social science is 69.50, and the mean of vocational is 74.64. The mean of natural science is higher than the social science, and vocational are significantly different. Furthermore, there was no statistically significant interaction between method and majors' background on post-test, whilst controlling for pretest, F(2, 63)=.53, p=.591, partial η2=.017.

Table 7: Intercorrelations Between the Conceptual Understanding and Self-Efficacy

Pearson Correlation	*1*	*2*	*2.1*	*2.2*	*2.3*	*2.4*	*2.5*	
1.Post-test of CU		--	.394*	.479**	.231	.092	.288	.354*
2. Post-test of SE			--	.882**	.856**	.632**	.648**	.789**
2.1. Post-test of General SE	--	.685**	.404*	.523**	.715**			
2.2. Post-test of Grade no Anxiety		--	.356*	.600**	.560**			
2.3. Post-test of Future				--	.149	.487**		
2.4. Post-test of In-Class					--	.427**		
2.5. Post-test of Assignment					--			

* p< .05. ** p< .01.

Table 8. Tests of Between-Subjects Effects

Source	df	Type III SS	MS	F	p	η2
Corrected Model	6	1576.34	262.72	3.45	.005	.247
Pretest of CU	1	6.90	6.90	.09	.764	.001
Method	1	211.13	211.13	2.77	.101	.042
Ma_Background	2	878.07	439.04	5.77**	.005	.155
Method * Ma_Background	2	80.63	40.32	.53	.591	.017
Error	63	4796.54	76.14			

a R2= .247 (Adjusted R2= .176)

This shows that majors' background affected students' conceptual understanding. No matter what method was used, the majors' background influenced students' conceptual understanding. This proves that the number of learning hours students spent in senior high school affected students' basics in different calculus learning at university. This may be related to varying levels of students' interest in mathematics or related to intelligent students. In Indonesia, students who entered natural science during senior high school, on average, were students who enter the top 25% in the previous class. Furthermore, there was no interaction between method and majors' background. To find out more, the Scheffe test was carried out, as in the table 9:

The table 9 shows that natural science was significantly different from social science and vocational in PTFC method. Meanwhile, social science and vocational was not significantly different. On the other hand, there was no significant difference in the CFC method among majors' background. To overcome and consider this, the researcher suggests that the PTFC method in the future also considers the students' majors background in each group division as well as considering the students' majors background in the division of roles in the group.

Comparison between Conceptual Understanding in CFC and PTFC Methods in Term of Prior Achievement Level

The data shows that the high ability (M=83.33, SD=7.62) higher than medium (M=75.58, SD=6.08) and low ability (M=77.75, SD=5.41) in PTFC methods. The data also shows that the high ability (M=75.75, SD=10.98) higher than medium (M=68.33, SD=11.20) and low ability (M=76.80, SD=10.04) in CFC methods. Next, the heterogeneity of slopes is not statistically significant. The data is homogeneous with F(5,64) = .69, p=.634> .05. Then it is further analyzed using the Two-Way ANCOVA test (Table 10).

The table 10 reveals that there is statistically significant method with F(1, 63)=6.05, p= .017, partial η2=.088. The mean of PTFC in terms of the mean of all abilities is 78.89, and the mean of CFC is 73.44. So, PTFC is better than the CFC in terms of prior achievement level. Moreover, the data also shows that there is a statistically significant prior achievement levelwith F(2, 63)=4.20, p=.019, partial η2=.118. The mean of high ability in both methods is 79.54, the mean of medium ability is 71.96, and the mean of low ability is 77.32. The mean of high ability is higher than the medium and low ability are significantly different. Furthermore, there is no statistically significant interaction between method and prior achievement level on post-test, whilst controlling for pretest, F(2, 63)=.99, p=.377, partial η2=.030.

The results shows that method affected students' conceptual understanding. This indicates that prior achievement level affected students' conceptual understanding. But there was no interaction between method and prior achievement level. To find out more, the Scheffe test was carried out, as in the table 11:

This explains that the method was suitable for the prior achievement level. Students with high ability performed better than medium in using the PTFC method. In contrast, medium and low ability was not significantly different. On the other hand, there was no significant difference between students at each level. In CFC method.

Comparison between Self-Efficacy in CFC and PTFC Methods in Term of Majors' Background

The data in PTFC method shows that natural science (M=87.29, SD=7.69) higher than social science (M=84.00, SD=4.98) and

Table 9: Multiple Comparison

			CFC Method	*PTFC Method*
Multiple Comparison	*(i) Majors Background*	*(j) Majors Background*	*p*	*p*
Conceptual Understanding	Natural Science	Social Science	.263	.001**
		Vocational	.940	.010**
	Social Science	Vocational	.664	.493

Table 10: Tests of Between-Subjects Effects

Source			*df*	*Type III SS*	*MS*	*F*	*p*	*η2*
Corrected Model	6	1396.70	232.78		2.95*	.013	.219	
Pretest of CU		1	4.18		4.18	.05	.819	.001
Method		1	477.62	477.62		6.05*	.017	.088
PA_Level		2	633.54		331.77	4.20*	.019	.118
Method * PA_Level	2	158.40		78.20	.99	.377	.030	
Error			63	4976.17	78.99			

[a] R2= .219 (Adjusted R2= .145)

vocational (M=78.89, SD=3.95). The data in CFC method also shows that natural science (M=82.29, SD=6.41) higher than social science (M=79.63, SD=5.95) and vocational (M=78.80, SD=4.76). Next, we will carry out the homogeneity test and continue with the Two-Way ANOVA test to determine whether the majors' background is a factor that affects the differences in self-efficacy. Next, the data is homogeneous with F(5,64)=.70, p=.625>.05. Then, it can be further analyzed using the Two-Way ANOVA test (Table 12).

The data explain that the mean of the method is no significant different with F(1,64)=3.17, p=.080>.05, partial η2=.047. The mean of PTFC in terms of the mean of all majors' background is 84.64, and the mean of CFC is 81.15. However, PTFC is higher than the CFC method but is no significant difference. The data show that the mean of majors' background is a significantly different with F(2,64)=4.63, p=.013<.05, partial η2=.126. The mean of natural science in both methods is 84.79, the mean of social science is 81.50, and the mean of vocational is 78.86. The mean of natural science is higher than the social science, and vocational are significant differences. The interaction between method and majors background is no significant with F(2,64)=.74, p=.408>.05, partial η2=.023.

These data indicates that the method did not not significantly affect students 'self-efficacy, while the majors' background had more impact on students' self-efficacy. Students who had natural science backgrounds were better than students with other backgrounds in both methods. There was also an interaction between the method and majors' background in terms of self-efficacy. This happened because students with medium ability in the PTFC had higher self-efficacy than students with high abilities in the CFC method. To find out more, the Schefft test was carried out, as in the table 13:

This means that students with a natural science background had better self-efficacy than students from vocational background because students who had a natural science background could predict their abilities and they believed that they could calculate calculus, they could follow calculus learning well and implement it outside the classroom and in the future. They also thought that they would get a good grade in calculus learning. With their background, there was a strong belief and self-efficacy for them to take calculus learning. They had much time at the senior high school level to do math questions with a high difficulty level to be more mature and feel more confident in their ability to learn calculus well.

Comparison between Self-Efficacy in CFC and PTFC Methods in Term of Prior Achievement Level

The data in PTFC shows that the high ability (M=89.33, SD=8.30) higher than medium (M=81.08, SD=5.73) and low ability (M=83.50, SD=5.45). The data in CFC shows that the medium ability (M=82.00, SD=7.77) higher than high (M=80.17, SD=5.25) and low ability (M=81.30, SD=5.23). Next, we will carry out the homogeneity test and continue with the Two-Way ANOVA test to determine whether the majors' background is a factor that affects the differences in self-efficacy. Next, the data is homogeneous with F (5,64) = .23,

Table 11: Multiple Comparison

			CFC Method	*PTFC Method*
Multiple Comparison	*(i) Majors Background*	*(j) Majors Background*	*p*	*p*
Conceptual Understanding	High	Medium	.258	.021*
		Low	.975	.121

Table 12: Tests of Between-Subjects Effects

Source	*df*	*Type III SS*	*MS*	*F*	*p*	*η2*
Corrected Model	5	733.64	146.73	3.62**	.006	.221
Method	1	128.31	128.31	3.17	.080	.047
Ma_Background	2	374.89	187.44	4.63*	.013	.126
Method * Ma_Background	2	60.11	30.06	.74	.480	.023
Error	64	2592.14		40.50		

[a] R2= .221 (Adjusted R2= .160)

Table 13: Multiple Comparison

Multiple Comparison	*(i) Majors Background*	*(j) Majors Background*	*p*
Self-Efficacy	Natural Science	Social Science	.254
		Vocational	.014*
	Social Science	Vocational	.550

Table 14: Tests of Between-Subjects Effects

Source	df	Type III SS	MS	F	p	η2
Corrected Model	5	665.42	133.08	3.02*	.012	.200
Method	1	478819.70	478819.70	11518.96*	.018	.074
PA_Level	2	131.87	65.93	1.59	.213	.047
Method * PA_Level	2	318.92	159.46	3.84*	.027	.107
Error	64	2660.35	41.57			

[a] R2= .200 (Adjusted R2= .138)

P = .950> .05. Then we can continue the Two-Way ANOVA test (Table 14).

The data explain that the method is significantly different with F(1,64)=11518.96, p=.018<.05, partial η2=.074. The mean of PTFC in terms of prior achievement level is 84.64, and the mean of CFC is 81.15. So, PTFC is better than the CFC in terms of prior achievement level. Whereas the data show that the mean of prior achievement level was no significant difference with F(2,64) =1.59, p=.213>.05, partial η2=.047. The mean of high ability in both methods is 84.75, the mean of medium ability is 81.54, and the mean of low ability is 82.50. Although the mean of high ability is higher than the medium and low ability are not significantly different. The interaction between method and prior achievement level is significant with F(2,64)=3.84, p=.027<.05, partial η2=.107.

The powerful method affected student self-efficacy. Students who used the PTFC had more self-efficacy than students who used the CFC method. This happened because students in the PTFC method had more loads and activities than the CFC method, so they had more confidence in their abilities and contributed to their ability to measure and assessed themselves better.

The interaction between method and knowledge happened because medium grade students in the PTFC method had a role as supervisor and quality control. They had the task of concluding and evaluating their teammates. So, they had more time to spend assessing teammates than themselves. This can be seen when assessing themselves, they were vulnerable to give a score that was not high compared to the value they give to their teammates. They felt that they did not provide high marks to themselves, so this continued until the end of the study. This needs to be anticipated by asking other teammates to give peer assessment to the students who played role as the quality control.

Meanwhile, students with high abilities had the lowest self-efficacy in the CFC method. When they did a quiz before class, they gave high predictions of themselves because they had understood a lot by watching teachers' videos. However, after learning in-class, they knew that they did wrong on the quiz before class, as the result, the students were not confident about giving high scores in-class activity so that their self-efficacy decreases. As the result, there is an interaction between methods and knowledge-abilities.

Discussion Section Before Class Activity

It can be concluded that several things are essential to the students' activities before class in the peer teaching flipped classroom, including heterogeneous group division (different background), making videos, student feedback, and quizzes.

The Benefits of Group Division For Conceptual Understanding

Peer teaching flipped classroom is a group learning strategy. Rawas (2019) argues that the design of flipped classroom learning with group learning methods is better than individual learning. Group learning also has other positive effects, namely, better knowledge, application, and integration. In particular, learning can also increase concern for others. As stated by Rawas, it appears that peer teaching is better than individual learning in conceptual understanding. In peer teaching flipped classroom, students learn in groups before class while conventional flipped classroom learns independently. This makes a significant difference felt by the researcher when providing a stimulus at the beginning of each meeting, students with peer teaching flipped classroom method understand more and deeper concepts, they are more active in asking more important things and are interested in discussing problems found before class. Teaching students in groups can make learning interactive and collaborative to affect math skills (Reynolds, 1999). The group size arrangement also determines the success of group learning, where usually the group ranges from 3-6 people for each group. The group size is made in small numbers to prevent laziness in the group (Trytten, 2001).

The Effect of Students' Efforts of Reading Various Sources on Conceptual Understanding

Various videos were made by students through various sources. Students understand the material in depth before making a video (Eugenia, 2018). There are many variations of videos watched in flipped classroom learning, this provides an opportunity for students to apply and gain much knowledge (Obradovich, 2015). The provision of information before class is advantageous in transferring knowledge (Elfeky, 2020). And they were providing information before class using flipped classroom results in better learning. Flipped classroom

learning conducted using pre-recordings, online quizzes, and group learning in class can increase student satisfaction and better learning experiences (Awidi, 2019).

Furthermore, flipped classroom learning that involves students in editing videos both individually and in groups can positively impact first-year students (Eugenia, 2018). In short, we can conclude that giving before class information makes students have knowledge before coming to class. On the other hand, students must understand the material before making videos, edit and watch many variations of their classmates' explanation videos. It impacts the assortment of students having to deepen the material so that they are indeed masters of the topic being studied. This helps students to develop their conceptual understanding.

The Benefits of Feedback on Self-efficacy

Students become more sensitive to the performance feedback given, and their perceptions become more realistic, constant, and stable (Dweck, 2002). Feedback provides opportunities for students to evaluate their understanding, and other classmates who provide feedback can also improve their assessment skills. This helps students to develop their self-efficacy.

Discussion Section for in-class Activity

In summary, several things are essential to student activities in-class in peer teaching flipped classrooms, including numbering, submitting, thinking, answering, evaluating, and discussing students. Peer teaching flipped classrooms create better interaction between teacher and students, peer interaction, make students more creative, make learning fun, enthusiastic, make maximum use of time in class, students participate in making decisions and make conclusions (Graziano, 2017). Peers will facilitate before class learning to have prior knowledge (Tsai, 2020; Graziano, 2017). Activities in peer teaching flipped classrooms allow students to be more involved and active in learning by utilizing technology (Nerantzi, 2020). Peer teaching engages students and encourages conceptual understanding (Schell & Butler, 2018). Peer teaching is interactive learning activities, student-centered paradigm, play more active roles in driving instruction, they studied what they need and what they want to learn (Bishop, 2013). Peer-teaching gives flexibility, in-depth, students' self-learning, interactive instruction, efficiency, practical learning, and empowers students to teach and learn from each other (Baepler, 2014). Peer-teaching is useful for improving students' conceptual understanding, problem-solving, and decision-making (Nicol, 2003).

The Benefits of Students' Feedback/Evaluation on Self-Efficacy

Students' feedback is essential in peer-teaching, and word-cloud in Mentimeter application is part of peer-to-peer interaction within study groups (Yun, 2008). Peer assessment is another commonly employed peer-to-peer learning approach (Hersam, 2004). Peer evaluation is more widely employed in high education (Lee, 2012). Peer learning from and with each other in increased education is useful for making students more critical thinking and developing their self-efficacy (Boud, 2014).

The Relationship Between Conceptual Understanding and Self-Efficacy

Calculus self-efficacy assesses students' abilities in understanding concepts and problem solving (Bandura, 1987). Students' experience every time they do calculus assignments affects calculus self-efficacy (Usher, 2008; Pajares, 2009). Moreover, self-efficacy provides positive messages on student performance and evaluative feedback (Joe€t et al., 2011). Furthermore, calculus self-efficacy was a predictor of achievement and increased students' conceptual understanding (Pajeres, 1995).

The Effect of Majors' Background on Conceptual Understanding and Self-Efficacy

Another thing that is essential as an increase in the peer teaching flipped classroom's success is the students' background. It is crucial to think about this in order to make students more developed and active in the group/class. Students help each other in understanding the material and solving calculus questions. Peer teaching is useful for promoting diversity in the background and students' prior knowledge abilities so that they are easy to blend in (Chubin, 2005). Moreover, Usher (2019) maintains that student background influences students' self-efficacy. Furthermore, Grigg (2018) also revealed that self-efficacy and affecting students' achievement also affect interest and intention.

Conclusion

This research is experimental research that found out the flipped classroom learning design in calculus class. Based on the results of research and discussion, it can be concluded as follows:

1. Peer teaching flipped classroom superior to conventional flipped classroom
   a) The results showed that students' conceptual understanding using peer teaching flipped classroom perform better than conventional flipped classrooms.
   b) The results showed that students' self-efficacy using peer teaching flipped classroom perform better than conventional flipped classrooms.
2. Positive correlation between conceptual understanding and self-efficacy
   a) The results showed that students' self-efficacy influence students' conceptual understanding in peer

teaching flipped classroom and conventional flipped classrooms.

3. Student's background affects conceptual understanding and self-efficacy
   a. The results showed that the students' majors background and prior achievement level in peer teaching flipped classroom influence students' conceptual understanding. Moreover, students' majors background influence students' self-efficacy, while prior achievement level did not influence students' self-efficacy.
4. The success of the peer teaching flipped classroom method

Peer-teaching flipped classroom successfully and very helpful for students to develop their ability to understand concepts and self-efficacy. Besides that, the students' teaching abilities also improve in preparing them to become teachers in the future. Peer teaching is also useful for fellow students in helping to understand learning, share information and knowledge. Moreover, they enjoy, appreciate, and are responsible for the role they play. They are very creative in making videos, active providing questions and comments, answering questions, providing feedback, enjoyable to do quizzes with the Kahoot application, and making conclusions with the Mentimeter application.

Recommendation

Based on the conclusions and research implications above, the authors provide the following suggestions:

1) The implementation of flipped classroom in calculus courses.
   It is recommended that calculus teachers use this learning model because this learning model's application can improve students' conceptual understanding and self-efficacy.
2) The implementation of peer teaching flipped classroom in advanced calculus
   It is suggested that calculus teachers try out this method in further calculus courses, such as: integral calculus, vector calculus, multivariate calculus, differential equations, and others, to see a further and more prolonged effect on students in calculus courses.
3) Considering the majors' background
   It is recommended that the group division must consider the students majors' background besides we must also consider the prior achievement level.
4) Big size participant
   It is recommended that other researchers try out / experiment with peer teaching flipped classroom over a more extended period and a more comprehensive number of samples.
5) The influence of peer teaching flipped classroom on other learning skills
   It is suggested that other researchers test other aspects besides students' conceptual understanding and self-efficacy in calculus courses.
6) Providing a backup strategy for students who did not attend the class
   It is suggested that other researchers think of solutions for students if students cannot attend or have problems with the internet network so that students can still follow all the learning processes properly without feeling disadvantaged.
7) Recording the discussion process
   It is recommended that researchers ensure/observe all students in discussing each group and ask students to record and recap each group discussionRecording the discussion process
   It is recommended that researchers ensure/observe all students in discussing each group and ask students to record and recap each group discussion

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