Faculty of Cognitive Sciences and Human Development

THE EFFECTIVENESS OF THE FLIPPED CLASSROOM INSTRUCTION FOR LEARNING ADDITIONAL MATHEMATICS AT A SECONDARY SCHOOL IN KUCHING

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THE EFFECTIVENESS OF THE FLIPPED CLASSROOM INSTRUCTION FOR LEARNING ADDITIONAL MATHEMATICS AT A SECONDARY SCHOOL IN KUCHING

ALBERT BONG CHUN WEI

A dissertation submitted
in partial fulfilment of the requirements for the degree of
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The dissertation entitled **The Effectiveness of The Flipped Classroom Instruction for Learning Additional Mathematics at a Secondary School in Kuching**
was prepared by Albert Bong Chun Wei and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfilment of the requirements for the degree of Master of Science (Learning Sciences).

It is hereby confirmed that the student has done all the necessary amendments for examination and acceptance.

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LIST OF ABBREVIATIONS

HP	High Performance
LP	Low Performance
FC	Flipped Classroom
NFC	Non-flipped Classroom
PT3	*Pentaksiran Tingkatan* 3 / Form 3 Evaluation
SPM	*Sijil Peperiksaan Malaysia*

ABSTRACT

The aim of this study is to investigate the effect of the flipped classroom and the non-flipped classroom on student's engagement and performance in learning Additional Mathematics for high-performance students and low-performance. This quasi-experimental research involved the form four students (n=34) the high-performance group (HP) and (n=20) from the low-performance group (LP) from a secondary school in Kuching. There were seventeen students participated in the flipped classroom (FC) and non-flipped classroom (NFC) respectively in the HP group while there were only ten students participated in the flipped classroom and the non-flipped classroom respectively in the LP group. The students taught using the flipped classroom watched the instruction video at home before engaging actively in the formal class at school while those taught using the non-flipped classroom went through the traditional instruction which is more to the lecture instruction. At the end of the session, the students sat for the Additional Mathematics Test and Student Engagement Questionnaires to measure the academic performance and the student engagement respectively. The finding of the study showed that there was no significant difference in academic performance between students taught using the flipped classroom and the non-flipped classroom for both high-performance group and low-performance group. However, there was a significant difference in student engagement between the students taught using the flipped classroom instruction and the non-flipped classroom for the high-performance group only. Lastly, the study also showed that student engagement had a positive effect on the academic performance for the students taught using the flipped classroom instruction but not for the non-flipped classroom.

Keywords: High-performance group, Low performance group, Flipped classroom instruction, Non-Flipped Classroom instruction, Academic Performance and Student Engagement.

ABSTRAK

KEBERKESANAN KAEDAH FLIPPED CLASSROOM *DALAM PEMBELAJARAN MATEMATIK TAMBAHAN DI SEBUAH SEKOLAH DI KUCHING*

Penyelidikan ini ingin mengkaji keberkesanan kaedah flipped classroom *dan kaedah* non-flipped classroom *ke atas keterlibatan dan pencapaian murid dalam pembelajaran Matematik Tambahan bagi kumpulan murid yang berprestasi tinggi dan berprestasi rendah. Kajian kuasi-eksperimen ini melibatkan murid tingkatan empat (n = 34) yang merupakan murid berprestasi tinggi (HP) dan (n=20) yang merupakan murid berprestasi rendah (LP) dari sebuah sekolah di Kuching. Seramai 17 orang murid yang terlibat dalam* flipped classroom *dan* non-flipped classroom *masing-masing bagi kumpulan HP manakala seramai 10 orang murid yang terlibat dalam* flipped classroom *dan* non-flipped classroom *masing-masing bagi kumpulan LP. Murid-murid diajar dengan kaedah* flipped classroom *menonton video pengajaran di rumah dan melibatkan diri secara aktif dalam aktiviti kelas manakala murid-murid diajar* non-flipped classroom *akan mengikuti kaedah tradisional yang merupakan kaedah kuliah. Pada akhir sesi kajian ini, semua murid akan menduduki Ujian Matematik Tambahan dan Soal Selidik Keterlibatan Pelajar untuk mengukur pencapaian dan keterlibatan murid. Dapatan kajian ini menunjukkan tidak ada pembezaan yang ketara dalam pencapaian murid bagi yang diajar dengan kaedah* flipped classroom *dan* non-flipped classroom *bagi kedua-dua kumpulan HP dan LP. Namun demikian, terdapat pembezaan yang ketara dalam keterlibatan murid di antara murid diajar dengan* kaedah flipped classroom *dan* non-flipped classroom *bagi kumulan berprestasi tinggi sahaja. Akhir sekali, kajian ini juga menunjukkan keterlibatan pelajar berkadar terus dengan prestasi murid bagi murid yang diajar dengan kaedah* flipped classroom *sahaja.*

Kata Kunci: *Kumpulan Berprestasi Tinggi, kumpulan Berprestasi Rendah, Kaedah* Flipped classroom*, Kaedah* Non-flipped Classroom*, Pencapaian akademik dan Keterlibatan Murid.*

CHAPTER 1

INTRODUCTION

Background of Study

Education plays an important role for Malaysia to answer the obstacles and needs of a Science, Technology, Engineering and Mathematics (STEM)-driven economy in order to achieve the status of the developed nation by the year 2020 (Ministry of Education, 2013). Ever since 1970, the Malaysian has implemented the education policy of ratio 60:40, which refers to the ratio of the number of student study Science/Technical to the number of Arts' students at the upper secondary level (Ministry of Education, 2013). In order for students to qualify for science stream in upper secondary level, they have to score at least grade B in science and mathematics in Penilaian Menengah Rendah (PMR) or Penilaian Tingkatan 3 (PT3). However, the policy of ratio 60 : 40 has never been met because it is undoubtedly due to the low quality of our students in Mathematics and Sciences. This was further confirmed through the poor performance of the form two students who sat for Mathematics and Science in Trends in International Mathematics and Science Study (TIMSS) and Programme for International Students Assessment (PISA). According to the recent report done by the Ministry of Education (Laporan PISA, 2016), they scored 446 and 443 in Mathematics Literacy and Science Literacy respectively and it was still below Organization for Economic Co-Operation and Development (OECD) average score. The finding also showed that 37.5% and 33.6% of the students scored below par in Mathematics and Science respectively.

In the year 2011, there were only 45% of the students graduated from Science stream (Ministry of Education, 2013). Hence, it is estimated Malaysia will be short of 236,000 scientists and engineers by the year 2020 (Ministry of Education, 2013). Additional Mathematics is one of the compulsory subjects to be taken up by the students who are in the Science stream for the preparation for the students who want to pursue STEM courses in the higher education. It is perceived as one of the toughest subject (Wong Jing Kae, 2010) to learn apart from Chemistry, Physics and Biology. Hence, Additional Mathematics may be the culprit for the decline in the outcome of students from Science stream. The reasons for the students cannot perform well in Additional Mathematics during Sijil Pelajaran Malaysia (SPM) mostly due to their low learning capability, low motivation (Reeve & Lee, 2014) and also the teaching and learning instruction (Ministry of Education, 2013). Currently, the traditional instruction is most widely practice instruction in learning Additional Mathematics apart from the proposed instruction which intends to engage students in active learning such as contextual learning, constructivism, cooperative learning, mastery learning, enquiry and exploratory (Curriculum Development Centre, 2006).

The traditional instruction only allows transmitting of knowledge from teacher to the students with a minor interaction between teacher and students and also between student and student (Overmyer, 2014). Therefore, students are passively accepting the information without thinking or questioning for the information given (Juhary, 2015). Apart from that, the instruction time is not sufficient for the meaningful learning to happen in the class because most of the class time is used for lecturing. In fact, the students are in need of more class time (Overmyer, 2014) to learn the concept of Additional Mathematics by consulting their teachers and interacting with friends. In other words, the students need to engage actively in the learning activities in the

classroom in order to learn better. However, the students need to prepare well (Rahman et al., 2015) by learning lower-level cognitive knowledge before the face-to-face class (Sun, 2015) which focus on the learning of higher level cognitive knowledge through active learning. In order to prepare well before class, the students can learn through online materials such as Khan Academy and EduWebTv. Hence, there is a need to consider the application of constructivism instruction that can promote active learning among the students especially in learning mathematics (Rahman, Aris, Mohammed, Zaid, & Abdullah, 2014).

In Malaysia Education Blueprint (2013), blended learning is one of the instruction highly recommended for the school. Blended learning is the integration of face-to-face and technology-assisted instruction (Malaysia Education Blueprint, 2013). The flipped classroom, which is one of the blended learning models, may become a solution for learning additional mathematics because what is normally done in class will be flipped to the outside of the classroom so the students can engage with guided learning activities in the classroom (Freeman Herreid et al., 2013). Students are going to watch the video such as Khan Academy and YouTube video (Freeman Herreid et al., 2013) at home at their own pace and own time. They even can rewind, pause and forward the video to accommodate their own learning capability. The in-class activity of the flipped classroom can, therefore, increase teacher-student interactions, student-student interaction and assist the students to excel including the struggling students and the busy students (Bergmann & Sams, 2014). Therefore, flipped classroom can be an alternative instruction for Additional Mathematics teachers to enhance student learning by their own pace through watching video outside the classroom while engaging actively in the class activity through interaction with peers and teacher.

Problem Statement

Most researchers reported that students were more motivated (Kumar Bhagat, Chang, & Chang, 2016) and performed better in the flipped classroom than those who were in the traditional classroom (Cronhjort, Filipsson, & Weurlander, 2017; Kumar Bhagat et al., 2016). The flipped classroom had also proven to provide a positive impact on student performance in various subjects (Love et al., 2014; Tong, 2014; Ramaglia, 2015; Poomorn & Kaewsaiha, 2015). However, some students were not satisfied with the flipped classroom especially for those who were low achievers in mathematics (Ingram et al., 2014) and there was also a significant difference in the performance of low achievers in the experimental and control groups (Kumar Bhagat, Chang & Chang, 2016). In addition, some studies found out that there was no significant difference in term of student's performance in learning mathematics between the flipped classroom and the traditional classroom (Clark, 2013; Holik, 2016; Saunders, 2014). Therefore, the design of flipped classroom may be only suitable for students with certain level of cognition and the subject matter with certain complexity for the students to learn.

Students who show positive engagement usually achieve positive performance (Cronhjort et al., 2017). However, some studies showed that students' engagement has no significant effect on students' performance in the flipped classroom (Clark, 2013; Lape et al., 2014). Therefore, there is a need to confirm whether the flipped classroom has a positive impact on academic performance of the secondary school students who are used to traditional classroom instruction and shy to questions in the class.

Most of the studies on flipped classroom were done in the western countries for various of subjects at elementary schools, high schools and university and few in Asian countries such as Hong Kong (Tong, 2014) and Thailand (Poomorn & Kaewsaiha, 2015; Unakorn & Klongkratoke, 2015) involving university students and secondary school

students respectively. In Malaysia, the flipped classroom instruction can be considered a new instruction to be used in education in Malaysia because there were only limited studies for accounting course in Polytechnic (Jamaludin, 2016; Osman, Jamaludin, & Mokhtar, 2014) and for English at higher education (Jamaludin & Osman, 2014). Hence, the present study will fill in the gap on the effect of flipped classroom instruction in learning Additional Mathematics in Malaysia's secondary school which it is still rare or none in Malaysia.

Research Objectives

General objective. To examine the effectiveness of the flipped classroom instruction on students' performance, and student's engagement in learning additional mathematics at a secondary school in Kuching district for two group of students: the high-performance group (HP) and low-performance group (LP).

Specific objectives

(a) Effects of different type of instructions and different performance group on academic achievement in learning Additional Mathematics:

RO1a: To determine whether there is any significant difference in terms of Additional Mathematics test scores between students taught using the flipped classroom instruction and those using the non-flipped classroom instruction.

RO1b: To determine whether there is any significant difference in terms of Additional Mathematics test scores between students taught using the flipped classroom instruction and those using the non-flipped classroom instruction for different type of performance group.

(b) Effects of different type of instructions and different performance group on student's engagement in learning Additional Mathematics:

RO2a: To determine whether there is any significant difference in terms of student's engagement between students taught using the flipped classroom instruction and those using the non-flipped classroom instruction.

RO2b: To determine whether there is any significant difference in terms of student's engagement between students taught using the flipped classroom instruction and those using the non-flipped classroom instruction for different type of performance group.

(c) The relationship between student's engagement and student's performance in learning Additional Mathematics.

RO3: To determine whether there is any relation between student engagement and academic performance for the flipped classroom instruction.

Research Questions

The following are the research questions which will be the guide for this research:

(a) Effects of different type of instructions and different performance group on academic achievement in learning Additional Mathematics:

RQ1a: Does the different type of instructions has an effect on the Additional Mathematics test scores?

RQ1b: Do the different type of instructions and the different type of performance group have an effect on the Additional Mathematics test scores for different type of performance group?

(b) Effects of different type of instructions and different performance group on student's engagement in learning Additional Mathematics:

RQ2a: Does the different type of instructions has an effect on student's engagement in learning Additional Mathematics?

RQ2b: Do the different type of instructions and different type of performance group have an effect on student's engagement in learning Additional Mathematics?

(c) The relationship between student's engagement and student's performance in learning Additional Mathematics.

RQ3: Is student's academic performance associated with students engagement in learning Additional Mathematics for students taught using the flipped classroom instruction?

Research hypothesis

The following research hypotheses (Null hypotheses) were investigated based on Research Question 1 (RQ1a – RQ1c), Research Question 2 (RQ2a - RQ2c) and Research Question 3 (RQ3).

RQ1a: Does the different type of instructions has an effect on the Additional Mathematics test scores?

$H_0 1a$: There is no significant difference in the test scores between student taught using the flipped classroom and those taught using the non-flipped classroom.

RQ1b: Does the different type of instructions has an effect on the Additional Mathematics test scores for different type of performance group?

$H_0 1b\ (i)$: There is no significant difference in the test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for the high-performance group.

$H_0 1b\ (ii)$: There is no significant difference in the test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for the low-performance group.

RQ2a: Do the different type of instructions has an effect on student's engagement in learning Additional Mathematics?

$H_0 2a$: There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom.

RQ2b: Do the different type of instructions and different type of performance group has an effect on student's engagement in learning Additional Mathematics?

$H_0 2c(i)$: There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom for high-performance group.

$H_0 2c(ii)$: There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom for low-performance group.

RQ3: Is student's academic performance associated with student engagement in learning Additional Mathematics for students taught using the flipped classroom instruction?

$H_0 3$: There is no relationship between the scores for student's engagement and test scores for students taught using the flipped classroom instruction.

Conceptual Framework

In this study, the investigation of the effect of two group of students with two different types of instructions on student's engagement in the in-class activities and also in student's performance in learning Additional Mathematics. The two group of students are high performance group (HP) and low performance group (LP) while the two typed of instructions are Non-flipped classroom instruction (NFC) and flipped classroom instruction (FC).

To measure the student's engagement, questionnaire will be given to the both group of students with different type of instructions to fill in at the end of the lesson

taught. The students from both group of students with two different type of instruction will also sit for a test at the end of the lesson to obtain the score of the test as the measurement for student's academic achievement. Therefore, types of instructions and the different group of students are the independent variables while students' performance and students' engagement are the dependent variables.

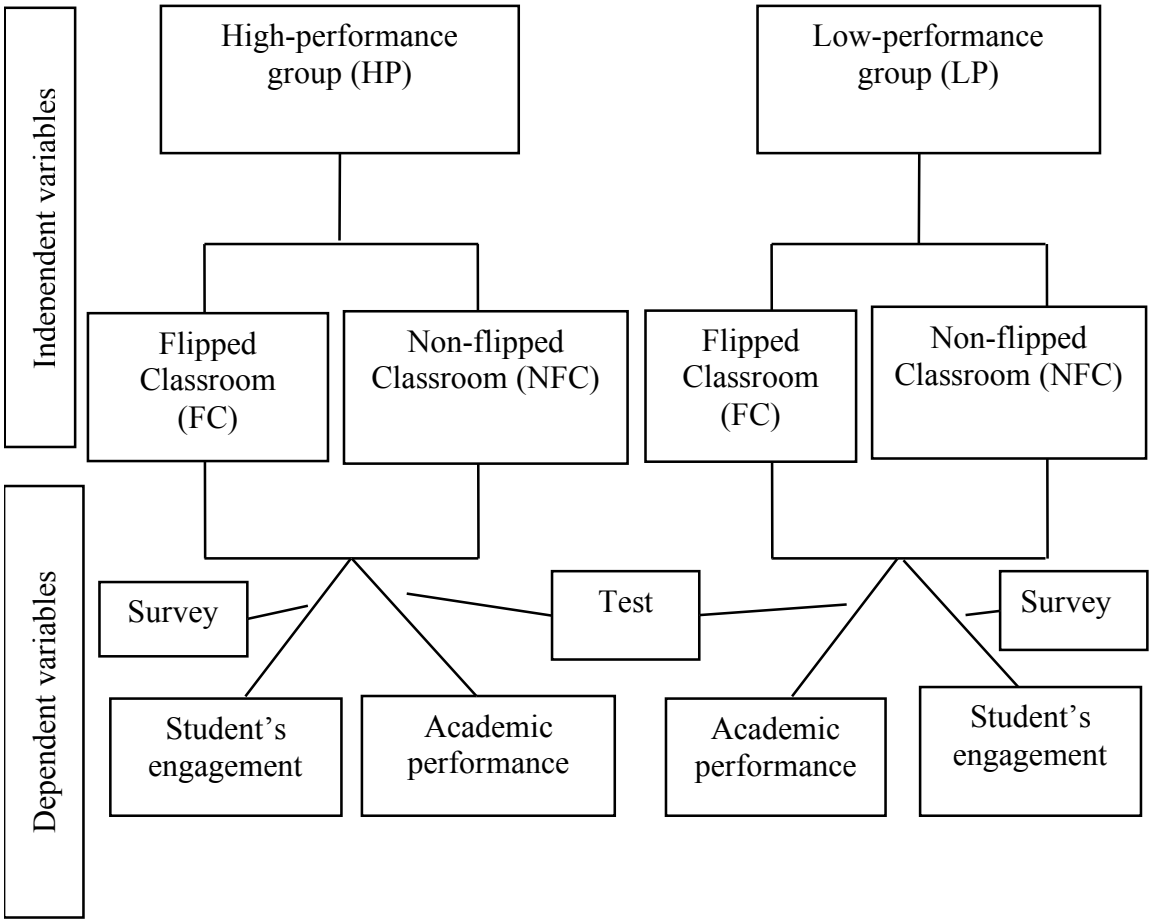


Figure 1.1 The conceptual framework of this study

Definition of Terms

The Flipped Classroom

Conceptual Definition. Flipped classroom is defined as "approaches to replace the traditional lecture with the pre-class/post-class work and active in-class tasks" (Abeysekera & Dawson, 2015)

Operational Definition. In this study, the flipped classroom is an instruction that consists of out of the classroom activity which the students need to watch video instruction prior to in-class activities which will be carried out in the formal classroom setting. In-class activities including group work and pair work.

The Non-Flipped Classroom

Conceptual Definition. Non-flipped classroom refers to instruction that is not using flipped classroom instruction.

Operational Definition. In this study, non-flipped classroom refers to traditional classroom instruction which is a teacher centred instruction or lecture style of instruction and one instruction applied to all the students in a class.

The High-Performance Group

Conceptual Definition. The high-performance group is referred to a group of students who are high achiever in a certain subject.

Operational Definition. In this study, a high-performance group is referred to a group of students who achieve grade A for Mathematics in Form 3 evaluation (PT3).

The Low-Performance Group

Conceptual Definition. Low-performance group is referred to a group of students who are the low achiever in a certain subject.

Operational Definition. In this study, the low-performance group is referred to a group of students who achieve grade B, C and D for Mathematics in Form 3 evaluation (PT3).

Student Engagement

Conceptual Definition. Student engagement as "the extent to which students are contributing to activities" (Alsowat, 2016)

Operational Definition. In this study, the student engagement is "the level of students' involvement in the class activities of the flipped classroom. To measure the student engagement, 19 items of questionnaire with 5 Likert scale was established, for both students taught using the flipped classroom and the non-flipped classroom, at the end of the instruction.

Academic Performance

Conceptual Definition. Academic performance represents performance outcomes which can be measured by standardized assessments to indicate the extent to which a person has accomplished specific goals in instructional environments.

Operational Definition. In this study, academic performance is defined as the test scores of the students in the Additional Mathematics Test to measure their learning outcome of the topic of function in Additional Mathematics. The Additional Mathematics Test consists of 12 items which all were extracted from the real Sijil Peperiksaan Malaysia (SPM) questions from year 2003 until year 2017. All the 12 items were valid and reliable which the questions all fulfilled the requirements of the Malaysia Examination Board. The questions used in this study was to test the outcome of the students only and not for the commercial purpose.

Significant of the Study

The result of the study could provide insights to educators to address the needs of the students who are technology savvy to be able to learn Additional Mathematics effectively. In addition to that, this study may also provide a better understanding on the impact of flipped classroom instruction towards students' engagement and academic performance in learning Additional Mathematics for two type of students which are high-performance students and also low-performance students. If the result of study proved that the flipped classroom has a positive effect on the students' performance and

engagement, then the management of the school will be able to provide professional development to fulfil the needs of the teacher in order to adopt the flipped classroom instruction which is student-centred instruction to be the alternative pedagogy in the classroom.

This study also may contribute to the research methodology where the methods and instrument used in conducting this research could be used by other researchers to conduct their studies on the same subject or other subjects matter. This study will be conducted in a quantitative method of approach with the adaptation of an existing questionnaire to suit the local context.

Limitations of the Study

This study only limited to 54 out of 140 Form 4 Science students from a secondary school in Kuching. The subject in the study was Additional Mathematics only. Although 34 students of Form 4 Science 1 were considered as high-performance students and 20 students from Form 4 Science 5 were considered as low-performance students according to their PT3 Mathematics results, their level of performance was not homogenous. Apart from that, the students may have tuition and guidance from their own subject teachers during the time frame of study especially the students from non-flipped classroom who were with their subject teachers while the students from the flipped classroom were with the researcher. Therefore, the findings of this study cannot be generalised to all the Science students and other subjects in the Kuching district.

The length of the study was limited to four weeks from 2nd February 2018 until 2nd March 2018 which including a week of Chinese New Year's holiday. Besides that, the total number of periods in this study was only 12 periods, with 35 minutes per period, each for the flipped classroom and non-flipped classroom. The students of the flipped classroom were having double periods for each session while the students of non-flipped

classroom had a single period for each session. Apart from that, the flipped classroom's students did not have enough time to adapt to the new instruction especially watching videos at home before attending the in-class activities. Furthermore, they only had two to three days to watch the 7 videos, with the length less than 5 minutes, for each outcome of lesson. The limitation was due to the fixed timetable by the management of the school.

The study was not fair to the low-performance students who need more time to watch the videos and digest the content before answering the quiz questions related to the content. This was because the instructor cum the researcher need to complete the lesson according to the planned syllabus before the students would sit for the first examination which was a week after the study was over. Hence, the result of the study may be affected by this factor.

CHAPTER 2

LITERATURE REVIEW

Introduction

This chapter focus on the flipped classroom instruction in learning Additional Mathematics. It is divided into 6 sections which are introduction to Malaysia mathematics education, teaching and learning instruction in mathematics education, technology in education, traditional and constructivism instruction, the learning theories behind the flipped classroom instruction, the flipped classroom instruction and its benefit, the effect of the flipped classroom instruction on the student's engagement and student's performance through the eyes of past literature, the discussion on Additional Mathematics subject and the conclusion of this chapter.

Malaysia Mathematics Education

Malaysia Mathematics education has gone through several changes. It started with the traditional mathematics focusing on basic skills which circling around Arithmetic, geometry and algebra as separate entity (Ahmad Zanzali, 2000) (cited on (Asiah Abu Samah, 1984)). In the 1970's, modern topics of set theory, statistics, vectors and etc. were introduced through "Modern Mathematics Program" (MMP) (Ahmad Zanzali, 2000) (cited on (Yeoh, Kanasabai & Ahmad, 1977)). In the 1980's, mathematics education underwent reformation through new curriculum based on National Philosophy of Education (Ahmad Zanzali, 2000). The separate entities then coherently connected and the main purpose of mathematics is to solve problems. In 2003, mathematics education

went through another reformation which was the integrated curriculum (Ministry of Education, 2013) that focused on solving problems related daily lives problems, reasoning, mathematics communication and the integration of Information, Communication and Technology (ICT) in education.

In 2016, mathematics education transformed again into standard curriculum which in line of the education transformation for Malaysia to be in the top third of countries in terms of performance in international assessments as measured by outcomes in Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) (Ministry of Education, 2013). In this new standard curriculum, the aims of the mathematics are generating higher order thinking skills (HOTS), creative and innovative skills and the 21st century skills, promoting explicit mathematics values and the use of ICT in education (Bahagian Pembangunan Kurikulum, 2016). Hence, the mathematics education will undergo transformation in line with the needs of Malaysia to cope with globalization.

Teaching and Learning Instruction in Mathematics Education

According to Standard Curriculum for Secondary School (KSSM) in Mathematics (Bahagian Pembangunan Kurikulum, 2016), the focus of teaching and learning in mathematics is to engage students actively by discovery learning through exploration and investigation in mathematics, problem based learning and technology usage for constructing concept. Hence, the instructions in mathematics education must change from traditional lecture instruction to student centred instruction which require to interact and subdue learning skills based on their previous experience so that the learners have fun, meaningful and challenging learning experience to instil in-depth understanding of the mathematical concept. Teaching and learning instruction must also be in line with the needs, the interest and the different learning styles of the students. In addition,

intellectual dialog or mathematical communication also must be incorporated into the instruction through collaboration among the students to solve challenging and meaningful mathematics tasks. Hence, the suggested teaching and learning instructions are cooperative learning, mastery learning, contextual learning, constructivism, project based learning and etc. The instructions for mathematics learning are not fixed but flexible to meet the needs of the students according to the syllabus. Malaysian mathematics teachers had a common agreement that multiple teaching methods with teaching aids of concrete objects ensure effective teaching (Brown & Roy, 2014).

Technology in Mathematics Education

Technology used in the classroom can prepare leaners to be independent and active in their learning. In addition, learners will be able to construct their own knowledge based on previous knowledge incorporated with the new information gained through the use of technology (Nikian, Nor, & Aziz, 2013) (cited on Bitter and Pierson (2005)). The claims further concreted by the standard curriculum (Bahagian Pembangunan Kurikulum, 2016) which emphasizes on the use of technology in mathematics education in order to assist the learners to create concept, enhance their understanding, visualization of mathematics concept, investigate and explore mathematics idea, solving mathematics problems and enrich the learning experience. Technology stressed in the standard curriculum including computer and software such as *Geometry Sketchpad*, *Geogebra*, learning application, internet and so on. In summary, technology is seen as a tool to enhance learning in the classroom instruction but not as a cognitive tool for learners to learn by themselves which is also the aim of the Malaysian mathematics educations to create self-regulated learners (Bahagian Pembangunan Kurikulum, 2016).

The traditional instruction and constructivists instruction

The traditional instruction is refer to a teaching method that involves the direct interaction between instructor and the learners in the face to face classroom (Li, 2016). The discussion in the classroom is taking charged by the teachers, and the focus of the discussion mostly is the content in the textbook and also in the notes (Li, 2016). Traditional teaching basically is the teacher-centred instruction (Unakorn & Klongkratoke, 2015) that teacher deliver the lecture to the whole class of students who will receive it passively (Alleyne, n.d.; Azlina et al., 2014). In the constructivist instruction, however, is student-centred instruction which focuses on the student's learning and teacher only acts as facilitators or collaborator who works with students in groups.

According to Johnson (2013), the attention of the students will be less after 10-20 minutes in traditional classroom instruction. Apart from that, the main task of the student will be taking notes from the teacher and less learning occur(Johnson, 2013). The traditional classroom is one bite at the cherry approach which students do not have the opportunity to pause, reflect or get clarification and the approach will cause cognitive overload (Johnson, 2013). In the constructivist classroom, teacher guides on side while students learn through discovery learning and peer instruction, hence, the interaction between students and teacher is two-way communication with questions from students and feedback from teacher (Johnson, 2013).

In the traditional classroom, students are passive learners (Li, 2016) and communication between them and their teacher and other peers is limited or it is a one-way interaction (Azlina et al., 2014; Clark, 2013). In addition, deeper engagement (Strayer, 2007) will only happen when homework is done at home (Gough, 2008). In

constructivist classroom, student learn actively by collaborating with peers so that they can learn in-depth and to solve problems.

In traditional classroom, technology used to assist learning for drill and practice, tutorial and simulations while technology tools are used for communication, collaboration, information exploring and online learning in constructivist classroom (Clark, 2013).

Learning Theories of the Flipped Classroom Instruction

The flipped classroom is basically based on the learning theories of constructivism of Piaget 1967 and social learning theory of Vygotsky 1978 (Bishop & Verleger, 2013). To justify the basic theory for the flipped classroom is to answer why classroom time is not used to deliver lectures (Bishop & Verleger, 2013). Constructivism is also the core of active student engagement and student-centred learning classroom (Clark, 2013). Constructivism is a theory of learning attempting to explain what knowledge is and how it is acquired. Constructivists assume that all knowledge is constructed from previous knowledge, irrespective of how one is taught (Bransford, Brown & Cocking, 2000). Thus, knowledge is not gained through imitation or repetition but interactions with content (Clark, 2013). In short, constructivism views individual's learning is an active process not passively received knowledge like pouring water into the empty vase.

Russian psychologist Lev Vygotsky, like Piaget, also believed individuals constructed their own knowledge (Clark, 2013). However, Vygotsky believed knowledge constructed by the learner through making sense of the social interaction and cultural environments (tools) (Vygotski, 1978). Vygotsky (1978) greatest contribution to cognitive learning theory included what he called the zone of proximal development, "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving

under adult guidance or in collaboration with more capable peers"(p. 86). Construction of knowledge to the higher level within the zone of proximal development can be built through scaffolding. Scaffolding can be a technology tool, instruction or social interaction. Viewing learning as a profoundly social process, Vygotsky has been associated with what a social learning theory or social constructivism (Bishop & Verleger, 2013).

The cognitive theory of multimedia learning (CTML) assume that learners able to learn deeply with words and pictures presented together to learners compare to words and pictures presented separately (Sorden, 2016) (cited on Mayer, 2009). The aim of CTML is to foster learner to construct logical mental illustration from material given and the learners task is to understand the information given by participating actively before new knowledge can be constructed (Sorden, 2016). Therefore, the purpose of the video instruction is to ensure learners learn the basic concept of remembering and understanding as the lowest levels of the cognitive domain to be achieved outside the class hour (Zainuddin & Halili, 2016) which enable them to take charge of their own learning at their own pace by rewinding, pausing or fast forward the video (Bergmann & Sams, 2014). In other words, the learners process actively the content from the video instruction through assimilation and accommodation and encode it to store in their long-term memory. In short, the learning theories behind the flipped classroom instruction are based on Mayer's cognitive theory of multimedia learning (CTML), Piaget's cognitive constructivism and Vygotsky's social constructivism learning theories.

The Flipped Classroom Instruction

The Flipped classroom instruction replaces the traditional lecture with the pre-/post-class work and active in-class tasks (Abeysekera & Dawson, 2015). The criterion of flipped classroom are video lectures as out-of-class activities and learning activities not

lecture as in-class activities (Bishop & Verleger, 2013). Flipping the classroom interchanges the transfer of knowledge and assignments such as homework occur (Amresh, A., Carberry, A. R., & Femiani, 2013). The flipped classroom instruction is a distinct approach which inverts the role of homework and classroom activities (Chen Hsieh, Wu, & Marek, 2016). According to Azlina A Rahman et al. (2015), the flipped classroom is one of the blended learning which the student-centred learning activities is emphasized.

The flipped classroom is pedagogy method which transforms from the space of group learning to the individual space of learning which in turn change the resulting group space into a lively two-way interaction learning environment where the application of the concepts and engagement creatively by guided students in the subject matter (Flipped Learning Network, 2014). The flipped classroom is the class that flipped by having outside class activities that students will read notes or watch videos assigned by the instructors and inside the classroom of collaborative or cooperative learning involving problem-solving (Flipped Learning Network, 2014). In flipped classroom instruction, knowledge is acquired by students at home, such as viewing the videos, and in turn, the skills are practised in class, where the students can be monitored in ease and their mistakes can be corrected easily (Chen Hsieh et al., 2016). According to Gardner (2015), "the low levels of cognitive work are done, outside of the class, and the higher cognitive work can be focused in the class".

Freeman Herreid et al., (2013) stated that the flipped classroom that uses the videos to enable student's engagement and student learning can be focused. This is supported by research done by Heo and Choi (2014) showed that positive academic achievement had a relationship with the higher numbers of videos watched for students who studied the 7^{th} grade math for a month. O'Flaherty and Phillips (2015) find out that

there is no specific flipped classroom model at the moment but there is an important guideline of the flipped classroom which the content is delivered in advance, the students understanding are monitored by the educators, and the engagement of higher order learning by the students during the in-class time. The self-paced learning environment is also promoted in the process of learning in the flipped classroom. Self-paced learning is believed can enhance learners learn at their own learning by using technology. Active learning which interaction and collaboration among the learners are promoted in the face to face formal classroom (Azlina A Rahman et al., 2015). In the face to face the formal in-class hour of the flipped classroom instruction, students will be focusing on the higher, more complicated levels of Bloom's taxonomy which is analyse, evaluate and create (A. Taylor, 2015) (cited on Marshall & DeCapua, 2013).

Johnson (2013) (cited November & Mull, 2012) stated the negative comments about the Flipped Classrooms. Some common critiques highlighted such as

(a) Teachers felt they are not important in the flipped classroom.

(b) Bored video lecturers will not attract the kids sit at home and watch through the web.

(c) Most kids do not have internet access and computer to watch the video at home.

(d) Some students are not accountable to watch the video at home.

(e) Teachers admit they do not have the capability to produce own video.

In short, the flipped classroom is basically the combination of traditional classroom which refers to face to face formal classroom and constructivist based classroom refers to students construct knowledge by their own based on their own or previous experience through active learning activities in class activities and learning by their own by using technology through watching video of instruction at home or out of formal class time.

Student's Engagement with Flipped Classroom Instruction

Alsowat (2016) that the definition of engagement is "the extent to which students are contributing to activities". Engagement is also defined as "the extent to which students are actively involved in a variety of educational activities that are likely to lead to high-quality learning". Students' engagement refers to "students' active learning or students' desire to actively participate in the routine class activity such as submitting homework, listening to the topic, working on what the instructor asks them to do, and actively attending the class" (Zainuddin & Halili, 2016). The student's engagement is defined as how it is measured on (L. Taylor & Parsons, 2008). According to Reeve and Lee (2014), classroom engagement consisted of four aspects of engagement which are behavioural engagement, emotional engagement, cognitive engagement, and agentic engagement.

According to Skinner, Kindermann, and Furrer (2009) (cited in Reeve & Lee, 2013), behavioural engagement refers to "how effortfully involved the student is in the learning activity in terms of attention, effort, and persistence." According to Jamaludin and Md Osman (2014), behavioural engagement can be promoted through beneficial communication, the demonstration of a caring attitude toward students' learning, active learning opportunities are provided and the use of cooperative learning approaches.

Emotional engagement refers to the presence of positive emotions or negative emotions when involving in the task (Reeve & Lee, 2014). According to Jamaludin and Md Osman (2014), the student will not learn a particular subjects or topic if no feedback given in the class or on the discussion boards. However, this is not always true because students can still learn well or complete their task although emotionless involved in learning. Nevertheless, emotional engagement will motivate students to complete tasks

given. Hence, learning activities which are considered as active learning will enhance emotional engagement.

Cognitive engagement is defined as the student try to learn with a plan in terms of using advanced learning strategies, such as elaboration (Reeve & Lee, 2013). The study conducted by Jamaludin and Md Osman (2014) shows the students are cognitively engaged when questions were posted by the lecturer in the class or discussion board. They are trying to make sense by connecting to their own experience to comprehend the concepts through constructing own examples.

Agentic engagement refers to "the extent of the student's constructive contribution into the flow of the instruction they receive in terms of asking questions, expressing preferences, and letting the teacher know what one wants and needs" (Reeve & Lee, 2013). Agentic engagement is the student's proactive way to build own motivation and the environment that will encourage learning for themselves so that educators can scaffold students to engage themselves (Reeve & Lee, 2013). Students who engage agentically will enhance learning levels and more motivational support (Reeve & Lee, 2013).

There are few factors that affect the student engagements which is relevant to this study including teacher's support, interaction, and instruction used.

Teacher's support. In an experimental study done Cronhjort et al. (2017) at KTH Royal Institute of Technology, to compare between 4 flipped classrooms of 226 students and 3 traditional classrooms of 413 students for the course SF1625 Calculus I. The study showed that the flipped-classroom group scored significantly higher on the engagement survey for cognitive engagement, emotional engagement and behaviour engagement/active participation. The most obvious difference found in the relationship between teacher and student such as the care from teachers to their learning, the teacher

responded seriously on their questions and support from the teacher (Cronhjort et al., 2017).

Instruction provided. Most of the studies on the flipped classroom instruction found out that student engaged more in the flipped classroom compared to the traditional classroom because of instruction provided by the teachers. The study done by Alsowat (2016) showed that the English as Foreign language – Flipped Classroom Teaching Model (EFL-FCTM) was effective in improving student engagement for 33 graduate female students because of the way teaching is carried out where students were able to learn at their own pace, own time and own learning environment. This is further confirmed by Jamaludin and Osman (2014) that students were more to emotional engagement with flipped classroom's material provided and followed by the behavioural engagement with the activities directed by the teacher. Cummin (2016) also found out that the levels of student engagement were statistically significantly different across activity level and group size with 50% in class activities done in a small group.

Strohmyer (2016) conducted a qualitative phenomenological study to describe high school math students' live experiences of flipped learning compared to traditional learning. The finding showed that the student favoured the flipped classroom because of the consistency of instruction used, interaction occurred, and level of learning in the flipped classroom. The action research study was done by Clark (2013) also suggested the student enjoyed and responded well to the different methods of instructional and the class time used in the secondary mathematics flipped classroom. The qualitative study on students' perception in statistic course in a university also showed that students are satisfied with flipped classroom because of the beneficial method of instruction including hands-on and interacting with peers in the class activities (Wilson, 2013). Johnson (2013) conducted in his study on three classes of high school students who took up the

Foundations and Pre-Calculus 10 course and Pre-Calculus 11 courses in British Columbia, Canada. The result of the study showed that the students appreciated that they did less exercise, they enjoyed more time to engage in learning activities provided, they were able to interact more with the teacher and with the content by watching the video in the class (Johnson, 2013). A quasi-experimental study done by Al-Rowais (2014) at Salman bin Abdul-Aziz University found out that the technology used in flipped learning and educational software in teaching may enhance student's engagement.

In the study done by Nouri (2016) on the undergraduate students (n = 240) at Stockholm University in Sweden who took up taking the course of Research methods and communication in the autumn semester of 2015. The result of the study showed that the low achievers presumed the flipped classroom could increase learning and was more effective in learning compared to high achievers. Apart from that, the low achievers favored the video compared to high achievers (Nouri, 2016).

However, the qualitative study done by Ingram, Wiley, Miller, and Wyberg (2014) found out that low achievers in mathematics were not satisfied with the flipped classroom in Stillwater Area Schools for fourth and fifth-grade students during spring 2013. It was because it was hard for them to learn from video with unclear explanation, fast instruction and and could not consult their teachers at the dot. Apart from that, they were aslo frustated with bored engagment with teachers in the class activities and ended up with unfinish assignments which they needed more time to do so. In the study done by Taylor (2015) on 28 Asian undergraduate students found out that some of the participants enjoyed the flexibility of learning while some did not bother or not engaged at all in the flipped classroom including the interactive quizzes and videos employed in this study.

Interaction. The action-based research, done by Holik (2016), on 24 secondary high school students in the post-secondary Culinary Arts program. The study (Holik, 2016) found out that student was more engaged in participation with friends and instructor in the flipped classroom compared to the traditional classroom. Besides that, students also reported being more engaged when they interact with the material by watching video lessons because they need to sit for mastery quiz in the next class. Sierra (2015) conducted a qualitative study in a high school involved the boys and 11 girls who took up Mathematics Analysis course which covered 6 periods over three weeks. The study revealed that student reacted positively to the class time designed for learning, interaction and collaboration promoted in learning activities, a safe social environment created by the teacher, and the flexibility in learning with the integrated technology tools. In the study done by Unakorn and Klongkratoke (2015) on 42 grade-11 students in the mathematics class at Suan Sunandha Rajabhat University, it showed most students had positive towards the flipped classroom where they had more opportunity given to interact with classmates and teachers.

Students' Performance with Flipped Classroom Instruction

Students' performance will be defined as students' academic performance in quiz or tests (Tong, 2014). Many students agreed with the statements that flipped classroom had an encouraging impact on their learning or their performance in the class (Stone, 2012). Most of the studies also showed that the flipped classroom had a positive effect on student performance (Love et al., 2014; Tong, 2014; Ramaglia, 2015; Poomorn & Kaewsaiha, 2015; Sahin et al., 2015).

In the study, done by Love et al. (2014), conducted on 27 students in a flipped model and 28 students in the traditional lecture in the Spring semester of 2012 for an applied linear algebra course in a sophomore-level. The result of the study showed that

the students in a flipped model were still performed better on the final exam compared to their friends in a traditional section because of the usefulness of the video instructions viewed, the relatedness of linear algebra to future career and fun in-class activities such as pair-work, peer discussion and also on board problem solving (Love et al., 2014).

The sample of the study, done by Sahin et al. (2015), consisted of 60 freshman students, 34 sophomore students, a junior and a senior who took Math 152-Engineering Mathematics II course during the Spring semester of 2013 semester in a southeast Texas college. The result of the mix-method study showed that the students' achievement in mathematics in quiz scores is significantly higher in flipped sections than non-flipped sections may due to better preparation before attending class, better understanding towards content learnt, high self-efficacy and high motivation of the students in the flipped sections (Sahin et al., 2015).

Tong (2014) conducted a full school term study on four secondary one geographies flipped classes in a local Hong Kong school. Throughout the term, students access the learning resources at home through online education platforms such as the class blog, Knowledge Forum, and Edmodo. In class time, students engaged in interactive activities created by their teacher. The student assessment results which included the pre-test and post-test, midterm and exam all certified that the student's knowledge was increased throughout the school term. The reasons for the student's performance were students had limitless access online video, positive view of flipped learning and there is ample resource of teachers had created for the students in the classroom.

Ramaglia (2015) conducted a quasi-experimental research to explore the reasons for the difference of the student achievement in middle and high school mathematics classrooms between the flipped method of classroom instruction and traditional classroom

instruction. The study results showed that there was a significant difference in student achievements which sided to the flipped classroom because of the learning activities used in the flipped classroom which were peer to peer discourse, modelling activities including project-based learning and also the physical arrangement in the classroom environment. Poomorn and Kaewsaiha (2015) conducted their study on 35 grade-11 students studying in the second semester of the academic year 2014 at Mahaprutaram Girls' School in Thailand. A total of 9 lessons were designed by using flipped classroom instruction for the topic of "Vector in 3 Dimensions". The study showed that the students' positive academic achievement may due to the students were able to apply the lesson in out-of-class activities and learn from practical applications.

In the research done by Kumar Bhagat et al. (2016) on 82 participants aged 14 and 15 years old taught using flipped classroom and traditional classroom to learn Mathematical concept of trigonometry in a high school. The result of the study showed that there was a significant difference in the performance of low achievers in the experimental and control groups which the post test showed that flipped classroom's students scored averagely 9.18 compared to 7.18 of the traditional classroom's student. The greater attention of the teacher toward the low achievers in the flipped classroom caused the positive result obtained. The research also found out that there was no significant difference in post test scores among the high achievers between 17 students in flipped classroom with mean marks of 10.00 and 14 students in traditional classroom with mean marks of 9.87. The study, hence, concluded that lower achievers benefited the most compared to high and average achievers which suggested student-centred approach was most suitable to low achievers.

Though most research proved that the flipped classroom has a positive impact on student performance but some research showed the opposite findings. Lape et al. (2014)

reported that a trend of suggesting that those students of the flipped classroom had a disadvantage in their performance from pre-test to post-test on the Math 45 assessment. The reasons for the result obtained in the study were due to the participants were above average students and the instruction used in the flipped classroom which was just the rearrangement of the same activities used in traditional classroom.

The experimental research study done by Saunders (2014) included 2 teachers and 58 student participants in two sections of 11th-grade Mathematics III classes. The control section is the traditional classroom comprised of 15 females and 15 males while the treatment group which was the flipped classroom that the of 14 females and 14 males. The results of this study showed that there was no significant difference in academic performance scored between the flipped classroom and traditional classroom. The reasons why the negative results were caused by student's low technology literacy, participant's low commitment in learning material outside the classroom, inappropriate teacher's instructional and pedagogical strategy used, and no alignment in syllabus and test content.

In the study of Clark, (2013) also showed that there was no significant effect of students' engagement towards the students' achievement in the flipped classroom if compared to students in the traditional classroom because the mathematics content learnt was too difficult for the students to learn by themselves and they had to adapt to new instruction (flipped classroom) at the same time. This is further confirmed by the action research conducted by Holik (2016) on a culinary flipped classroom at a post-secondary school. The analysis of the study showed that there is no significant difference in final grades between the flipped classroom and traditional classroom but the student performed 4% better than their peers from the traditional classroom. This may be caused by the use of technology by the students in the classroom.

Research indicated that flipped classroom has mix impact on student performance by using flipped classroom if compared to the traditional classroom. Therefore, there is a need to fill in the gap whether flipped classroom instruction has a positive impact on students' performance in learning Additional Mathematics in one of the secondary school in Kuching district.

Additional Mathematics

In Malaysia, the form four students will be streamed into science stream or art/commerce stream or vocational studies according to their result of Mathematics and Science in Form 3 evaluation (PT3). They will study science stream subjects or art stream subjects for form four and form five before they sit for Siji Pelajaran Malaysia (SPM) which is equivalent to O-level Cambridge. The results they obtained in SPM will determine their future study in form 6 or matriculation or diploma in polytechnic or A-level in private colleges/universities.

Only students who score minimum grade C in Mathematics and Science in PT3 will be granted to study science stream. They are compulsory to study Physics, Biology, Chemistry and Additional Mathematics. Additional Mathematics, however, is an elective for arts or commerce streams students. Normally, Malaysian students will address “Add Maths” for Additional Mathematics. The students need to learn topics from the five components in the core package which are algebra, geometry, statistics, calculus and trigonometry. Apart from that, the students have the option to learn science and technology component and social science component from the elective package.

The skills emphasized in learning Add Maths include problem-solving, communication in mathematics, reasoning, making the connection and the use of technology. Among the teaching and learning strategies suggested which enhance active learning such as constructivism, cooperative learning, mastery learning and contextual

learning. Hence, the aim of the Additional Mathematics curriculum designed for secondary schools is to produce students who will be equipped with in-depth mathematical knowledge and ability so that mathematics can be used responsibly and effectively in solving the problem and communicating in mathematics. Lastly, they are able to pursue STEM courses and hopefully contribute to nation building in STEM field (Curriculum Development Centre, 2006).

The summative assessment for Additional Mathematics is SPM which consists of two papers. Paper 1 consist of 25 structured questions with total marks of 80. Paper 2 consists of section A (6 compulsory structured questions), section B (students answer 4 out of 5 long questions) and Section C (students to answer 2 out of 4 long questions). The total marks for paper 2 are 100 marks. The questions to be evaluated are considered tough because limited formulae are given and students need to use their procedural and conceptual knowledge to solve the problems especially the HOTS questions. Therefore, Add Maths is recognized as a predictor for a student to be able to advance in STEM field.

Challenges faced by teachers who taught Additional Mathematics. The teaching and learning of Mathematics and Additional Mathematics seem to be a daunting challenge at the secondary school in Malaysia. Among the component in the Add Math, algebra was most difficult for the teachers to teach (Kalaivani & Tarmizi, 2014) (cited on Hmelo-Silver, 2004). Clearly, most of the challenges in the learning of algebra are due to the student difficult to grasp and solve problems with abstract concepts. In addition to that, students have learning difficulty in algebra were caused not only by the lack of consistent and least meaningful in the current curriculum but also the instructional approach used. Therefore, an effective instructional approach is needed to enhance student to understand abstract concepts and complicated relationships. The topic of the function is the first topic learn by the form four students and also from the algebra

component. In this topic, the students will study relation, function, composite function and inverse function. The function is always seen as the predictor of how well the students will do in SPM. Based on the results from the prerequisite survey put forward to several teachers who teach Additional Mathematics, on teacher's perception of student's challenges in learning Additional Mathematics can be found in table 2.1. From the result, three main challenges can be identified which are student's basic foundation in mathematics is weak, limited instruction time and students weak in developing conceptual knowledge and hence, they are unable to solve HOTS questions which basically relate to real life problems.

Steps taken to overcome the challenges faced by the teachers. From table 2.1, the strategy used to overcome the challenges faced by teachers are more to behavioural ways such as drill and practice, giving notes and punishments system for careless mistakes. The ways used presumed useful by the teachers to develop procedural knowledge. Procedure knowledge is the procedure to solve problems (Rittle-johnson & Alibali, 1999). These ways can be categorized as traditional classroom instruction which can be ineffective for students to construct their knowledge (Azlina et al., 2014). In order to overcome the challenges stated in the table 2.1, a better holistic instructional approach is needed for the students to be responsible for their own learning and gradually become an independent learner and hence, able to be a long-life learner (Kalaivani & Tarmizi, 2014). Hence, the flipped classroom may be the solution to overcome above challenges which can promote self-regulated learning and long-life learning.

Table 2.1

Teacher's Perception of Student's Challenges in Learning Additional Mathematics

Teacher	Challenges	Ways to overcome	Level of effectiveness (1 -5)
A	1. Students don't want to do HOTS questions and easily give up.	1. Motivation gave (Quiz givens and reward them with pencil and rulers.	2
	2. Student's basic in the calculation is not strong.	2. Do more exercises	2
	3. Students lazy to do exercise.	3. Remind them to hand in and give the due date for the exercise.	
B	Students are the weak foundation of skills in mathematics.	Teaching & Learning activity starts from the basic for the poor performance shown by students.	4
C	1. Students learning ability not fit to learning Add Maths (not conscientious type, or doesn't have the arithmetic/logic talent)	1. A penalty in exam marks for careless mistakes.	3
	2. Poor students' attitudes (not serious in learning, lazy to try/exercise etc.)	2. Motivational talk / Counselling careless mistakes	2
	3. Students weak in basic mathematics concepts and skills leading to their difficulty to master the Add Maths topics	3. Remedial short notes during solution discussion to remind them of the mathematical basis.	3
	4. Constrained instruction time to cover/finish the Add Maths syllabus	4. Extra classes to make up for little instructional time	4
D	1. Students' weak basic, not qualified to study in Science Stream.	1. Drill and practice	4
	2. Students' attitudes – They think that Add Maths is not important, less self-directed learning motivation.	2. Group work	2
	3. Students don't understand the concepts, therefore can't make the connection and understand the use of add maths. They cannot relate to daily life.	3. Project-based learning – effective to good students, not effective to weak students	2

	4. Instruction time is short, not enough for add math only 3 hours per week.

Conclusion

From the previous literature, the flipped classroom indeed has an impact on student engagement and student performance for various subjects at secondary and tertiary education. However, it is undeniable the flipped classroom also has setback especially the low achievers do not engage in the flipped classroom while high achievers were not affected by the flipped classroom instruction in term of academic achievement. Though many research showed that students performed better in the flipped classroom compared to the traditional classroom in learning various Mathematics subjects including algebra, calculus, statistics and geometry for secondary and tertiary education but mostly done in western countries and few in Taiwan, Hong Kong and Thailand. In Malaysia, there is a few of research done on Polytechnic, Matriculation and Universities involving Accounting, English language and Mathematics. However, it is still rare and none research on the flipped classroom in learning Additional Mathematics.

CHAPTER 3

METHOD

Introduction

The Method of the study describes the basic research plan. This is really the heart of the study here the activities that use to complete the proposed study should be described in detail. Research method and procedure is a plan, which determines how to complete the research systematically.

Research Design

The study was essentially quantitative in nature. The research is a quasi-experimental research design (Creswell, 2012) that consisted of 2×2 factorial design that consisted of independent variables of different type of instructions (the flipped classroom and the non-flipped classroom) and the different performance level (high-performance and low-performance). The different performance level was determined by their mathematics grades obtained in Form 3 Evaluation (PT3). Two dependent measures were the Additional Mathematics test which to obtain their academic achievement and student engagement questionnaire which used to obtain the level of student's engagement in learning Additional Mathematics.

Research Population and Research Sample

The population of this study is the all the form four science students who take up the subject of Additional Mathematics from SMK Green Road. In the beginning of the year, the students already been categorised into 5 classes which were 4 Science 1, 4

Science 2, 4 Science 3, 4 Science 5 and 4 Science 5 according to their overall results in the PT3 for the year 2017 and the total population was around 140 students. Hence, the 4 Science 1 is the high-performance class while 4 Science 5 is the low-performance class. Therefore, the research sample of this study were the students from the 4 Science 1 which represents the students from the high-performance group and the 4 Science 5 which consists of students from low-performance group. High-performance group of students were those who obtained grade A for Mathematics subject in PT3 in the year 2017 while the low-performance group of students were those who obtained grade B, C and above for Mathematics subject in PT3 in the year 2017. Therefore, the total sample was 54 students in total which were 34 students for high-performance group and 20 for the low-performance group.

Sampling Procedure

In this study, the researchers used purposive sampling method where the participants were chosen from the students from the 4 Science 1 as the high-performance group and 4 Science 5 as the low-performance group who agreed to take part in the study. The reason to use purposive sampling was due to the need for the study which required a high performance and low-performance group. In both class, the class teacher already created a list of name with their numbering from 1 to 34 for the high-performance group while from 1 to 20 for the low-performance group. Therefore, all the students with odd numbers were assigned into the flipped classroom instruction while those with the even numbers were assigned into the non-flipped classroom instruction for the high and low performance groups.

Research Instrument

The instrument of the data was divided into summative evaluation to investigate the performance of the students in this approach. The second instrument was the closed

questionnaire to collect information to find evaluate the students' engagement in the flipped classroom and non-flipped classroom.

Consent form. The researcher developed a consent form for the participants and also their parents. This was to ensure the respondents that the information given was confidential and not exposed their identity.

Academic achievement test questions. The test questions will be adapted from Sijil Peperiksaan Malaysia (SPM) real questions from the year 2003 until the year 2017 which following the standard set by the examination board of Malaysia. The test questions, therefore, were valid and reliable.

Questionnaires for students' engagement. To explore the students' engagement with the flipped classroom and students' engagement with non-flipped classroom, a 19-item, five-point Likert questionnaire adapted from Alsowat (2016), ranging from (strongly disagree to strongly agree) was designed and distributed (Appendix A) to the students from experimental and control group and the to measure student engagement. According to Alsowat (2016), the questionnaire was reviewed by a number of experts in language teaching and assessment to examine its validity and some modifications were undertaken. The reliability of the questionnaire with Cronbach's Alpha of 0.86. The questionnaire was then modified by the researcher after receiving the approval to use the survey questions through email.

Validity and reliability

Experts Involvement

Test questions. Since the test questions were extracted from the SPM real questions, therefore, the questions were valid and reliable to test the outcome of learning. The experts needed to analyse, evaluate, comment and refine the marking scheme made by the researchers. The experts are Madam Chai Lee Fah, Madam Chong Nyet Fung and

Mr. Hamzah from SMK Green Road who have more than 10 years experiencing teaching Additional Mathematics and marking Additional Mathematics test paper according to SPM marking scheme.

Video instruction. The videos created were validated, two weeks before the actual study, by other expert teacher, Mr. Foo Tze Yaw from SMK St Mary and experienced teachers, Madam Chong Nyet Fung and Mr. Hamzah from the SMK Green Road. This was to ensure the content of the video is following the syllabus of Integrated curriculum for the secondary school in Additional Mathematics. Apart from that, the quality of the video in terms of sound and image was clear to be viewed by the students. Overall, they were satisfied with the clear image and the content of the videos which were abide by the syllabus of Integrated curriculum for the secondary school in Additional Mathematics. However, they complaint about the sound was too soft to listened by the students which was later rectified by the researcher.

Pilot Test. The role of the pilot test in this inquiry was to thin out the errors in the video and the instruction to be carried out in the real study, the reliability of the student's engagement questionnaires and also the test questions. Moreover, the pilot test was able to guarantee that all the points in the questionnaires are easy and intelligible for the answerers. However, the pilot test of the planned research could not be carried out due to the students of the schools in the same Kuching district also learning the same topic at the same time. The pilot test, to check on the reliability of the questionnaires, was carried out to the 46 Form four science students from the same school which was SMK Green Road who were no involved in this research and already studied the topic of Function early February 2017. The pilot test was carried out on the 20th November 2017, a day before the year-end holidays started. The reliability of the questionnaire is reliable (19 items, $\alpha = .865$).

Data Collection Procedures

The instructor. Both groups of students will be taught by the researcher who holds an honours degree in Mathematics with Economics and diploma in education majoring in Mathematics. He has 16 years of teaching experience. In 2009, he is appointed as an expert teacher (*Guru Cemerlang*) for Mathematics and actively involved in sharing the best practises in teaching Mathematics and also the answering skills for students who sit for Mathematics in SPM.

Topic involved in the research. The topic chosen for this study is *Function* which is the first algebra topics to be learnt. The topic *function* consists of the component of relation, function, composite function and inverse function. The reason the topic *function* is chosen because students always faced problems when solving questions related to this topic. According to Lembaga Peperiksaan Malaysia (2014), low-performance students could not understand the basic concept of object and image, composite function and inverse function. According to the yearly planner for form four Additional Mathematics from SMK Green Road, the length of the instruction for the topic *function* would take minimum 3 weeks.

Video instruction

Video creation and editing. The videos were created by the researcher by using the IPad and edited by using Camtasia or another free online video editor. Then, the videos were converted into mp4 and uploaded to YouTube through researcher's YouTube Channel. The videos in the YouTube Channel were linked to Edmodo so that the students could watch the video through Edmodo. The length of the videos were 7 minutes to 10 minutes (Mok, 2014) in order to engage the student to watch the online video. There were total 19 videos (Appendix M) created and 7 videos each for each learning outcomes.

Edmodo. Edmodo is a free learning platform enables the teacher to create own classroom, own teaching plan, quiz, a discussion board for the classroom, interacting and sharing of teaching material with other teachers to overcome teaching difficulties faced. The researcher is one of the members of Edmodo and class had been created a week before the actual study after the list of the students received from the class teacher. The students just needed to log in with the password provided since the researcher already registered the students in the class assigned. Apart assignments and the videos', the researcher also created quiz questions related to the video which they have watched.

Uploading procedure and WSQ technique. The video for each lesson will be uploaded to be viewed and watched by the students for three days because the study will follow the timetable assigned by the school administration. Besides teacher's recorded video instruction, the students will also be encouraged to watch the video in the Khan Academy. To ensure student engage in the video watching, the technique of WSQ by Crystal Kirch. According to Kirsh (2012), WSQ technique involves students to watch the video and take notes, to summary what learners understand and to question or inquiry the material watch. Therefore, students need to summarise and post a question in a group chat through Edmodo or WhatsApp. Apart from that, the students need to write down the solutions, from the video, into the printed notes given to them at the beginning of the lesson. After watching the video, the students also required to answer 5 short questions a day before the next class in the formal class during school time. The quizzes were posted in the WhatsApp group due to the application of equation could not be used in the Edmodo and the students only need to write down their solutions and sent to the researcher in private message. Prior to the class activity, the teacher or researcher checked the students' work and discussed the actual quiz solution. This was carried out to ensure the students would watched the video, understood the content of the video,

wrote the solutions for the examples in the notes and answered the quiz questions posted a day before.

Readiness and Competency of the Students. The survey was done on the readiness and competency of students of the flipped classroom for Information technology and shown in Figure 3.1. The questions asked in the survey through WhatsApp were:

Question 1: Do you have laptop or personal computer at home?

Question 2: Do you have internet connection at home or mobile data?

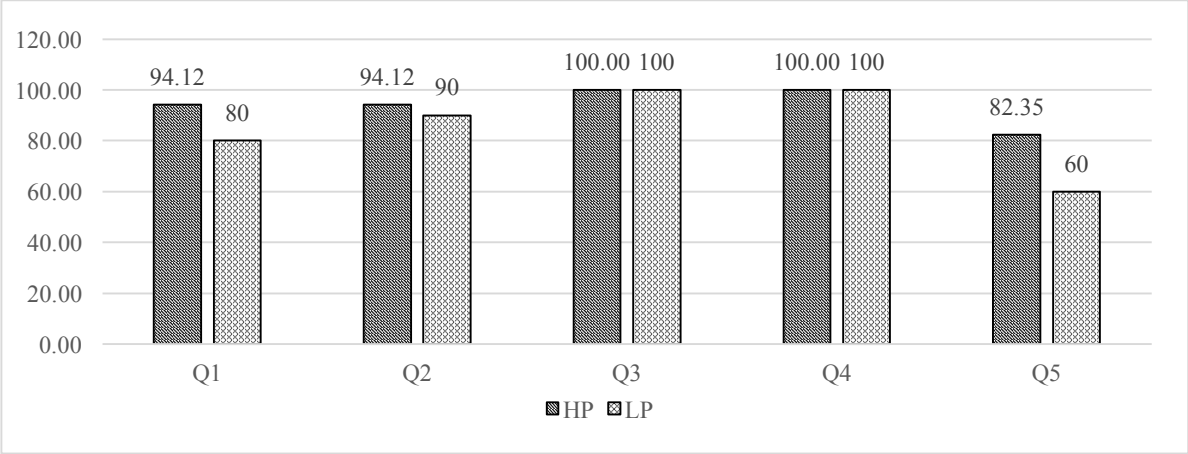
Question 3: Do you own a smartphone?

Question 4: Do you use social apps like WhatsApp, WeChat and etc. for discussion?

Question 5: Do you frequently watch education video through YouTube or other application?

From the Figure 3.1, 94.12% of the high-performance students and 80% of the low performance students have laptop or personal computer at home. 94.12% of the high-performance students and 90% of the low performance students have internet access at home. Both high and low performance students own a smart phone and familiar with social apps including WeChat, WhatsApp and others. However, only 82.35% of the high-performance students and 60% of the low-performance students watch education online videos through YouTube. Therefore, the students chosen are competence in Information Technology and own hardware either laptop, personal computer or smartphone with internet access. The high-performance students were more ready than the low-performance students on watching the online videos of the lesson. The issues of students actually would watch the videos could be traced through the number of views on YouTube channel and also the quiz solutions sent through WhatsApp. The high-performance students participated actively in watching the videos and answering the quiz

questions. In the other hand, the low-performance students did not participate actively in answering the quiz questions because they complaint they did not quite understand the content in the videos though they did watch the videos at home.



*HP – High-Performance Students *LP – Low Performance Students

Figure 3.1 Readiness and Competency of the flipped classroom's students

The structure of the flipped classroom. The students in the treatment group were taught using the flipped classroom instruction. The students and their parents were given a consent of this study and they all agreed to participate in the study. The participants were given the clear instruction on how to participate in the study on the first day of meeting. All the participants own either laptop, personal computer or smartphone with internet connections and able watch the videos at home.

The flipped classroom was divided into two parts of learning; first part needed the students to watch the videos at home and answered quiz questions; and the students attended and took part in the face-to-face in-class activity. Notes were given to the students which consisted of examples without solutions with ample space provided for them to write the solutions by watching the video at home.

On the actual formal class interaction of 80 minutes, the students went through brief discussion on the quiz questions and also given the opportunity to ask or clarify any

concept which is not clear for 10 minutes. Then, they participated in 3 or 4 small groups by interacting with peers for 45 minutes to solve problems given to them. The teacher went around from group to group to assist in case they need clarification or prompt with questions or examples. Each group presented their solutions on boards and followed counter checked by assigned group and Question and Answer (Q&A) section happened at the same time for 20 minutes. The last five minutes are to the summarize the whole in-class activity done. During the activity, they were reminded to ask questions so to promote active learning. Homework were not given for the flipped classroom and all exercises were done as a group activity in the formal face-to-face class.

The structure of the non-flipped classroom. The students taught in non-flipped classroom instruction which is teacher centred instruction. The students were given the same notes received by the students taught using flipped classroom. The contact time of the non-flipped classroom was 35 minutes for each period and there were four periods per week. The instruction started off with induction for 5 minutes. Then, the teacher would demonstrate and explained the concept and examples for 10 minutes. After that, students would do some questions to test their understanding or learning outcomes based on the teacher's teaching on that day. It would take 10 minutes for them to solve the questions given and followed by discussion for 8 minutes. The students either solved the questions individually or in pair or in a group. Next, the summary the learning outcome of the day was done by the students for a minute. Lastly, the students were given extra exercise to do at home to strengthen their skills to solve problems.

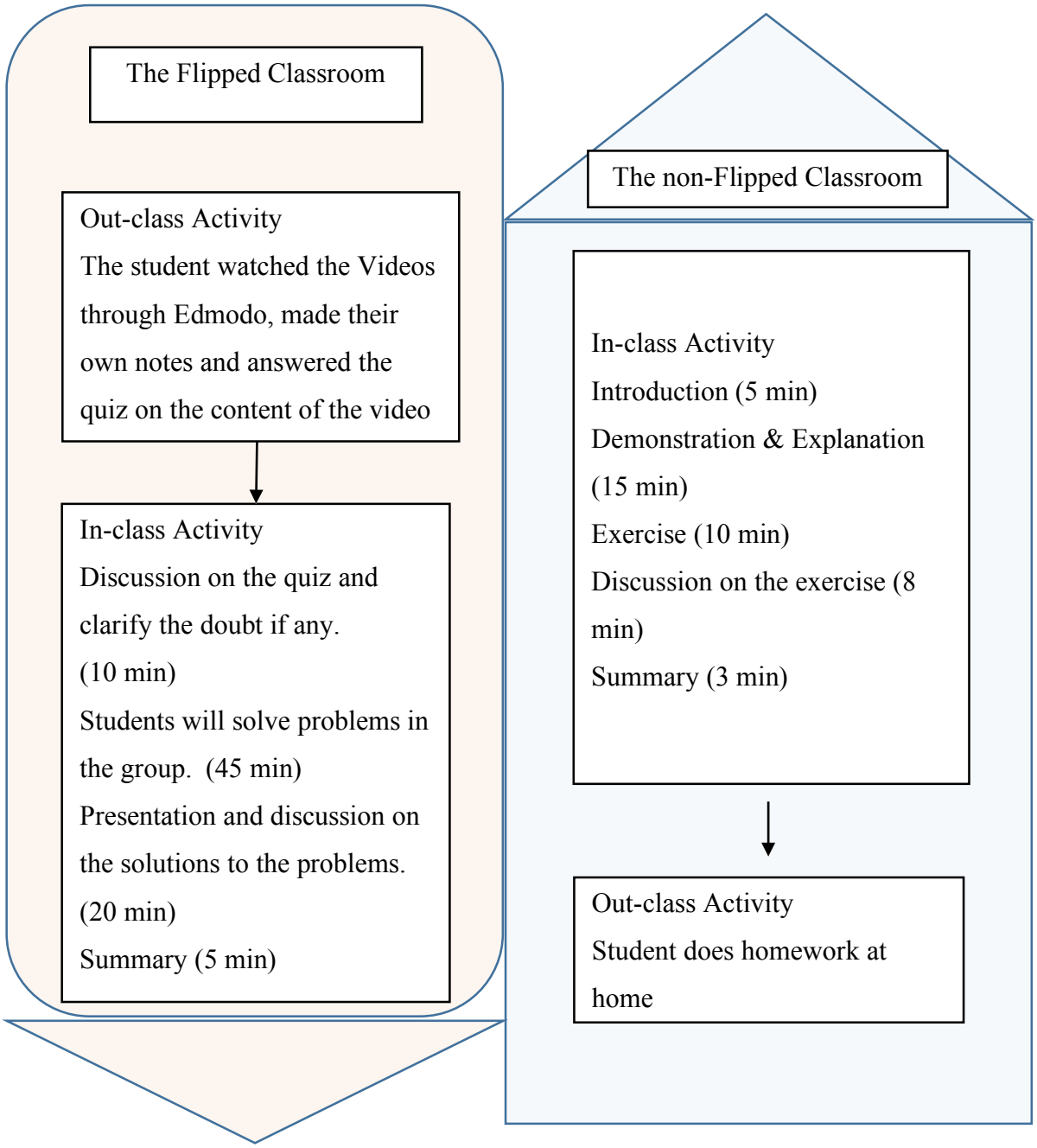


Figure 3.2 The structure of the flipped classroom and non-flipped classroom in this study

Data collection process

Before conducting the research, approvals were obtained from Educational and Research Division, Ministry of Education, the Director of Sarawak Education Department, the Education Officer of Kuching District Education Department and the principal of the SMK Green Road.

There were five science classes and a semi-science class which offered the subject of Additional Mathematics. The students from Form Four Science 1 and Form Four Science 5 were chosen to participate in this research. The students from Form Four Science 1 were chosen as high-performance group because they scored grade A on their PT3 Mathematics while the students from Form Four Science 5 were chosen as low-performance group as they scored lower than grade B on their PT3 Mathematics as mentioned section 3.3. The students were randomly labelled numbers, from 101 until 134, for the high-performance group while the students in the low-performance group were labelled from 501 until 521. The students with odd numbers were chosen to join the flipped classroom (FC) and those with odd numbers joined the non-flipped classroom (NFC). The gender of the students for flipped classroom and non-flipped classroom will not be assigned equally because they are chosen randomly among the students. Hence, there were four groups of students involved in this study which were High-performance group (HP) in FC, High-performance group (HP) in NFC, Low-performance group (LP) in FC and low-performance group (LP) in NFC.

All four groups of students were taught by the Add Maths teacher (the researcher) and the notes used are based on the textbook, Ace Analysis book and the Ministry of Education Integrated curriculum for secondary school in Malaysia. All the participants would remain in the study for four weeks according to the yearly planning as mentioned in the section 3.6.2. After the lessons were completed, the students sat for the *Functions* Achievement Test. The marks collected to determine the effect of different performance group and different type of instructions on student's achievement in learning Additional Mathematics (RO1). After sitting for the test, the students answered the questionnaire for student's engagement which to determine the effect of different performance group and different type of instructions on student's engagement in learning Additional Mathematics

(RO2). The test marks and the scores from questionnaire of student's engagement were used to determine the relationship between the test scores and the scores from the questionnaire of student's engagement for those taught using the flipped classroom instruction (RO3).

Data Analysis

The two effects of the independent variables of the different type of instructions and different performance group were tested on the dependent variables of test scores and the scores from the questionnaire of student's engagement using a Mann Whitney-U Test because the number of samples for each group was 17 and 10 students each which already violated the normality of the number of sample size. The use of Mann Whitney-U Test was suitable to investigate the effect of two nominal independent variables namely the different type of instructions and different performance group on the dependent variables of Additional Mathematics test scores and the scores of questionnaires of student's engagement which are measured at the scale level. The data analysis will be carried out based on the research hypotheses of the study as seen in table 3.1.

Ethical Issue

To follow the ethical criteria of conducting research, the researchers came out with the consent form. The consent form was an official agreement between the researchers and research participants to participate in the research so that the participants know the study's aim, the application of the study's result, and also the probable effect of the study on their lives (Creswell, 2012). The researchers distributed the consent form before the actual study conducted.

Before going ahead with the data collection, the permission to do research at SMK Green Road, Kuching had been secured by approaching the head of the school two months before the actual study. The researcher had been given the permission by the

head of SMK Green Road before conducting the research to their students. The researcher asserted that they bared no personal relationship with people that took part in this research. The researcher also realized that truthfulness is the best key element when conducting ethical research and affirmed that in order to avoid the significance of research bias or conflict of interest. Hence, manipulation of data was fully obviated in the research findings. This research was also conducted free from personal prejudice and conflict.

Conclusion

In summary, this chapter discussed the methodology of the whole process of this study including the design of the study, research population, research sample and sampling, research instrument, no of data collection and data analysis and interpretation.

Table 3.1

Data Analysis

No	Research Hypothesis	Source	Analyses
$H_0$1a	There is no significant difference in test scores between student taught using the flipped classroom and those taught using the non-flipped classroom.	Test scores	Mann-Whitney U Test
$H_0$1b (i)	There is no significant difference in test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for high-performance group		
$H_0$1b (ii)	There is no significant difference in test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for low-performance group		
$H_0$2a	There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom.	Student Engagement Questionnaire	Mann-Whitney U Test
$H_0$2b(i)	There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom for the high-performance group.	With Likert responses (1 – 5)	

$H_0$2b(ii)	There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom for the low-performance group.		
$H_0$3	There is no relationship between the scores for student's engagement and the test scores for the students who taught using the flipped classroom instruction.	Test Scores and Student's engagement Questionnaire	Spearman correlation

CHAPTER 4

RESULTS

Introduction

This chapter consists of six sections to present the result of the data analyses of this study which are the results of the reliability of test questions and survey questions of the actual students are presented, the demographics of the students, the result of the effects of different type of instructions and different performance group on academic achievement in learning Additional Mathematics, the result of the effects of different type of instructions and different performance group on student's engagement in learning Additional Mathematics, the result of the relationship between students' performance and student's engagement for students who taught using the flipped classroom instruction and the summary of the main results of this study.

Reliability of the Research Instruments

The reliability of this study instruments are Additional Mathematic Test and Student's Engagement Questionnaire were measured using Cronbach's Alpha values for the actual study data are shown in Table 4.1. All the Cronbach's Alpha values were at least 0.70 as suggested by (Tavakol & Dennick, 2011) and considered as suitable for the research purpose.

Table 4.1

Cronbach's Alpha Coefficients of the Research Instruments

Research Instrument	Cronbach's Alpha
Additional Mathematics Test	0.907
Student's Engagement Questionnaire	0.780

Demographic of the Sample

The study was conducted at SMK Green Road from Feb until 2 March 2018. The sample of the study was students from 4 Science 1 and 4 Science 5 with ages of 16 years old. Students from 4 Science 1 are high achievers who scored A in PT3 in 2017 while students from 4 Science 5 are low achievers who has scored B, C or D in PT3 in 2017. The high achievers and low achievers then grouped into Flipped Classroom (FC) and Non-Flipped Classroom (NFC). The demographic of the sample is shown in Table 4.2.

The Gender distribution is shown in Table 4.3. For the high-performance group, there were 8 male students and 9 female students in the flipped classroom while there were 3 male students and 14 female students in the non-flipped classroom. For the low-performance group, there were 7 male students and 3 female students in the flipped classroom but only 3 male students and 7 female students in the non-flipped classroom.

The distribution of the PT3 Mathematics grade is shown in Table 4.4 and Table 4.5 respectively. For the high-performance group, 17 of the flipped classroom and 17 of the non-flipped classroom all scored A in Mathematics in the PT3. For the low-performance group of the flipped classroom, two students each scored *B* and *C* while three students each scored *D* and *E* for Mathematics in PT3. For the non-flipped classroom, one student each scored *B* and *E*, two students scored *C* and six students scored *D* for Mathematics in PT3.

Table 4.2

Sample's Distribution of the Study

Performance Group	Flipped Classroom	Non-Flipped Classroom
High Performers	17	17
Low Performers	10	10

Table 4.3

Gender Distribution of the Study

	Instruction			
	Flipped Classroom		Non-Flipped Classroom	
	Gender			
Performance Group	Male	Female	Male	Female
High Performers	8	9	3	14
Low Performers	7	3	3	7

Table 4.4

Grade Distribution for High Performance Group

	Grade				
Instruction	A	B	C	D	E
Flipped Classroom	17	-	-	-	-
Non-Flipped Classroom	17	-	-	-	-

Table 4.5

Grade Distribution for Low Performance Group

	Grade				
Instruction	A	B	C	D	E
Flipped Classroom	-	2	2	3	3
Non-Flipped Classroom	-	1	2	6	1

Effects of different type of instructions and different performance group on academic achievement in learning Additional Mathematics.

Descriptive Analysis for Additional Mathematics Test Scores. Table 4.6 shows the overall mean, median and standard deviation scored by high performance's and low performance's students respectively while Table 4.7 and Table 4.8 shows the overall mean, median and standard deviation test scores according to instruction and performance group respectively. From Table 4.6, there was no difference in the mean test score in the high-performance group which the students taught using the non-flipped classroom (M = 25.18, SD=7.38) scored a bit higher than the students taught using flipped classroom (M=25.29, SD=5.44). In the low performance group, the students taught using the flipped classroom (M= 8.80, SD=5.16) scored a bit higher than the students taught using the non-flipped classroom (7.80, SD=6.09). In the overall test scores shown in Table 4.7, the students in the flipped classroom (M=19.11, SD=10.38) scored a bit higher than the students in the non-flipped classroom (M=18.81, SD=10.25). Table 4.8 showed that the high-performance students (M=26.50, SD=6.39) scored much higher than the low-performance students (M=8.00, SD=5.51).

Table 4.6

Descriptive Statistics on Overall Test Scores According to Performance Group and Instruction

Group	Instruction	n	Mean	Median	Std. Deviation
High Performance	Flipped Classroom	17	25.1765	27.0000	7.38440
	Non-Flipped Classroom	17	25.2941	26.0000	5.44018
Low Performance	Flipped Classroom	10	8.8000	8.5000	5.15967
	Non-Flipped Classroom	10	7.8000	6.5000	6.08824

Table 4.7

Descriptive Statistics on Overall Test Scores According to Instruction

Instruction	n	Mean	Median	Std. Deviation
Flipped Classroom	27	19.1111	18.0000	10.37873
Non-Flipped Classroom	27	18.8148	21.0000	10.25459

Table 4.8

Descriptive Statistics on Overall Test Scores According to Performance Group

Performance Group	n	Mean	Median	Std. Deviation
High Performers	34	25.2353	26.5000	6.38682
Low Performers	20	8.3000	8.0000	5.5148

The Mann-Whitney U test was carried out to test the effects of different type of instructions and different performance group on academic achievement in learning Additional Mathematics because the sample size is less than 20.

Research Question 1a: Does the Instruction Type has an Effect on the Additional Mathematics Test Scores?

Ho: There is no significant difference in the test scores between student taught using the flipped classroom and those taught using the non-flipped classroom.

Table 4.9

Mann-Whitney U-Test for Test Scores from Different type of Instruction

Instruction	n	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Flipped Classroom	27	27.89	753.00	354.000	-.182	.856
Non-Flipped Classroom	27	27.11	72.00			

From the Table 4.9, the Mann-Whitney U test indicated that there is no difference in test scores between students taught using flipped classroom (*Mdn* = 18.00) and students taught using non-flipped classroom (*Mdn* = 21.000), **U**= 354.000, p =.856, r = .025.

Research Question 1b: Do the Instruction Type and Performance Groups have an Effect on the Additional Mathematics Test Scores?

Ho(i): There is no significant difference in the test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for the high-performance group.

Table 4.10

Mann-Whitney U-Test for Test Scores of the High-Performance Group

Instruction	n	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Flipped Classroom	17	17.79	302.50	139.500	-.173	.863
Non-Flipped Classroom	17	17.21	292.50			

From the Table 4.10, the Mann-Whitney U test indicated that there is no difference in test scores between students who taught using the flipped classroom (*Mdn* = 27.00) and those using non-flipped classroom (*Mdn* = 26.00) for the high achievers, **U**= 139.500, *p* =.863, *r* = .029.

Ho(ii): There is no significant difference in the test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for the low-performance group.

Table 4.11

Mann-Whitney U-Test for Test Scores of the Low Performance Group

Instruction	n	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Flipped Classroom	10	11.35	113.50	41.500	-.644	.519
Non-Flipped Classroom	10	9.65	96.50			

Table 4.11 shows a Mann-Whitney U test which indicated that there is no difference in test scores between students taught using the flipped classroom (*Mdn* = 8.500) and the

students taught using the non-flipped classroom (*Mdn* = 6.500), **U**= 41.500, p =.519, r = .144.

Effects of Instruction Type and Performance Group on Student Engagement in Learning Additional Mathematics.

Descriptive Analysis for Student Engagement. Table 4.12 shows the overall mean, median and standard deviation scored by high performance's and low performance's students respectively. Table 4.13 and Table 4.14 shows the overall mean, median and standard deviation test scores according to instruction and performance group respectively.

Table 4.12

Descriptive Statistics on Student Engagement Scale According to Performance Group and Instruction

Group	Instruction	n	Mean	Median	Std. Deviation
High Performance	Flipped Classroom	17	3.9598	3.8947	.31498
	Non-Flipped Classroom	17	3.5015	3.4211	.44196
Low Performance	Flipped Classroom	10	3.5526	3.5526	.50131
	Non-Flipped Classroom	10	3.4632	3.6053	.44369

Table 4.13

Descriptive Statistics on Overall Student Engagement Scale According to Instruction

Instruction	n	Mean	Median	Std. Deviation
Flipped Classroom	27	3.8090	3.8421	.43380
Non-Flipped Classroom	27	3.4873	3.4737	.43440

Table 4.14

Descriptive Statistics on Overall Student Engagement Scale According to Performance Group

Performance Group	n	Mean	Median	Std. Deviation
High Performers	34	3.7307	3.8158	.44372
Low Performers	20	3.5079	3.6053	.46303

The Mann-Whitney U test was carried out to test the effects of different type of instructions and different performance group on academic achievement in learning Additional Mathematics because the sample size is less than 20.

Research Question 2a: Does the Instruction Type has an Effect on Student Engagement in Learning Additional Mathematics?

Ho: There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom.

Table 4.2

Mann-Whitney U-Test for Student Engagement of Different type of Instruction

Instruction	n	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Flipped Classroom	27	33.20	896.50	210.500	-2.667	.008
Non-Flipped Classroom	27	21.80	588.50			

The Mann-Whitney U test in table 4.15 indicated that there is a significance difference in the mean of engagement test scores between students taught using the flipped classroom (*Mdn* = 3.842) and students taught using the non-flipped classroom (*Mdn* = 3.474), **U**= 210.50, p =.008, r=.363.

Research Question 2b: Do the Instruction Type and the Performance Groups have an Effect on Student Engagement in Learning Additional Mathematics?

Ho(i): There is no significant difference in the student engagement between student taught using the flipped classroom and those taught using the non-flipped classroom from the high-performance group.

Table 4.3

Mann-Whitney U-Test for Student Engagement of Different type of Instruction for the High-Performance Group

Instruction	n	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Flipped Classroom	17	22.09	375.50	66.500	-2.691	.007
Non-Flipped Classroom	17	12.91	219.50			

The Mann-Whitney U test, in table 4.16, indicated that there is a significant difference in the mean of student's engagement between students taught using flipped classroom (*Mdn* = 3.8947) and students taught using non-flipped classroom (*Mdn* = 3.4211) for the high-performance group, **U**= 66.500, p =.007, r = .046 with student who taught using flipped classroom engaged more than students who taught using non-flipped classroom

Ho(ii): There is no significant difference in the scores from the questionnaire for the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom for the low achievers.

Table 4.4

Mann-Whitney U-Test for Student Engagement of the Different type of Instruction for the Low Performance Group

Instruction	n	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Flipped Classroom	10	11.25	112.50	42.5	-.570	.569
Non-Flipped Classroom	10	9.75	97.50			

The Mann-Whitney U test indicated that there is no significant difference in the mean of student engagement between students taught using flipped classroom (*Mdn* = 3.553) and students taught using non-flipped classroom (*Mdn* = 3.605) for the low-performance group, **U**= 42.500, p =.569, r = .127.

The Relationship between Academic Performance and Student Engagement for Students Who Taught Using the Flipped Classroom Instruction.

Research Question 3: Is Academic Performance Associated with the Student Engagement in Learning Additional Mathematics for the Students Who Taught Using the Flipped Classroom Instruction?

Ho3: There is no relationship between the scores for student engagement and academic performance for students taught using the flipped classroom.

Table 4.5

Spearman's Correlation of Student Engagement and Students Tests Scores for Flipped Classroom

		Test Scores	Student Engagement
Test Scores	Correlation Coefficient	1.000	.413*
	Sig. (2-tailed)	.	.032
	N	27	27
Student Engagement	Correlation Coefficient	.413*	1.000
	Sig. (2-tailed)	.032	.
	N	27	27

*. Correlation is significant at the 0.05 level (2-tailed).

From the Table 4.18, the output of Spearman's correlation shows that high test scores were moderately weak correlate with high scores in mean of students' engagement, **r** (27) =.413, **p** =.032 < .05.

Conclusion

This chapter consisted of six sections. The first section was the overview of the study and the second section portrayed on the demographic variables of the study. The third, fourth and fifth section showed the results of the statistical analysis which answered the Research Question 1 until 3 and the summary of the results of the hypotheses are shown in Table 4.19. Last section was the summary of the whole chapter.

Table 4.6

Summary of the Result of Hypotheses

No	Research Hypothesis	Result
$H_0$1a	There is no significant difference in test scores between student taught using the flipped classroom and those taught using the non-flipped classroom.	H_0 failed to be rejected **U**= 354.000, p =.856, r = .025.
$H_0$1b (i)	There is no significant difference in test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for high-performance group	H_0 failed to be rejected **U**= 140.500, *p* =.890, *r* = .024.
$H_0$1b (ii)	There is no significant difference in test scores between student taught using the flipped classroom and those taught using the non-flipped classroom for low-performance group	H_0 failed to be rejected **U**= 41.500, p =.519, r = .144.
$H_0$2a	There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom.	H_0 failed to be rejected **U**= 210.50, p =.008, r = .363
$H_0$2b(i)	There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom for the high-performance group.	H_0 was ejected **U**= 66.500, p =.007, r = .046
$H_0$2b(ii)	There is no significant difference in the student's engagement between student taught using the flipped classroom and those taught using the non-flipped classroom for the low-performance group.	H_0failed to be rejected **U**= 42.500, p =.569, r = .127.
$H_0$3	There is no relationship between the student engagement and academic performance for the students who taught using the flipped classroom instruction.	H_0 is rejected **r** (27) =.413, **p** =.032 < .05.

CHAPTER 5

DISCUSSION AND CONCLUSION

Introduction

This chapter consists of four main sections. Section one discusses the research finding of chapter four. Section two outlines the implication of this study. Section three discusses the future research recommendation and Section four is the conclusion of the study.

Discussion of the Finding

Effects of Different Type of Instructions and Different Performance Group on Academic Performance in Learning Additional Mathematics. From the result, it showed that there was no significant difference between test scores scored by the students taught using flipped classroom and those using non-flipped classroom. The result contradicted with the findings that flipped classroom had a positive effect on student performance (Love et al., 2014; Tong, 2014; Ramaglia, 2015; Poomorn & Kaewsaiha, 2015, Shain et. al (2015)) which the studies involved university and high school students who had higher self-efficacy, able to learn by themselves and well prepared for the in class activities compared to participants of this study. The participants of the study paid less attention (Saunders, 2014) to the video instructions because they were not used to the flipped classroom instruction and the teacher was not their own subject teacher. Apart from that, the result may be due to the in class activies for the flipped classroom were more to solving problems in the text books in group which was contradicted with the

interactive activities (Tong, 2014), modelling activities (Ramaglia, 2015) and the out of class application activities ((Poomorn & Kaewsaiha, 2015) done in their respective study. Apart from that, the result of the study may be caused by the activities applied by the researcher were just mere rearrangement of the similar activities done in the traditional classroom (Lape et al., 2014).

The results also showed that there was no significant difference for test scores between students taught using the flipped classroom and those taught using the non-flipped classroom among low-performance group. Though no difference, the students taught using the flipped classroom scored a bit better than the non-flipped classroom students for low-performance group which the mean scores for the students taught using the flipped classroom was 24.30 compared to 21.30 for the students taught using the non-flipped classroom. This was contradicted with the study done by Kumar Bhagat et al. (2016) which showed that there was significant difference in the performance of low achievers in the experimental and control groups to examine the impact of the flipped classroom on Mathematical concept learning in high school. The low achievers in this study had low self-efficacy because they did not receive much needed attention to be guided from the teacher due to short contact hours of 30 minutes per period. In addition to that, they were not well prepared to engage in the class activities because they did not fully understand the content of the videos and did not consult the teachers through WhatsApp. Lastly, the result of this study may be due to the duration of the study which was only 4 weeks and it was considered as too short compared to 6 weeks done by Kumar Bhagat et al. (2016).

The research done by Kumar Bhagat et al. (2016), however, supported the result of this study that there was no significant difference between test scores between students taught using the flipped classroom and those taught using the non-flipped classroom

among high-performance group. This could be explained by the high achievers were self-directed learner who were not dependable to any type of instructions or the quality of the teachers. However, the result would be different if practical or interactive activities were applied in the class activities for the flipped classroom.

Effects of Different Type of Instructions and Different Performance Group on Student Engagement in Learning Additional Mathematics. The result of this study showed that there was no significant difference in student's engagement between the flipped classroom and the non-flipped classroom. The result of this study is contradicted with the experimental study done Cronhjort et al. (2017) at KTH Royal Institute of Technology which showed that the flipped-classroom group scored significantly higher on the engagement survey for cognitive engagement, emotional engagement and behaviour engagement/active participation. This may be due to the participants in this study were only secondary students whereby the participants in research done by Cronhjort et al. (2017)were university students. In addition to that, the instruction used by the teachers which was similar to traditional instruction may be the cause for the participants in the flipped classroom to lose their behaviour engagement which was contradicted to the study of Jamaludin and Osman (2014).

The result of the study also showed that there was a significant difference in student engagement between students taught using the flipped classroom and those using the non-flipped classroom for the high-performance group. The participants in this study were more engaged in the classroom activities because they could interact with peers in the group discussion which was supported by the research done by Holik (2016). Apart from that, the participants in the flipped classroom had emotional engagement because they loved the idea of no homework and were able to work with peers and teacher which was supported by the study done by Johnson (2013) that showed that the students

engaged more in the flipped classroom because they appreciated that they did less exercise and were able to interact more with the teacher and with the content by watching the video in the class. Lastly, the participants in this study had cognitive engagement through watching video of instruction at their own pace, time and environment (Alsowat, 2016) and technology used in this study may also enhance student engagement (Al-Rowais, 2014).

The result of the study also showed there was no significant difference in student engagement between students taught using the flipped classroom and those using the non-flipped classroom for the low-performance group. The result was supported by the study done by Ingram, Wiley, Miller, and Wyberg (2014) which found out that low achievers in mathematics were not satisfied with the flipped classroom in Stillwater Area Schools for fourth and fifth-grade students during spring 2013. The low achievers in this study were not engaged was mainly due to unclear explanation and instruction in the videos which were more to lecture style without interactive activities (Ingram, Wiley, Miller, and Wyberg, 2014). Hence, the low achivers could not engage actively in the class activities which were more to problem solving in group and this result contradicted with the study's result of Nouri (2016) which indicated that low achievers had more positive favour to the use of video as a learning tool and learnt more effectively through the flipped classroom. The data in the study also pointed out that students who were difficult to learn mathematics did not favour the flipped classroom which implied to the high performers engaged more in the flipped classroom compared to low performers (Ingram, Wiley, Miller, and Wyberg, 2014).

The Relationship between Students' Performance and Student's Engagement for Students Taught Using the Flipped Classroom Instruction. The result of this study found out that there was a relationship between student's performance in Additional

Mathematics Test and the student's engagement in the flipped classroom. The result is contradicted to the study of Clark (2013) which reported that there was no significant effect of students' engagement towards the students' achievement in the flipped classroom if compared to students in the traditional classroom because the students perceived the mathematics content learnt was very difficult and they had to learn the new instruction (flipped classroom) which may affect their academic performance. The positive result was mainly due to students taught using the flipped classroom instruction were given authority to study by their own pace, time and space. In addition to that, collaboration with peers and teacher in order to solve problem may enable them to construct their own knowledge through social learning. The relationship was stronger for high achievers compared to low achievers because they were academically above average and they were able to participate actively because they were well prepared compared to low achievers who were still dependent to teacher.

Implication of the Study

Implication to the Literature. The result of this study contributes to the literature that both high performance and low performance students perform equally with the flipped classroom instruction and also the non-flipped classroom instruction in learning Additional Mathematics at a secondary school in Malaysia. Therefore, it can be concluded that the flipped classroom may not be effective instruction that suit the Malaysian students who are learning Additional Mathematics which is considered as one of the hardest subject for science students. This may be caused by the students involved in the study were more comfortable to the non-flipped classroom which was not student-centred instruction. It is the fact that traditional classroom is still the main instruction that practised by the Malaysian teachers including those teaching Additional Mathematics. Additional Mathematics was still taught in the traditional method because of time

constraint, ample of syllabus to cover and students possessed weak basic mathematics concept especially Algebra. Learning takes time therefore the flipped classroom could be an effective way if the students in this study were given time to adapt to the instruction especially watching the video at home, digesting the content of the video and also answering the quiz questions that related to the video by studying by their own.

The result of the study also suggested that high performance students engaged more in the flipped classroom compared to low performance students. This result was contradicted to the study done by Nouri (2016) which showed that low achievers engaged more to the flipped classroom compared to high achievers. The study done by Ingram, Wiley, Miller, and Wyberg (2014) also supported that low performance students who had difficulty to learn Mathematics did not favour and engage in the flipped classroom because they could not understand the content in the video and thus could not engage in the class activity which need them to solve problems related to the videos' content prior to the class activities. Apart from that, the low performance students in this study were also not familiar to the student-centered in class activity that needed them to solve problems actively by interacting with each others in group. Most of the time, the low performance students could not solve all the problems given to them and only managed to solve some through the step by step guidance of the teacher.

The study also showed that the student's engagement of the flipped classroom was correlate with the test performance if compare to their counterpart in the non-flipped classroom who did not engage in the non-flipped classroom but still perform well in the test. The student's engagement indeed correlate with the students' performance especially the high-performance students but not the low performance students because the low performance students engaged less in the flipped classroom.

Implication for Practice. The flipped classroom could not engage and help the low performance students to perform better in the test. Therefore, teachers need to find alternative instructions that could help students to learn with the guidance of teacher in the class. In order for the low-performance students to learn effectively through the flipped classroom, they need to be exposed to the structure of the flipped classroom before actual instruction to be carried out. They need to be encouraged to ask questions if they do not understand the content of the video and voice out their worries about the flipped classroom and do not let bygones be bygones.

As for the high-performance students, they engaged more in the flipped classroom. They could learn by themselves and would ask questions if they were doubtful or confused with the content of the videos. They were also participated actively in the class activity except few of them who were not serious and treated the researcher as an outsider. Overall, they participated actively and they loved the idea of having no homework at home. Although the result of the study proved they engaged actively in the flipped classroom but proper lesson need to be planned carefully especially the topics that are suitable for them to learn by themselves. Therefore, the flipped classroom is a suitable instruction to be introduced to the high-performance students which in line with the aim of the Ministry of Education in the Malaysia Education Blueprint.

Recommendation for Future Research

Future research should look into the other factors that will give impact to the student's performance in learning Additional Mathematics such as the frequency of watching videos, student's engagement in watching videos, the readiness of students prior to formal in-class activity, the effect of gender, the experience of instructor, different type of in-class activities and the difficulty of the topics taught in the study.

Future research should also focus on the sample from the lower secondary students of the age of 13 or 14 years old and expand the study to other subjects such as linguistic subjects, history, geography and even science subjects. Besides that, future research should also expand to the students from other schools in the urban, suburban or even the rural areas which have less internet coverage and not well equipped with technology.

Future research should also look at the effects of the flipped classroom not only student's performance and engagement but also student's self-efficacy in mathematics, student's self-regulated learning, student's high order thinking skills and student's mathematics problem solving skills.

Future research also need to take into the account of the time factor, the time frame of the study and the instructors who involved in the study. The time factor means the time that students could be more focused in learning and should avoid the festive holidays such as Chinese New Year and Hari Raya. Apart from that, the time frame should take consideration of the time for students to familiarise with the instruction introduced to them including the technology, the learning management system used such as Frog VLE and also the student-centred activities used in the in-class activity. Lastly, the instructor ought to be their own subject teacher so that the students will be more serious and focus in the study and the instructor must be expert in the flipped classroom instruction.

Conclusion

The research investigated the effect of the flipped classroom on the student's performance, student's engagement and also the relationship between student's engagement and student's performance in learning Additional Mathematics at a secondary school in Kuching.

The finding of the research showed that the flipped classroom instruction has no positive effect on student's test scores for both high-performance group and low-performance group. The students taught using the flipped classroom and non-flipped classroom in the high-performance group performed and low performance group performed equally in the test scores. Therefore, it can be concluded that different type of instruction did not have effect on the student's test performance for either high-performance students or low performance students. This may be resulted by the attitude of the students; the type of instructions used, the time constraint and the students were not familiarised with the flipped classroom instruction.

The findings from the research also showed that the high-performance students from the flipped classroom engaged more compared to the students from the non-flipped classroom in learning Additional Mathematics. However, there was no significant difference in student's engagement, for low performance group, between students taught using the flipped classroom and those using non-flipped classroom in learning Additional Mathematics. Therefore, the flipped classroom may be effective instruction for high-performance students to increase their engagement in learning Additional Mathematics but not advisable for students from low performance group who need more direct guidance of the subject teacher. It can be concluded that the Malaysian students could accept the constructivist instruction but they need to be exposed to it at the very young age especially in the primary education.

Lastly, the finding of the research showed that the student's engagement has positive relationship with the student's performance in learning Additional Mathematics for those taught using the flipped classroom but no relationship between student's engagement and student's performance in learning Additional Mathematics for those taught using the non-flipped classroom instruction.

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Appendix A: Letter of Approval from Education Planning and Research Department (EPRD)

KEMENTERIAN PENDIDIKAN MALAYSIA
BAHAGIAN PERANCANGAN DAN PENYELIDIKAN DASAR PENDIDIKAN
ARAS 1-4, BLOK E8
KOMPLEKS KERAJAAN PARCEL E
PUSAT PENTADBIRAN KERAJAAN PERSEKUTUAN
62604 PUTRAJAYA

TEL : 0388846591
FAKS : 0388846579

Ruj. Kami : KPM.600-3/2/3-eras(116)
Tarikh : 12 Januari 2018

ALBERT BONG CHUN WEI
NO. KP : 741213135741

88, EVERBRIGHT PARK
BATU 3 1/2, JALAN PENRISSEN 93250 KUCHING
SARAWAK

Tuan,

KELULUSAN UNTUK MENJALANKAN KAJIAN DI SEKOLAH, INSTITUT PENDIDIKAN GURU, JABATAN PENDIDIKAN NEGERI DAN BAHAGIAN DI BAWAH KEMENTERIAN PENDIDIKAN MALAYSIA

Perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa permohonan tuan untuk menjalankan kajian seperti di bawah telah diluluskan.

" THE EFFECTIVENESS OF THE FLIPPED CLASSROOM INSTRUCTION FOR LEARNING ADDITIONAL MATHEMATICS AT A SECONDARY SCHOOL IN KUCHING "

3. Kelulusan adalah berdasarkan kepada kertas cadangan penyelidikan dan instrumen kajian yang dikemukakan oleh tuan kepada bahagian ini. Walau bagaimanapun kelulusan ini bergantung kepada kebenaran Jabatan Pendidikan Negeri dan Pengetua / Guru Besar yang berkenaan.

4. Surat kelulusan ini sah digunakan bermula dari **22 Januari 2018** hingga **30 April 2018**.

5. Tuan dikehendaki menyerahkan senaskhah laporan akhir kajian dalam bentuk *hardcopy* bersama salinan *softcopy* berformat pdf dalam CD kepada Bahagian ini.Tuan juga diingatkan supaya mendapat kebenaran terlebih dahulu daripada Bahagian ini sekiranya sebahagian atau sepenuhnya dapatan kajian tersebut hendak diterbitkan di mana-mana forum, seminar atau diumumkan kepada media massa.

Sekian untuk makluman dan tindakan tuan selanjutnya. Terima kasih.

"SEHATI SEJIWA"

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

Ketua Sektor
Sektor Penyelidikan dan Penilaian
b.p. Pengarah
Bahagian Perancangan dan Penyelidikan Dasar Pendidikan
Kementerian Pendidikan Malaysia

salinan kepada:-

JABATAN PENDIDIKAN SARAWAK

Appendix B: Letter of Approval from Education Department of Sarawak

KEMENTERIAN PENDIDIKAN MALAYSIA
Jabatan Pendidikan Negeri Sarawak
Jalan Diplomatik, Off Jalan Bako
Petra Jaya, 93050 Kuching, Sarawak

Tel : 082-473445
Faks : 082-473684
Emel : unitlatihan007@gmail.com

Ruj Kami : JPNSW.SKPP.LAT.600-1/1/1(57)
Tarikh : 16 Januari 2018

Albert Bong Chun Wei

No.88, Everbright Park
Batu 3, Jalan Penrissen
93250 Kuching

Tuan,

KEBENARAN UNTUK MENJALANKAN KAJIAN DI SEKOLAH-SEKOLAH, INSTITUT-INSTITUT PERGURUAN, JABATAN PENDIDIKAN DAN BAHAGIAN-BAHAGIAN DI BAWAH KEMENTERIAN PENDIDIKAN MALAYSIA

Dengan hormatnya saya merujuk kepada perkara di atas.

2. Sukacita dimaklumkan bahawa pada dasarnya Jabatan Pendidikan Negeri Sarawak tiada sebarang halangan untuk membenarkan tuan menjalankan kajian bertajuk :

" The Effectiveness of the Flipped Classroom Instruction for Learning Additional Mathematics at a Secondary School in Kuching "

3. Diingatkan bahawa sepanjang tempoh kajian tersebut, tuan adalah tertakluk kepada peraturan yang sedang berkuatkuasa dan menjalankan kajian seperti tajuk yang diluluskan oleh Bahagian Perancangan dan Penyelidikan Dasar Pendidikan, Kementerian Pendidikan Malaysia bil. KPM.600-3/2/3-eras(116) bertarikh 12 Januari 2018.

4. Jabatan ini memohon agar sesalinan laporan kajian dihantar ke Unit Latihan Dan Kemajuan Staf, Jabatan Pendidikan Negeri Sarawak sebaik sahaja selesai untuk tujuan rekod dan rujukan.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

[KUSWADY BIN CHIL]
Sektor Khidmat Pengurusan Dan Pembangunan
b.p Pengarah Pendidikan
Sarawak.

Appendix C: Letter of Approval from District Education Officer

KEMENTERIAN PENDIDIKAN MALAYSIA
Pejabat Pendidikan Daerah Kuching
Jalan Diplomatik Off Jalan Bako
Petra Jaya,
93050 Kuching, Sarawak

Telefon : 082- 445288
Faks : 082- 313869
Emel Rasmi : ppdkuching.moe@1govuc.gov.my

Ruj.Kami : JPS(W)/PPDKch(Ups)/153/07/09/Jld.29 (10)
Tarikh : 23 Januari 2018

Albert Bong Chun Wei
No. 88, Everbright Park,
Batu 3, Jalan Penrissen,
93250 Kuching

Tuan,

KEBENARAN UNTUK MENJALANKAN KAJIAN DI SEKOLAH-SEKOLAH MENENGAH DAERAH KUCHING

Dengan segala hormatnya surat tuan bertarikh 18 Januari 2018 adalah dirujuk.

2. Sehubungan dengan itu, Pejabat Pendidikan Daerah Kuching **tiada halangan** untuk membenarkan tuan menjalankan Kajian di sekolah-sekolah menengah daerah Kuching mulai 22 Januari sehingga 30 April 2018.

3. Walau bagaimanapun sepanjang tempoh kajian tersebut, puan adalah tertakluk kepada peraturan yang sedang berkuatkuasa seperti pada surat daripada Bahagian Perancangan dan Penyelidikan Dasar Pendidikan, Kementerian Pendidikan Malaysia bil. KPM.600-3/2/3 –eras(116) bertarikh 12 Januari 2018

4. Kelulusan ini hanya untuk tujuan yang dipohon sahaja dan luput selepas tarikh **30 April 2018**.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

(CHEN FEI MING)
Timbalan Pegawai Pendidikan Daerah
Pejabat Pendidikan Daerah Kuching.

SM/ns

"MENJULANG PENDIDIKAN NEGERI SARAWAK"
"FLY KENYALANG FLY,FLY HIGH"

Appendix D: Student's Consent Letter

UNIVERSITI MALAYSIA SARAWAK
FAKULTI SAINS KOGNITIF DAN PEMBANGUNAN MANUSIA
KML6066 Kertas Penyelidikan

Student Consent Form

To the student:

Research title	:	The Effectiveness of the Flipped Classroom Instruction for Learning Additional Mathematics in a Secondary School at Kuching.
Researcher	:	Albert Bong Chun Wei (16030241)
Duration of study	:	4 weeks
Risk	:	Nil

Introduction

The purpose of this form is to provide you, as a participant, the information that may affect your decision as to whether or not to participate in this research study. The person conducting the research will describe the study to you and answer all your questions. Read the information below and ask any questions you might have before deciding whether or not to take part in the study. If you decide to be involved in this study, this form will be used to record your permission.

The Purpose of the Research.

The purpose of this research is to investigate the effect of the flipped classroom and the non-flipped classroom on student's engagement and performance in learning Additional Mathematics for high-performance students and low-performance students at a secondary school in Kuching.

What is the participant going to be asked to do?

If you agree to participate in this study, you, as a participant for the flipped classroom, need to **watch video of instruction for the topic of *Function* in Additional Mathematics at home** by using **laptop, personal computer, tab/iPad or smart phone**. Besides that, you need to log into **Edmodo** to complete the notes given and also answer short quiz. In addition to that, you need to interact with peers and teacher through **WhatsApp**. After the whole topic is completed, you will be asked to sit for a test and answer a survey question after you are involved in either in the flipped classroom instruction or non-flipped classroom instruction. This study will take about 4 weeks and there will be 34 participants from Form 4 Science 1 and 22 participants from Form 4 Science 5 in this study.

The Benefit of this Research

The possible benefits of participation are participants will be introduced to the flipped classroom instruction in learning Additional Mathematics and participants will be able to learn effectively through the flipped classroom instruction which needs participants to watch video of lesson at home and engage actively in class activities including small group and pair work which need them to communicate with each other in line of Social learning of Vygotsky.

Participation in the Research

Your participation in this study is voluntary. You may decline to participate or to withdraw from participation at any time. You can agree to allow your child to be in the study now and change your mind later without any penalty. There is no incentive will be given for your child's participation in this research.

The Confidentiality of Participation

The identity and the participation of your child will be confidential. The name of the participant will not be taken, but will be designated a code. Any information in this research including the test and the survey questions will be kept as safely and confidentially for the purpose of the research. The test paper and survey questions will be kept for 6 months and will be destroyed after that.

The Person to be Contacted

Prior, during or after your participation you can contact the researcher, Albert Bong Chun Wei at 019-8684087 or send an email to abcw74@yahoo.com for any questions or if you feel that you have been harmed. This study has been reviewed and approved by the Educational Planning and Research Division of Ministry of Education with the reference: **KPM.600-3/2/3-eras(116).**

Signature

Your signature below indicates that you have read the information provided above and have decided to allow them to participate in the study. If you later decide that you wish to withdraw your permission for your child to participate in the study you may discontinue your participation at any time.

Participant's Name : _____

Signature of the Participant : _____ **Date:** _____

Signature of the Researcher : _____ **Date:** _____

Appendix E: Parent's Consent Letter

UNIVERSITI MALAYSIA SARAWAK
FAKULTI SAINS KOGNITIF DAN PEMBANGUNAN MANUSIA
KML6066 Kertas Penyelidikan

Parent Consent Form

To the parents concern:

Research title	:	The Effectiveness of the Flipped Classroom Instruction for Learning Additional Mathematics in a Secondary School at Kuching.
Researcher	:	Albert Bong Chun Wei (16030241)
Duration of study	:	4 weeks
Risk	:	Nil

Introduction

The purpose of this form is to provide you, as the parent of a prospective research study participant, information that may affect your decision as to whether or not to let your child participate in this research study. The person conducting the research will describe the study to you and answer all your questions. Read the information below and ask any questions you might have before deciding whether or not to give your permission for your child to take part in the study. If you decide to let your child be involved in this study, this form will be used to record your permission.

The Purpose of the Research.

The purpose of this research is to investigate the effect of the flipped classroom and the non-flipped classroom on student's engagement and performance in learning Additional Mathematics for high-performance students and low-performance students at a secondary school in Kuching.

What is my child going to be asked to do?

If you allow your child to participate in this study, they need to **watch video of instruction for the topic of *Function* in Additional Mathematics at home** by using **laptop, personal computer, tab/iPad or smart phone**. Besides that, they need to log into **Edmodo** to complete the notes given and also answer short quiz. In addition to that, they need to interact with peers and teacher through **WhatsApp**. After the whole topic is completed, they will be asked to sit for a test and answer a survey question after they are involved in either in the flipped classroom instruction or non-flipped classroom instruction. This study will take about 4 weeks and there will be 34 participants from Form 4 Science 1 and 22 participants from Form 4 Science 5 in this study.

The Benefit of this Research

The possible benefits of participation are participants will be introduced to the flipped classroom instruction in learning Additional Mathematics and participants will be able to learn effectively through the flipped classroom instruction which needs participants to watch video of lesson at home and engage actively in class activities including small group and pair work which need them to communicate with each other in line of Social learning of Vygotsky.

Participation in the Research

Your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time. You can agree to allow your child to be in the study now and change your mind later without any penalty. There is no incentive will be given for your child's participation in this research.

The Confidentiality of Participation

The identity and the participation of your child will be confidential. The name of the participant will not be taken, but will be designated a code. Any information in this research including the test and the survey questions will be kept as safely and confidentially for the purpose of the research. The test paper and survey questions will be kept for 6 months and will be destroyed after that.

The Person to be Contacted

Prior, during or after your participation you can contact the researcher, **Albert Bong Chun Wei** at **019-8684087** or send an email to **abcw74@yahoo.com** for any questions or if you feel that you have been harmed. This study has been reviewed and approved by the Educational Planning and Research Division of Ministry of Education with the reference: **KPM.600-3/2/3-eras(116).**

Signature

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you are 18 years or older and have read the information provided above and have decided to allow them to participate in the study. If you later decide that you wish to withdraw your permission for your child to participate in the study you may discontinue his or her participation at any time.

Child's Name : _____

Parent's Name : _____

Signature of the Parent : _____ **Date:** _____

Signature of the Researcher : _____ **Date:** _____

Appendix F: Additional Mathematics Test Paper

Date: 1 March 2018 Code: 1___ ___ or 5 ___ ____ Marks: (/ 36)

Instructions : Answer all questions and write your answer in the space provided.

1. Based on the information in the diagram 1, the relation between *P* and *Q,* is defined by the set

$P = \{1, 2, 3\}$
$Q = \{2, 4, 6, 8, 10\}$

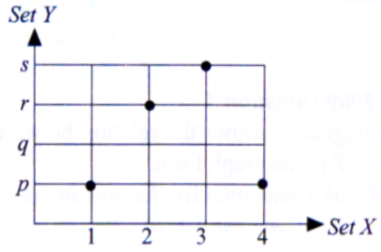
of order pairs $\{(1,2),(1,4),(2,6),(2,8)\}$.

Diagram 1

State
(a) the image of 2,
(b) the object of 6. [2 marks]

Answers:

(a) _____ (b) _____



2. Diagram 2 shows the relation between set *X* and set *Y* in the graph form.

Diagram 2

State
(a) the relation in the form of ordered pairs,
(b) the type of relation.
(c) the range of the relation. [3 marks]

Answers:

(a)

(b)

(c)

3. Diagram 3 shows the composite function gf that maps x to z.

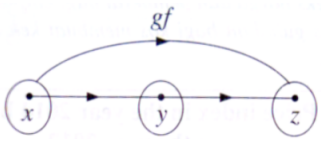


Diagram 3

State

(a) the function that maps x to y

(b) $g^{-1}(z)$. [2 marks]

Answers:

(a) _____ (b) _____

4. Diagram 4 shows the function $h : x \to \frac{m-x}{x}, x \neq 0$, where m is a constant.

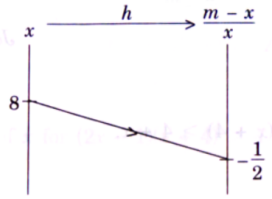


Diagram 4

Find the value of m. [2 marks]

Answers:

5. Diagram 5 shows the function h maps x to y and the function g maps y to z

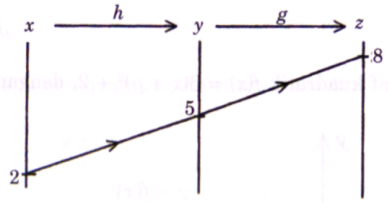


Diagram 5

Determine

(a) $g^{-1}(8)$, (b) $gh(2)$ [2 marks]

Answers:

(a) _____ (b) _____

6. Given the function $g: x \to 4x + h$ and $g^{-1}: x \to 2kx + \frac{5}{8}$, where h and k are constants, find the value of h and of k. [3 marks]

Answers:

7. Given the function $m(x)=\frac{6}{x}, x\neq 0$ and the composite function $mn(x)=3x$, find

(a) $n(x)$ (b) the value of x when $nm(x)=5$. [3 marks]

Answers:

8. Given the function $g:x\rightarrow|x+3|$, find the values of k such that $g(k)=5.$ [2 marks]

Answers:

9. Given the functions $h:x\rightarrow 3x+1$ and $gh:x\rightarrow 9x^2+6x-4$,find

(a) $h^{-1}(x)$ (b) $g(x)$. [3 marks]

Answers:

10. Diagram 6 shows the graph of the function $f(x)=|3x-1|$, for the $0 \le x \le 5$.

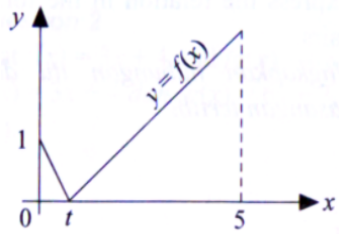


Diagram 6

State

(a) the value of t,

(b) the range of $f(x)$ corresponding to the given domain $0 \le x \le 4$. [3 marks]

Answers:

(a) _____

(b)

11. Given that the function $f : x \to 2x-3$ and $g : x \to 4x$, find

(a) $gf(x)$,

(b) the value of x if $gf(x)=\frac{1}{2}f(x)$. [4 marks]

Answers:

12. In the diagram 7, the function f maps set *A* to set *B* and the function g maps set *B* to set *C*.

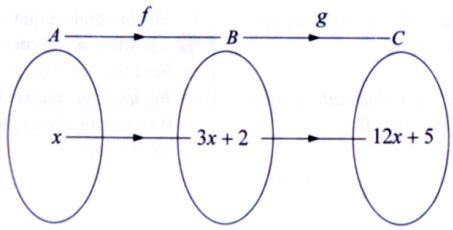


Diagram 7

Find

(a) in term of x, the function

(i) which maps set *B* to set *A*,

(ii) $g(x)$. [5 marks]

(b) the value of x such that $fg(x) = 8x - 1$ [2 marks]

Answers:

Appendix G: Student Engagement Questionnaire

UNIVERSITI MALAYSIA SARAWAK
FACULTY OF COGNITIVE SCIENCES AND HUMAN DEVELOPMENT
FAKULTI SAINS KOGNITIF DAN PEMBANGUNAN MANUSIA

Questionnaire Form on Student's Engagement in the Flipped Classroom and Non-Flipped Classroom Instruction.
***Borang soal selidik Keterlibatan pelajar terhadap kaedah* Flipped Classroom dan *kaedah* Non-Flipped Classroom.**

OBJECTIVE : To find out the student's engagement in the flipped classroom instruction and non-flipped classroom instruction.

OBJEKTIF : *Mengetahui keterlibatan murid dalam kaedah* Flipped Classroom *dan kaedah* Non-Flipped Classroom.

Instruction: Please tick (✓) the appropriate box that best describes your opinion.
Arahan: *Sila tanda (✓)dalam ruangan yang paling tepat dengan pendapat anda.*

1	2	3	4	5
Strongly disagree *Sangat tidak setuju*	Disagree *Tidak Setuju*	Undecided *Tidak pasti*	Agree *Setuju*	Strongly Agree *Sangat setuju*

No	Item	Responses / *Respon*				
		1	2	3	4	5
1	The flipped classroom is more engaging than traditional classroom. *Lebih keterlibatan dalam* flipped classroom *berbanding dengan kelas tradisional*.					
2	This instruction gives me greater opportunities to communicate with other students. *Kaedah ini memberi peluang kepada saya untuk berkomunikasi dengan murid lain.*					
3	I feel that this instruction has improved my understanding. *Saya berasa kaedah ini telah memperbaiki pemahaman saya.*					
4	I am more motivated to learn *Additional Mathematics* in this classroom with the current instruction. *Saya lebih bermotivasi untuk belajar Matematik Tambahan dalam kelas yang menggunakan kaedah ini.*					

5	When I am in class, I listen very carefully. *Semasa saya berada dalam kelas, saya mendengar dengan teliti*.					
6	When I am in class, I act like I am working. *Semasa dalam kelas, saya berpura-pura sedang membuat kerja*.					
7	I enjoy learning new things in class. *Saya seronok belajar ilmu baru dalam kelas*.					
8	When we work on something in class, I feel **discouraged**. *Semasa membuat kerja dalam kelas, saya berasa tidak digalakkan*.					
9	I outline the chapters in my book to help me study. *Saya merangkakan topk dalam buku saya untuk membantu saya belajar.*					
10	I ask myself questions to make sure I know the material that I have been studying. *Saya bertanyakan sendiri untuk memastikan saya mengetahui bahan semasa belajar*.					
11	Before I start a *group work / pair work / individual work*, I plan out how I am going to do it. *Sebelum memulakan kerja kumpulan/ kerja berpasangan/ kerja individu, saya merancang apa yang hendak dibuat*.					
12	When I have a *group work / pair work / individual work*, I worry a lot about it. *Sebelum memulakan kerja kumpulan/ kerja berpasangan/ kerja individu, saya sangat risau tentang banyak perkara.*					
13	I pay **less** attention in class. *Saya kurang menumpukan perhatian dalam kelas*.					
14	I am interested in working in class. *Saya berminat membuat kerja dalam kelas*.					

15	When I follow the lesson, I ask myself questions to make sure I understand what it is about. *Semasa mengikuti pelajaran, saya akan bertanyakan diri sendiri untuk memastikan saya memahami isi pelajaran tersebut*.					
16	The tests in my class do a good job of measuring what I am able to do. *Ujian diduduki dalam kelas ialah kaedah terbaik untuk menilai apa yang saya buat*.					
17	In my class, I do more than required. *Di dalam kelas, saya melakukan lebih daripada yang sepatutnya*.					
18	I enjoy discussing with my peers. *Saya berasa seronok semasa berbincang dengan kawan*.					
19	This instruction makes me want to learn more about the topic. *Kaedah ini menyebabkan saya ingin belajar lebih tentang sesuatu topik*.					

STUDENT'S ACADEMIC PERFORMANCE:

PENCAPAIAN AKADEMIK MURID:

Grade Mathematics in **Form 3 evaluation (PT3)** : _____ (A / B / C / D / E / F)
***Gred Mathematik dalam Penilaian* Tingkatan 3 (PT3)**:

The end of questionnaire

Thank you for your cooperation to answering this questionnaire.

Soal selidik tamat.

Terima kasih atas kerjasama anda untuk menjawab soalan kajian selidik ini.