A Project entitled

A qualitative study on the Teachers' Perception of Cooperative Learning Approach on Student Learning Mathematics in the Flipped Classroom.

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Declaration

I, *Liu Wing Man* , declare that this research report represents my work under the supervision of *Dr. Ho Chun Shing Maxwell*, and that it has not been submitted previously for examination to any tertiary institution.

Signed

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Abstract

This paper evaluates the perception of teachers and students towards cooperative learning on student learning in the flipped classroom undertaking mathematics lesson in Hong Kong local secondary school. The learner-centred approach as a flipped classroom has been rising that the pedagogical complication of a teacher-centred instruction could be addressed. The study aims to investigate the perception of putting the flipped classroom into effect with cooperative learning in Mathematics lessons and describe the teachers' and students' attitudes toward these approaches within mathematics lessons.

The target groups are three mathematics teachers in secondary schools located in New Territories. There are three components of flipped classrooms, such as pre-recorded lectures, quizzes, and in-class group activities, as stated objectives on Mathematics achievement by using three levels of Bloom's Taxonomy, including knowledge, comprehension, and application. The flipped classroom approach is expected to affect students' academic achievement, learning motivation and learning differences. It promotes learning diversity to overcome the limitations of the traditional classroom and satisfy the learning needs of the students (Basal, 2015; Roehl, Reddy, & Shannon, 2013).

The findings of this paper reveal the achievement on claimed benefits in math flipped classroom and then explore the complication of teaching implementing the flipped classroom on mathematics, and thus, analyze the challenge which hampered the development of flipped learning in mathematics. Based on the findings of this study, it can be summarized that teachers felt positive as students had more opportunities to take ownership of their learning as they could prepare lessons before class. This paper contributes to investigate some fatal flaws for applying the flipped classroom model in Hong Kong that will advance innovative teaching approaches in Mathematics. Beyond this board purpose, this paper provides some practical implications and should be further studied by teachers of mathematics in the future.

Key Words: flipped classroom, cooperative learning, active learning, student-centred learning academic achievement, learning motivation, learning differences, mathematics, secondary school.

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1. Introduction

A concern has been raised that flipped classrooms play an important role in innovative learning. The past century has witnessed a global movement towards establishing an active learning environment, motivated teaching strategies to the mainstream trend of active learning. The concept of saving free class time for in-class activities instead of transmitting information traditionally is first mentioned by Alison King (1993). Later on, Baker (2000) introduced an innovative pedagogy and coined flipped classroom in 2000. The flipped classroom is one of the innovative instructional approaches that is shifted to before-class learning online by multi-media to allow more class time for hands-on work, such as discussing the topics, experience, and applying the knowledge (Bergmann & Sams, 2012). Jonathan Bergmann and Aaron Sams in Woodland Park, Colorado, first researched flipped learning in class in 2007 (Bergmann & Sams, 2012). Flipped classrooms are rapidly moving into the mainstream across international countries in the past decade (Tucker, 2012). According to the findings of numerous investigations, the flipped classroom has an undeniable recognition of the achievement of effectiveness (Chen, Lui, & Martinelli, 2017; Mc Lean et al., 2016). The National Centre for Academic Transformation also mentioned that it enhanced learning effectiveness and academic achievement by using technology, experimented with positive results of flipped learning across math, science, English, and other subjects (Keengwe, 2014).

In Hong Kong, there is an inveterate phenomenon that students prefer passive learning (Kennedy, 2002). A teacher does most of the work in the lesson, and meanwhile, students passively listen to the teacher and then cram for an examination (Shakarian, 1995). Students act as the audience usually come to class with inadequate preparation. This kind of teacher-centred learning culture does not encourage students to engage in the learning process resulting in disempowering the effectiveness of learning. In light of the enhancement of active learning, many academic studies have acknowledged that the key strategy to shift the student's role from passive to active is a student-centred approach (Johnson & Johnson, 2008). It enables students to participate in lessons actively and facilitates their learning motivation eagerly. The classroom flip occurs to enhance learning outcomes (Bishop & Verleger, 2013). Some scholars claimed that flipped learning affected positive learning outcomes and learning motivation (Yilmaz, 2017; Hsieh, Huang & Wu, 2017). However, students achieve higher and brighter learning goals on their academic achievement in the flipped classroom compared to the non-flipped classroom (Lombardini, Lakkala & Muukkonen, 2018).

Mathematics is a significant subject in the education curriculum in Hong Kong. With the rapid advances in educational technology, it highly promoted to use technology during mathematics lessons as it enhances the student's understanding of the concepts and positive learning outcomes. Some scholars investigated the effect on teaching mathematics in the flipped classroom and found out that students who are in the flipped classroom perform higher learning achievement and motivation (Bhagat, 2016; Lai, & Hwang, 2016; Lazakidou & Retalis, 2010;

Mattis, 2015). The Fourth Strategy on Information Technology, which was held by the Education Bureau, officially recommended that flipped classroom teaching strategy should be developed under an advanced information technology supporting environment (Hong Kong Education Bureau, 2015). Nowadays, teaching in the flipped classroom with cooperative learning is still in a primitive stage in Hong Kong. However, there is limited research on direct educational outcome research on Mathematics and the challenge of the teachers encountered in the math flipped classroom in Hong Kong. To fill the research gap, this paper aims to investigate the perception of the front-line teachers about the challenge of implementing the flipped classroom model on mathematics concept learning in secondary school.

2. Purpose of the study

The purpose of this study was to investigate the front-line math teachers on the effectiveness of implementing the flipped classroom, replacing the traditional lecture in Mathematics lessons. Secondly, its purpose is to evaluate the learning motivation and the learning differences executed under flipped learning. It also attempted to explore the understanding of Mathematics concepts through flipped learning. Finally, its purpose is to investigate the difficulties in teaching Mathematics in the flipped classrooms. This study was conducted at local secondary schools in Hong Kong and interviewed three math teachers of three different schools. The specific three research questions that guided this study are as follows:

(1) How does the teacher perceive students' academic achievement in terms of their knowledge, comprehension and application levels in flipped classrooms on mathematics?
(2) How do the teachers assess the effect on students' learning motivation in mathematics flipped classrooms ?
(3) How do the teachers evaluate the outcomes of catering for the learning differences in mathematics flipped classrooms ?

This study is potential and constructive due to the following reasons. It examines whether the flipped classroom strategy is suitable for the student in Hong Kong. It is evident to promote active learning, increase learning motivation, ease learning differences, and have a positive impact on academic achievement.

3. Theoretical background

Flipped classroom strategy is a new trend in the world in recent years, such as America, Europe, Australia, Malaysia, Singapore, Taiwan and Hong Kong (Sandrone, Berthaud... & Weber, 2020). It was carried out by lots of teachers in their classroom to increases teacher-to-student and student-to-student interactions by creating a cooperative learning environment in the classroom so that it obtained its effectiveness in the development of educational processes and for the achievement of objectives (Saunders, 2014). The current trend of researches about evaluating the effectiveness of flipped classroom on mathematics is mostly focused on students' academic achievement, learning motivation and learning difference (Elian & Hamaidi, 2018; Mattis, 2015; Saunders, 2014; Zainuddin & Halili, 2016). Despite a slowly growing development of the flipped classroom in Hong Kong, there is still a large gap in knowledge about the embarrassment that the front-line mathematic teachers are facing in the flipped classroom. This paper aims to fit the research niche for investigating the teachers' perception on the performance of students' academic achievement, learning motivation and learning difference in math flipped classroom and understanding the challenge that math teachers encountered in the flipped classroom. Thus, it evaluates the achievement on claimed benefits in the flipped classroom and investigates why math teachers deprecated flipped classroom.

3.1 Flipped Classroom

The flipped classroom has been defined as an instructional strategy that moves outside the classroom by watching teacher-created video-recorded teaching material (Abeysekera & Dawson, 2015). The flipped classroom is a blended learning model that embraces three stages in class, including before class, during the class, and after class. The direct instruction is done through the online video and material to the student individually at home before the class (Abeysekera & Dawson, 2015). The time shift provides the interactive class in advance with better utilization and instant feedback for student discussions. Students review the class and rethink critically after the class. Flipped classroom regards as a learner-centred approach has been rising that the pedagogical complication of teacher-centred approach could be addressed, resulting in promoting active learning (Lewis, Chen & Relan, 2018).

3.2 Academic Achievement

Hung (2015) indicated that students' participation, satisfaction, and performance revealed a constructive development after enacting the flipped learning approach. It was shown that students who learned independently by using e-learning got substantially better learning outcomes on the assessments. Baepler et al. (2014) also exercised the flipped learning approach in the class, and the findings of the research found that the academic achievement was attained by students not less than the traditional classroom.

Some research found that flipped learning strengthens students' performance in Bloom's Taxonomy with comparison to traditional teaching (Cockrum, 2013; Morton & Colbert-Getz, 2017). The template used in the study implemented assessments incorporating Bloom's Taxonomy (Shorser, 1999). The academic achievement is assessed based on three levels of Bloom's Taxonomy, including

i.) knowledge: mathematics facts and principles,
ii.) comprehension: grasping of meaning, the ability of mathematical operation; and
iii.) application: problem-solving (Shorser, 1999).

3.3 Motivation

It is widely accepted that the learning characteristics of Hong Kong students, who are mostly and typically described as rote and silent, study in a passive learning environment (Sit, 2013). The teacher dominates most work in the lesson while students act as the audience that is passively listened to by the teacher and then cram for an examination (Shakarian, 1995). This kind of teacher-centred learning culture does not encourage students to engage in the learning process resulting in disempowering the effectiveness of learning. However, some studies state that the application of flipped classes in mathematics teaching will help to enhance students' interest and achievements in education (Van Sickle, 2016; Bhagat, Chang, & Chang, 2016). For example, it can not only promote active learning, which contributes to the enhancement of mathematics motivation but also can boost students' learning interests to strengthen the incentive of mathematics learning. As a result, students are more willing to face problems, and actively participate in discussions, and thus, improve their learning achievements. The most crucial thing of teaching is to make a substantial improvement in students' learning experience and learning outcomes.

3.4 Learning Differences

Traditionally, teachers deliver the knowledge by using the textbook that reveals the textbook directly influences the implications for student learning (Cohen, Raudenbush, & Ball, 2003; Stein, Remillard, & Smith, 2007). Students' learning is affected by the content of the textbook (Stein, Remillard, & Smith, 2007; de Araujo, Otten, & Birisci, 2017). Those are not included in the textbook that is unlikely to be taught, resulting in affecting students' understanding of the concept. Flipped learning encourages the rise of digital teaching materials, which creates another bridge for student learning other than the conventional printed textbook. It also increasingly inspires teachers to flip their lessons to conceptualize the video for teaching in the flipped instruction.

These multi-learning materials adapt to students with different learning needs. Scholars have endorsed this teaching strategy and revealed the flipped classroom overcomes the limitation of the traditional classroom and satisfies the learning needs of the Millennial students, resulting in alleviating the learning differences (Basal, 2015; Roehl, Reddy, & Shannon, 2013).

4. Methodology

This study conducts qualitative research methods to investigate the effect of cooperative learning in the flipped classroom on mathematics achievement. It studies the teachers' perception and is qualitatively based. In terms of methodology, the flipped classroom approach is expected to affect students' academic achievement and learning motivation. The perspectives of teachers concerning the effectiveness of implementing flipped classrooms in Mathematic lessons allow for a valid gauge of quality and efficiency.

4.1 Participants

The purpose of this study was to investigate the teacher perception of math flipped classroom delivery method. The target group for this study consisted of three math teachers in different secondary schools. These schools were located in new territories. The teaching experience of the teachers ranges from 2 years to 16 years. Teacher A is a subject panel with over sixteen-years teaching experience; teacher B is a senior mathematics teacher with over ten-years teaching experience; teacher C is a junior mathematics teacher with only two-years teaching experience. They have once implemented the flipped classrooms in their schools but deprecated the flipped learning ultimately. Teacher perception data and teacher's reflections were gathered into data analysis to evaluate results. This evaluation involves a qualitative review of math flipped classrooms.

4.2 Data collection

The convenience sampling is to select secondary schools and math teachers. A qualitative method to collect data from subject teachers is face-to-face and semi-formal interviews with open-ended questions to access thoughts and reasoning to the flipped classroom approach. It aims to investigate the effectiveness of flipped classroom teaching approaches in the view of the subject teachers. The researcher invited mathematics teachers from different schools for interviews. A consent form was collected before doing the interview that shows a person permitted to involve them in research. It is an agreement between the researcher and the research participant outlining the roles and responsibilities they are taking towards one another throughout the whole of the research process. This research requires the agreement of all participants. The interviews took approximately 45 minutes, which were held online, and the process was recorded on audiotape with the agreement of the interviewees. It would then be transcribed into the data so that the researcher could review, analyze, and summarize the research report in the thematic analysis procedures.

4.3 Data Analysis

Qualitative data analysis process engaged in transcribing, segmenting, and coding and category development of data that evaluated the intercoder reliability of interviews with open-ended questions and access thoughts and reasoning to the flipped classroom approach (Ruona, 2005). The record of the conversations in audiotape was transcribed. After the data collection, data reduction would be momentarily familiarized with the data. It means finding out some words with specific meanings that are important to the research. The most significant data analysis is regarding the coding process, including coding, sorting, synthesizing, and theorizing (Saldana, 2013). There are three types of coding which were used in this study, including descriptive code, interpretive code, and pattern code. Descriptive code is about what the interviewees had mentioned; interpretive code is about the main idea on the summary of interviewees' quotes; pattern code is. Next, categorize these segments of data into different patterns, such as performance aspect, achievement aspect and learning environment. After that, generate themes by identifying the linkage of these patterns (Checking for the validity and reflexivity). Finally, explain and report the phenomenon of the research questions. These interviews mostly reported teacher perception on students' academic achievement, learning motivation, and learning differences toward using the math flipped learning instructions outside of the class and the in-class activities.

5. Findings

The qualitative interview data were collected from the teachers' perception of the implementation of math flipped learning to obtain more in-depth information about teachers' experiences teaching in the flipped classroom. In the time between the qualitative data analysis, three significant themes developed from one-to-one interviews, adhere to specific sub-themes, particularly, (1) academic achievement, (2) learning motivation, (3) learning differences. Apart from that, four Tables were provided with patterns, quotes, and interpretive codes.

5.1 Findings on students' academic achievement

Table 1

Themes of students' academic achievement

Patterns	Example quotes	Interpretive code
Knowledge	"Students could often recall the learnt formula correctly" (n=3)	Self-learning
	"Students can still remember the learnt concept after a period" (n=3)	Self-learning
Comprehension	"Students tend to have better performance on explaining questions as they are internalizing the concept by themselves" (n=3)	Self-learning

	"Students with low learning ability performed better on the low-level questions" (n=2)	Teaching effectiveness
Application	"More time for discussing the higher-level questions" (n=1)	Teaching efficiency
	"Cannot discuss high-level questions due to the low learning ability of the student resulting in failure to meet deep learning" (n=1)	Perceived competence
	"The pre-class stage is not focused on the application of the math concept, so students sometimes feel confused in class." (n=2)	Learning association
	"Students sometimes interpreted the math concepts with the questions in the wrong way in the pre-class stage." (n=1)	Self-learning

In the interviews as depicted in Table 1, it assesses the teachers' perception of student academic achievement in terms of their knowledge, comprehension and application levels in flipped classrooms on mathematics. The findings showed that students performed better at both the knowledge and comprehension levels cognition while there was no significant improvement on the application level of cognition.

Interviewees all agreed that students performed better at both the knowledge and comprehension levels cognition. Interviewees explained that the mastery of preparation tasks could help students to facilitate the subject content through the self-learning. Students remembered the learned subject matter so they could direct to the significant aspects of the lesson. Besides, interviewees disclosed that individual learning helped students internalize the regurgitate facts, definitions and formulas of the mathematic concepts into a more understandable way. Therefore, students were able to explain the learned mathematic concepts in the lesson by themselves. Interviews also found that students performed better on the knowledge and comprehension levels of questions, especially the students with lower learning ability. They continued revealed their achievement on the knowledge and comprehension levels were shifted to a higher range.

In-class activities are encouraged in the flipped classroom. Although there was more time for the teacher to discuss the higher levels of questions in the class, students with lower learning ability might not be absorbed or even fail to meet deep learning. Interviewees reflected that students' performance on the application level of cognition was not likely improved. Two of them expressed that the pre-class stage was not focused on the application of math concept but the knowledge and comprehension levels. Some of the students interpreted mathematic concepts in the wrong way. Thus, students sometimes felt confused and lost in class as the lesson was only discussing the problem-solving application. It caused the lack of learning associated with their preparation tasks. Still, application skill is the most concerned with the assessment. In such wise, teachers could not obtain better academic performance of the students' assessment.

5.2 Findings on students' learning motivation

Table 2

Themes of students' learning motivation

Patterns	Example quotes	Interpretive code
Pre-class learning	"Multiple teaching materials could attract students' learning interest." (n=3)	Learning autonomy
	"Students have learnt the basic concept before class so that it made them not to feel so confused and lose in the lesson." (n=2)	Learning confidence
	"It made students long for learn as they understood better of the topic" (n=1)	Learning satisfaction
Pre-class challenges	"The lack of teaching monitoring leads students to skip the self-learning part." (n=3)	Perceived self-discipline cultivation
	"The preparation time of self-learning is much longer than the normal teaching strategy." (n=2)	Perceived positive motivation
In-class activities	"Students took ownership in the class." (n=3)	Learning autonomy
	"It boosts the interaction between students during the in-class activities, so they are willing to participate." (n=3)	Learning engagement
	"Everyone has different roles in the group and shift the role regularly that made them more responsible for the group work." (n=1)	Learning engagement

Table 2 summarizes the teachers' perception of the effect of students' learning motivation in the flipped classroom. The interviewees observed a positive influence on students learning motivation in flipped learning. The finding shows that various kinds of learning materials, such as video lectures, reading, quizzes, and games, could stimulate the students' curiosity and attracted them to explore the new topic with some preparation tasks. Students developed into more active with high learning autonomy. Teachers noticed that out-of-class preparation tasks raised students' learning confidence that contributes to their learning motivation during the class. Since they have learnt among various types of learning resources to investigate mathematics concepts, it simulated them learning independently in the self-study stage. It was beneficial to the teaching effectiveness that drove students to engage the in-class activities easily based on their pre-class work. One of the interviewees stated that flipped learning was not only raised the learning confidence of students when they were in class but also helped them gain learning satisfaction from learning better in the subject. This finding recognized that the three critical factors of autonomy, confidence, and satisfaction were the driving forces of students' learning motivation.

The out-of-class activities are self-directed learning to discover new information over the learning process. Interviewees realized that they could not monitor or evaluate the learning progress when students were during the self-study. Therefore, some of the students were less disciplined to skip the preparation tasks that caused them to suffer from the chance of quickly getting lost in class discussions and activities. It further lowered their learning engagement in the class and decreased their learning motivation. More than that, students took double the time to prepare the flipped learning that did not encourage them to study independently.

Aside from the pe-class stage, this finding shows that teachers agreed on the definite improvement of student's engagement in the cooperative learning environment. Flipped learning emphasizes student-centred instruction. It provides an opportunity for the student to take ownership of the class. As presented in table 2, teachers revealed student involving in class more actively. It enhances their learning engagement in class and is also beneficial to peer learning. They found that students became more active in a group and took responsibility for their learning. Interviewees mentioned that it booted not only student-to-student interaction during the in-class activities, but also enhance teacher-to-student interaction during the class discussion. One stated that students had different roles in the group, and they shifted the position regularly. So, it made them more responsible for the group works and more willing to participate in class discussion. This finding shows that flipped learning enhances students' learning motivation if they were self-discipline to finish their out-of-class activities.

5.3 Findings on students' learning differences

Table 3

Themes of students' learning differences

Patterns	Example quotes	Interpretive code
Pre-class stage	"Multiple teaching materials are beneficial to the different learning style of learners." (n=3)	Learning diversity
	"Help the student study in their learning speed, especially the student with high learning motivation and poor learning ability." (n=3)	Learning diversity
	"It provides an alternative way for the student with higher learning ability to learn more and deeper." (n=1)	Learning diversity
	"I could moderate the learning video clip to cope with the different learning needs of students." (n=1)	Learning diversity
Pre-class challenges	"Students with low learning ability usually need assistance. Their learning obstacle could not be overcome because of lacking teacher's support in the preparation time." (n=3)	Perceived teachers' support
Cooperative learning	"Students support one another in the group." (n=3)	Peer learning

The interview data in Table 3 disclosed that the evaluation of the teachers perceived on outcomes of catering for the learning differences in the flipped classroom. Flipped learning catered for the diverse needs of different students for both pre-class and in-class stage. In the pre-class stage, multiple learning resources could accommodate the study styles of students. For example, readings are suitable for the word smart of verbal learners; videos are favourable for picture smart of aural learners; quizzes and games are helpful for self-smart of kinesthetic learners. Interviewees realized that the traditional lecture in class could not fit for every student so that flipped learning could settle down their learning embarrassment. Students could take advantage of adjusting their learning speed for their learning progress, especially for the low learning ability students.

On the other hand, flipped learning is also favourable for students with higher learning ability. Teachers could not spend much time on the advanced part of the content. Students learned deeper and boarder with the provided extra learning material to extend their learning in flipped learning. Besides, one of the interviewees said that teacher foresaw the learning embarrassment and moderated the teaching video to cater to the learning need of students.

However, the interviewees acknowledged that lacking instant support in the pre-class stage was a challenge to the flipped learning. Students with low learning ability usually need assistance during self-study, otherwise, their learning obstacle could not be overcome because of lacking teacher's support in the preparation tasks.

Besides, the flipped learning made students more enthusiastic involving in the class that enhanced both teacher-to-student and student-to-student interaction. It contributed to the peer learning as they could help one another to settle down their learning difficulties.

5.4 Findings on challenges in executing math flipped classroom

Table 4

Themes of challenges in executing math flipped classroom

Patterns	Example quotes	Intrinsic need
Pre-class challenges	"Students skipped the preparation." (n=3)	Perceived self-discipline cultivation
	"Students engaged the class in meager participation since they skipped the preparation and lack behind the learning progress." (n=3)	Perceived self-discipline cultivation
	"Students with weak learning ability are not willy to learn without the teacher." (n=1)	Perceived independent learning
	"Students cannot accept this learning mode." (n=3)	Perceived acceptability
School support	"Double preparation time for sorting out the teaching materials	Perceived flexibility

	and producing video." (n=3)	
	"Lack of support from peer teachers." (n=2)	Perceived coordination with school
	"School has not provided support for flipped learning, so teachers have to follow the tight teaching progress." (n=3)	Perceived coordination with school
Assessment mode	"Hong Kong educational system is kind of a cramming education that focuses on skilled ability while flipped classroom aims to improve higher-order thinking. So, students felt it was not beneficial." (n=3)	Perceived satisfaction
	"Students could not achieve better results in the exam that caused low learning satisfaction and motivation." (n=3)	Perceived satisfaction

Table 4 summarizes that the unexpected findings of the obstacles of using flipped classroom on mathematics during the interviews. Teachers found that some students skipped the pre-class learning activities. Students do not have the habit of previewing and preparing new knowledge out of the class since they have long been used to listening to content passively from the instructor in class. Most notably, students, due to weak learning competencies, are dependent learners that prefer one-way instruction. They lack curiosity and to acquire new knowledge through the process of self-study. It is hard to drive their learning autonomy without any positive motivation. It also indicated that a low learning intention on self-study in the initial stage, which also hampered students from participating in class discussions. One acknowledged that not every student had watched the instructional video before the class; thus, they had a high chance of failing to understand the content and could not engage in in-class discussion. Teachers mentioned that students who skipped the pre-class content mastery engaged less in the class. The interviewees asserted that it caused a vicious cycle of learning.

The pressure of catching up with the course progress is not conducive to implement flipped learning. The interviewees stated that flipping the classroom increased the time pressure and burden for them to prepare teaching materials. Most of the schools in Hong Kong do not provide any encouragement or support on flipped classrooms; thus, teachers carry on the struggle single-handed. Teachers could not seek help from one another or share the ideas or learning resources with their colleagues. Another teacher mentioned that it was challenging to produce teaching videos without extra time as they had to deal with different affairs after class, such as meeting, correcting homework, and preparing the lesson. The pressure of catching up course progress and the burden of making teaching materials from the limited time is the significant resistance to the implementation of flipped classrooms.

The assessment model also became the main reason for the corporation's survival of flipped learning. The interviewees recognized that the education system in Hong Kong firmly focused on the examination skills in the mathematic exam papers. This kind of examination-oriented base culture is cramming education as opposed to aiming to train high-order thinking skills in flipped classrooms. Therefore, students could not achieve better academic results from learning better in the flipped classroom. It negatively affected students' learning satisfaction as it failed to meet their learning goals. The examination-oriented base culture was the fatal cause that developed into the failure of implementing a flipped classroom in math lessons. This finding shows that the learning environment was unencouraged for the students and teachers in the implementation of flipped learning. All emblematic quotes given imply that the failure of the flipped classroom on mathematics ware none about the theoretical aspects of the teaching method but their learning environment.

6. Discussion

Since there is insufficient research on the failure of implementing a flipped classroom, this review highlights the needs of understanding the challenge that math teacher encountered in the flipped classroom. This paper was a qualitative research study that analyzes the teachers' perception of the effects of student learning and investigates the challenge of the teachers in the mathematic flipped classroom in Hong Kong. In this way, this paper first evaluates the achievement on claimed benefits in math flipped classroom and then explore the complication of teaching implementing the flipped classroom on mathematics, and thus, analyze the reasons that math teachers deprecated flipped classroom. This discovery reveals that corruption was inherent in its learning environment.

Several explanations are accounted for the flipped classroom in student learning performance obtained in this paper. Increase students' acceptance to learn new knowledge independently and use of online learning. Flipping the classroom is a student-centred teaching model, which allows teachers to design different teaching activities for students to participate in the classroom. It can be summarized that teachers felt positive as students had more opportunities to take ownership of their learning as they could prepare lessons before class. It not only increases the participation of students in the classroom but also allows teachers to guide students from the discussion. The conclusion in this study has been drawn based on the affective interviews (e.g. academic achievement, learning motivation and learning differences.) to assess learning outcomes in the flipped classroom.

It shows the more facilitative effect of the flipped classroom in teaching and learning mathematics. First, it appears that the strategy is also capable of improving learners' mastery of content at the knowledge and comprehension levels than at the application level of cognition in Bloom's taxonomy. Second, it is conceivable that students' learning motivation was positively improved since the out-of-class activities enabled students to understand the subject better and

gained more learning confidence during in-class activities. Third, the flipped learning approach also supported students learning and catered their learning differences. In flipped classroom approach, it strengthens to conduct higher-order thinking to improve students' learning effectiveness for the student with higher learning ability. At the same time, it catered for the diverse needs of different students in the pre-class stage with multiple learning resources could accommodate the study styles of students, especially for the low learning ability students. The flipped learning helped settle down students' learning embarrassment.

However, the flipping classroom in Hong Kong faces many difficulties. Teachers with high junior qualifications believe that students do not have the habit of the pre-class stage as students lack self-discipline and unable to control their individual learning progress. The hasty introduction of the present learning model is awkward for students to cultivate the habit of independent learning. There are insufficient supports from teachers in Hong Kong, for example, they lack peer support and school support. Teachers in Hong Kong have to deal with much administrative work in their spare time, and they also have to face the pressure of catching up the course progress. So, it is hard for them to spend much time to find the appropriated learning materials and even produce a learning lecture on their own. Besides, students are lack of self-discipline in the pre-class stage as having low learning autonomy to finish the preparation task. The most importantly, the examination-oriented base of Hong Kong examination culture on Mathematic focuses on the examination skills instead of high order thinking skills, therefore, students cannot achieve learning satisfaction from learning better in the flipped classroom. All emblematic quotes given implies that the failure of the flipped classroom on mathematics are none about the theoretical aspects of the teaching method but their education system environment.

7. Practical implications

Based on the findings of this study, it is hereby recommended that the below four practical implications should be further studies by teachers of mathematics. To begin with, teachers could establish a learning goal for students. Due to the examination-oriented base of examination mode on mathematic focuses on the examination skills that student might lead to failure to achieve learning satisfaction from flipped learning. Teachers can set a goal for the student to help them gain greater learning satisfaction.

Additionally, flexible to "flip". Teachers can design tailor-made teaching materials or share useful online materials for the needs of different students. Many teachers said that they did not have enough time to produce teaching videos, which made it challenging to implement flipping classrooms. However, the implementation of flipped classrooms does not necessarily require the production of teaching videos. Teachers can focus on students when designing classrooms.

Furthermore, active learning is a habit by cultivating it. It is useful for dealing with the problem of lacking self-discipline in the pre-class stage. Teachers can cultivate the habit of learning autonomy with students for lesson preparation, such as KWLH worksheet. KWLH strategy can stimulate students effectively to record the summary of prerequisite knowledge and promote learning confidence (He, 2004). It helps their understanding and strengthens their motivation by cultivating a habit of self-study. Since many Hong Kong students do not have the habit of pre-class preparation, teachers are worried that the effect of flipping the classroom on students' learning will decline. Therefore, teachers can first establish a habit of preparing class with students. There is a great challenge where the student cannot keep up with the learning progress because of skipping preparation tasks.

Last but not least, flipped learning should be implemented under the coordination with the school to settle down the difficulty of lacking support from peer teacher and school policies. It is suggested to establish a professional group of teachers to obtain teaching support. Teachers can support one another with the coordination of school policy. They can also build relationships through professional dialogues between teachers and peer interactions, thereby gaining professional support. Since it takes a lot of time and mental preparation to implement the flipped classroom, support from peer teacher and the school can help teachers implement it more smoothly.

Limitations

Since the novel coronavirus epidemic tore across the globe, the data collection is limited to the teachers. It is hard to interview students. Besides, as a student teacher, I admit the variance might be caused between validity and reliability. The results of measurement might not be consistent as the data might be inconsistently achieved by using the flipped classroom approaches under different forms in secondary school. The high validity could not be ensured since the teaching content of different schools is not the same that might measure inaccurately. I realized that the high level of reflexivity could be guaranteed, so it was supervised and monitored by Dr. Ho to diminish the bias.

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Annexe - Interview Questions

Flipped classroom.

1. What are the differences between traditional lesson and flipped classroom for the teaching method?
2. Have you even taught in the flipped classroom for the teaching method?
   i. What made you do or not to do?
   ii. How did the teacher, students, school facilities, resources, school policies help the use of flipped classroom?
3. What teaching materials did you prepare in the pre-class stage?
   i. Was there any problem when students are learning online by themselves?
   ii. Did you find difficulty when you were preparing the teaching materials?
4. What is the impact of replacing the teacher instruction directly in-class time?
   i. What was the difference by using cooperative learning instead of the teacher instruction directly in the class time? What are the impacts?

Academic achievement.

5. How do you perceive students' academic achievement in terms of their knowledge, comprehension and application levels in flipped classrooms on mathematics?
6. In what extent, it affects the performance on students' academic achievement in terms of their knowledge, comprehension and application levels?
7. What is the impact of students' knowledge acquisition in the flipped classroom?
8. How did the flipped classroom affect students learning achievement in the class?

Learning motivation.

7. How do you assess the effect on students' learning motivation in mathematics flipped classrooms?
8. How did the flipped classroom affect students learning autonomy?
9. How did the flipped classroom affect students learning engagement in the class?

Learning differences.

10. How do you evaluate the outcomes of catering for the learning differences in mathematics flipped classrooms?
11. How did teaching materials affect your teaching or influence students learning differences?
12. How did the flipped classroom affect students' learning differences in the pre-class and in-class stage?

Others.

13. What caused you to deprecate the implementation of the flipped classroom at the end?
14. Any feedback on the utilization of the flipped classroom on mathematics?