MATHEMATICS EDUCATION: AN ANALYTICAL STUDY ON TEACHING HIGH SCHOOL MATHEMATICS

By

TEA JIN MAN

A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Science (Hons.) Applied Mathematics With Computing

Faculty of Engineering and Science
Universiti Tunku Abdul Rahman

APRIL 2019

DECLARATION OF ORIGINALITY

I hereby declare that this project report entitled "**MATHEMATICS EDUCATION: AN ANALYTICAL STUDY ON TEACHING HIGH SCHOOL MATHEMATICS** " is my own work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

Signature : _____

Name : _____

ID No. : _____

Date : _____

APPROVAL FOR SUBMISSION

I certify that this project report entitled "**MATHEMATICS EDUCATION: AN ANALYTICAL STUDY ON TEACHING HIGH SCHOOL MATHEMATICS**" was prepared by **TEA JIN MAN** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Science (Hons.) Applied Mathematics With Computing at Universiti Tunku Abdul Rahman.

Approved by,

Signature : _____

Supervisor : _____

Date : _____

ACKNOWLEDGEMENTS

In preparation of my final project, I received the help and guidance of some respected persons, who deserve my deepest gratitude. I would like to show my gratitude to Dr Tan Sin Leng, my supervisor, for giving me a good guideline for the project throughout numerous consultations. I would also like to expand my gratitude to teachers and students who had completed the questionnaire of the project.

In addition, a thank you to the late principal of Kuen Cheng High School, Principal Wei Rui Yu who introduced me to the Head of Mathematics Subject, Teacher Ang. I also thank Teacher Ng from Confucian Private Secondary School for giving me fully support. I would like to thank my parents and friends who gave me an inspiration and suggestions to improve the quality of the project.

TEA JIN MAN

MATHEMATICS EDUCATION: AN ANALYTICAL STUDY ON TEACHING HIGH SCHOOL MATHEMATCICS

TEA JIN MAN

ABSTRACT

In the latest result published by TIMSS(Trend In International Mathematics And Sciene Study) 2015, Malaysia had scored 465 points which increased by 25 points as compared to TIMSS 2011. There are some essential factors that contribute to the mathematics achievement of students in TIMSS 2015 which includes readiness of the principals and teachers, school environment and socioeconomic status of the students. In Malaysia Education Blueprint 2013-2025, the Ministry planned to undertake some measures for instance cultivating student interest through new learning approaches and an enhanced curriculum, sharpening skills and abilities of teachers and building public and student awareness. To strengthen delivery of STEM across the education system, different phases had been introduced. Various kind of pedagogical approaches, challenges faced by the teachers, opinion of students towards mathematics were investigated. In this project, questionnaire for teachers and students were designed. The results of teacher questionnaire were analyzed by using excel while the results of students questionnaire were analyzed by using SPSS. In general, the most commonly used teaching methods are teacher directed and homework. Most of the teachers were confident that their knowledge are sufficient for them to teach the students. Major problems encountered by the teachers included too much work unrelated to teaching, content does not cater for every students, low motivation and interest among student and uneven level among the students. Some recommendations for example constant professional meeting and reduce class size were made.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

In November 2016, Bernama newspaper reported that Malaysia mathematics and science education had shown improvement in the latest result published by Trend In International Mathematics And Science Study (TIMSS). TIMSS is one of the programmes conducted by International Association for the Evaluation of Educational Achievement (IEA) and involved more than 50 countries. It is held once every four years and Malaysia joined this programme starting from 1999. TIMSS had reflected the effectiveness of the education system of a country. It also provided insight into preparation of mathematics and science teaching resources and materials to nurture high-level thinking among the students. In 2015, Malaysia only took part in the investigation of TIMSS 2015 Grade 8 which is targeted at Form 2 students in secondary school but not TIMSS Grade 4 and TIMSS advanced. A total of 9726 Form 2 students, 859 science and mathematics teachers from 207 schools had participated.

Two instruments used in the investigation which are textbooks of mathematics and science as well as questionnaire for students, mathematics and science teachers and administrative staff. Sample were chosen randomly based on the location, types of school, types of administration and average grade of the schools. Students involved had answered the test papers and questionnaire while teachers only answered the questionnaire. For mathematics achievement, Malaysia is now ranked at 22nd out of 39 countries participated whereas Singapore is the top among all the participating countries. Malaysia had scored 465 points which increased by 25 points as compared to 440 points in TIMSS 2011.

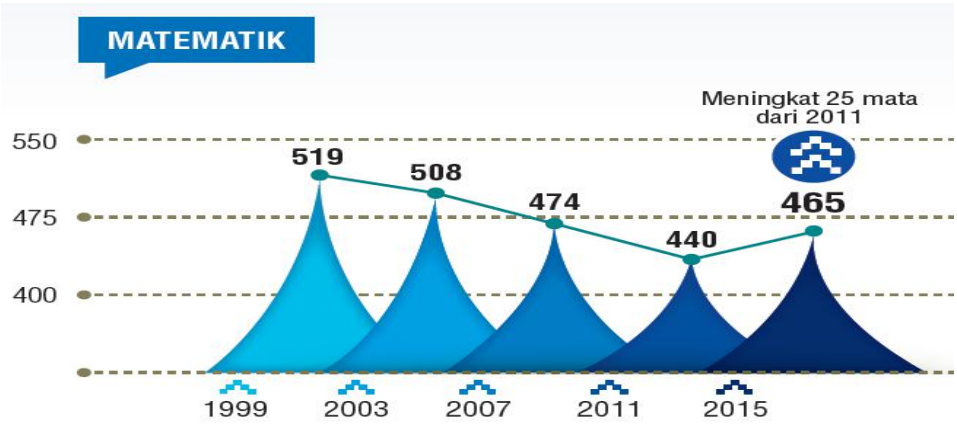


Figure 1.1: Chart showing trend in points obtained from 1999 to 2015.

TIMSS examined from two dimensions which are content and cognitive. Content part include 40% of knowledge, 35% of application and 25% of reasoning while cognitive part consists of 30% of number, 20% of geometry, 30% of algebra and 20 % of probability and statistics. The figure below shows the marks achieved by female and male in various aspects. In overall, female students had higher achievement in mathematics performance than male students, 470 points compared to 461 points by male students.

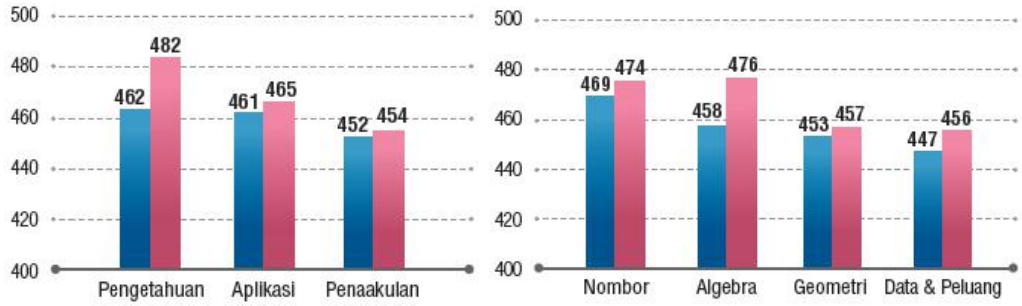


Figure 1.2: Points attained in various aspects of Mathematic (Male: blue, Female: pink)

Points attained are categorised into 4 levels, which are low (400points), intermediate (475 points), high (550 points) and highest (625 points). 400 points indicates that students possess the knowledge of numbers, decimals, operation and basic graphs. Whereas 625 points indicates that students have the ability to do reasoning with the data, make conclusion and generalisation as well as solve linear equation. In comparison with 2011, Malaysia had shown improvement in each level. In low, intermediate, high and highest categories, the points increased by 11%, 9%, 6% and 1% respectively.

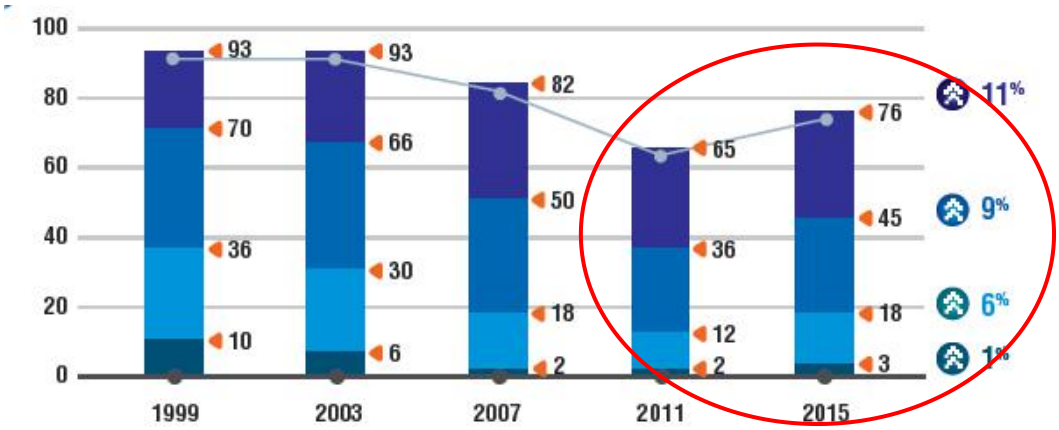


Figure 1.3: Percentage of students that achieved different categories of international level

There are some essential factors that contribute to the mathematics achievement of students in TIMSS 2015 which includes readiness of the principals and teachers, school environment and socioeconomic status of the students. Around 65% of the principals owns a bachelor degree and the rest had graduated as post graduate. For mathematics teachers, over 90 % of them graduated as bachelor or postgraduate, only 5 % of them only studied until diploma level.

With regard to years of teaching experience, 41 % of the mathematics teachers possess 10-20 years of teaching experience. Teachers with less than 5 years of experience only occupied 5%. However, less years of teaching experience doesn't indicate lower teaching quality and achievement of their students. The report showed that students taught by these teachers managed to score 475 points which is better than those students taught by more experienced teachers.

According to Comparative Study of Secondary Mathematics Curriculum between Malaysia and Singapore (Zarina,2010) , Singapore focused attention to the content matters and problem-solving skill of students while most of the Malaysian students are merely doing the routine calculations and limit themselves to the current education system.

Effects of mathematics anxiety should not be neglected as it results in low performance of students and a decline trend of graduates involved in math-related career. According to the news reported on July 2018, there is a decline in the numbers of students enrolled in programmes of Science, Technology, Engineering and Mathematics into tertiary education. Government expected the number of science students who registered for SPM to be at least 270,000 annually however right now only 90,000 per annum.

In this research of mathematics education, we aim mainly to have better understanding on the nature of mathematical teaching and learning from the perspectives of teachers and students. Over the last decades, there have been many initiatives taken by our Ministry of Education to improve mathematics education. In Malaysia Education Blueprint 2013-2025, the Ministry planned to undertake some measures for instance cultivating student interest through new learning approaches and

an enhanced curriculum, sharpening skills and abilities of teachers and building public and student awareness. To strengthen delivery of STEM across the education system, different phases/waves had been introduced.

In Wave 1(2013-2015), taking into consideration of the performance of students on the TIMSS and PISA assessments, the Ministry will review the existing secondary school Mathematics curricula and modify it. Elements such as critical thinking, hypothesising, analysing and decision making will be emphasized. Furthermore, the Ministry also investigate the possibility to increase the instructional time allocated to Mathematics. In this project, we are going to seek opinion for the teachers regarding the current curriculum and expected outcomes.

In the matter of professional development of teachers, content knowledge and pedagogical skills among teachers of STEM are important to facilitate better lesson delivery. With the purpose of providing support and inspiration for their lesson plans, the teachers had been coached for effective teaching strategies and trained to draw linkages between the curriculum and the real world application. Besides, using ICT tools to make STEM learning more engaging is also one of the objectives by the Ministry. We will also explore the viewpoint of teachers relating to their abilities and use of technology in this project.

1-1 Objectives

The purpose of this study is to

- To study the current high school instructional practices.
- To explore the influence of teacher in engaging students' interest in mathematics and developing positive attitude towards it.
- To evaluate the role of teachers in guiding students in logical thinking and ability to problem solving

1-2 Importance of the Study

Through this study, it helps to understand more about the importance of instructional strategies from different perspectives such as passion and commitment, classroom management and professional behaviour exhibited. Various kind of

pedagogical approaches can promote cooperation of the class and enhance students' mathematical proficiency. Being in the world inundated with information, students can learn out of the classroom however, most of the students need a stable classroom environment. Favourable learning environment that encourage self-directed thinking can create sense of achievement among students and raised their level of confidence.

1-3 Project Scopes

This study will focus on the mathematics teaching methods applied in private secondary school which is Chinese independent high school only but not national secondary school. Area of the selected high school will be in Kuala Lumpur.

1-4 Planning

Plans	Week													
	2	4	6	8	10	12	14	16	18	20	22	24	26	28
Define title and general ideas	●	●												
Obtain articles and books related	●	●	●											
Organise information from the study		●	●	●	●									
Classify theme and characteristic			●	●	●	●	●							
Draft questionnaire						●	●	●	●	●				
Distribute and collect questionnaire										●	●			
Analysis											●	●	●	
Conclusion													●	●

CHAPTER 2: LITERATURE REVIEW

2-1 Classical / Modern Books

Sullivan, P (2011) discussed the goal of school mathematics from practical perspective and specialized perspective. There is a broad consensus among public and educators that mathematics forms our daily lives and mathematics teaching can have enormous impact on students' enrolment in later year studies. Practical perspective includes various calculations of everyday living including budgeting, planning road trips, time management and so on. While specialized mathematics for example algebra, symmetry, randomness, infinity allows learners to contribute in the science, technology and engineering. Mathematical understanding and reasoning are important elements in STEM. In the compulsory years, practical mathematics should be emphasized in the school curriculum as this is the needs of most of the students when they do not study mathematics in higher level of education. Sullivan, P (2011) revealed that most of the mathematics teaching encounter same challenges which are repetitious and low-level task that involve only little reasoning. Swan, M (2005) found that students are mere receiver which accept all the concepts without deep thinking and understanding. Swan, M (2005) described that teachers might engage students in mathematics learning with these five mathematical actions which are expected to be experienced by students to produce desirable outcome.

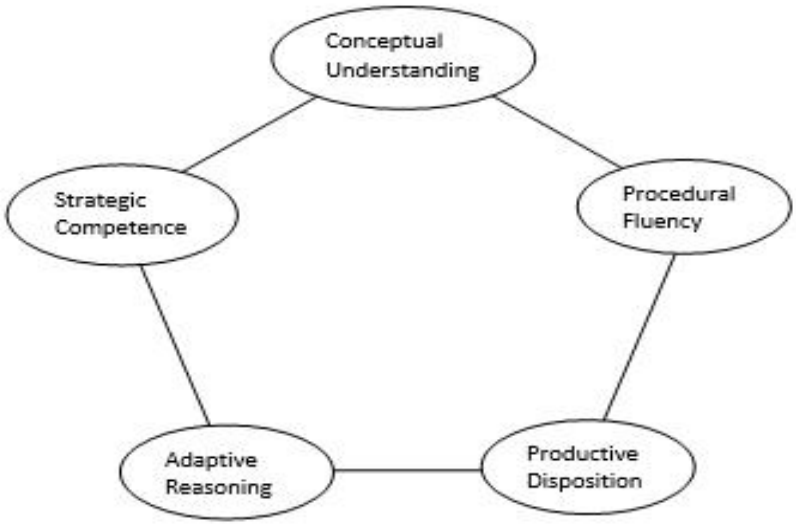


Figure 2.1: Five mathematical actions

Sullivan, P (2011) delineates the action needed to be incorporated into mathematics learning is conceptual understanding. Skemp, R.R (1976) differentiated the term ’instrumental understanding’ and ’ relational understanding’. The former highlights the importance of how to perform various task given and the latter emphasizes on the reasoning part which is to know the relationships between each mathematical ideas. Well-constructed knowledge can connect to each other and fully utilized in building new ideas. Kilpatrick et al. (2001) named another action as procedural fluency. To be able to perform skills accurately and appropriately, some procedures and concepts must come to mind readily. Fluency can reduce workload on working memory, allowing more capacity for other information processing. For instance, mathematical and language and definition can be an obstacle during learning if students cannot recall them readily. Sullivan, P (2011) posits that strategic competence is one of the key to be mastered in productive mathematics learning. It is described as the capability to identify, formulate and solve the problems systematically and effectively. The forth strand is adaptive reasoning. Ability to think logically and provide suitable explanation and justification has been neglected by teachers. Such action can reflect students thinking and learning strategies. Last but not least, positive disposition portrayed by students is always the best motivation to have high achievement in mathematics. They shows tendency to persist and eliminate any barriers in mathematics learning.

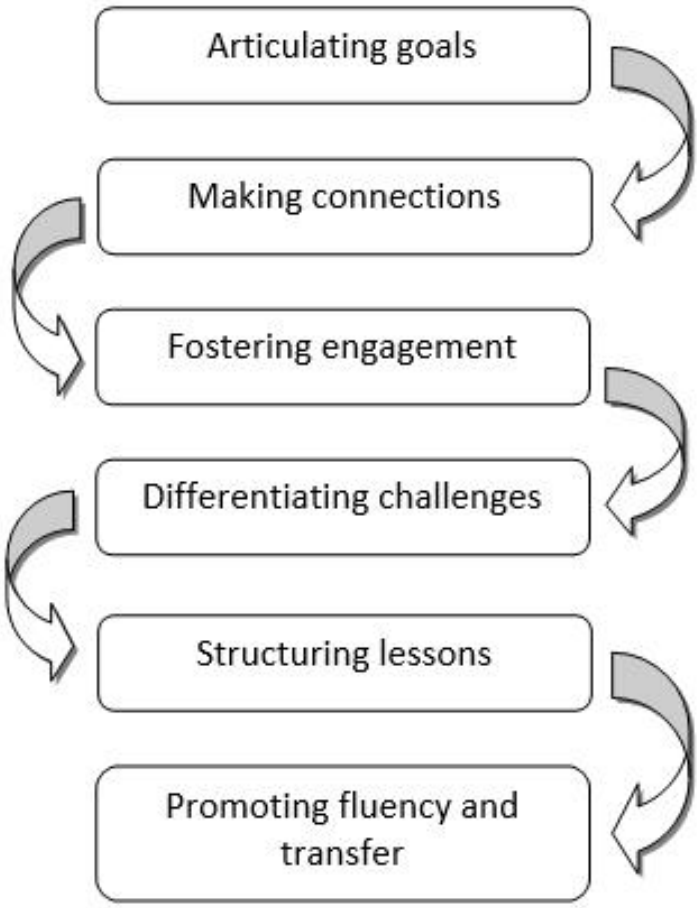


Figure 2.2: Guidelines of teaching

To bridge the gap between expected and demonstrated learning outcome, Sullivan, P (2011) outlines six principles which can be used as guidelines in teaching practices. In fact, the principles stated are related to common pedagogical approaches and executed in all curriculum areas. The subsequent principles act as a catalyst to improve teaching efficiency and can be applied in any education levels. First of all, teachers should articulate their goals in each lesson. Expressing your objectives and communicating with students enable them to receive a clear information about what they are going to learn and the learning outcomes they supposed to attain in the end of the lessons. Even listing down the outcomes on the board is advisable. The curriculum has to be planned precisely and specifically. Flexibility in making any judgements in the curriculum indicates that teachers are sensitive to the needs of the students. Another principle that teachers should draw attention to is making connections between the topics in each subjects. Elaboration on prior knowledge gives a presentation of broader perspective to students. Reformulation the problem which is to

make the changes to the context of the same problem can examine students understanding of the concepts and enhance their mathematical thinking. Apparently, ones must get their hand dirty before they can master any skills. Students engagement in various meaningful and relevant task correlates to their achievement in mathematics. They are exposed to different orders of challenges and these strategies addressed by teachers can effectively boost up students' comprehension. Students disengagement can be summarized as follows:

- Family factors such as domestic violence and parental educational attainment
- Personal factors such as stage of physical development and learning difficulties
- School-related factors such as nature of the curriculum and negative relationships with teachers and peers

Apart from that, differentiating challenges that caters for different levels of students contribute to effective classroom teaching. Interacting with each other including Q&A section can capture students' attention and concentration in the lessons. The term 'enabling prompt' refers to goals and tasks set for the students who are facing difficulty. Assuming these students might not be able to fulfill all the learning outcomes, they are engaged in practical and active contexts rather than listening to explanation of different examples. While extending prompts can be given to the students who are perceive and comprehend the lessons quickly. Without going so far from the original context, appropriate task tests and brainstorms their thinking. Sullivan, P (2011) depicts the importance of the teachers to predict the most frequently occurring mistake and encourage students to explain or exchange their thinking. The fifth principle focuses on the structure of the lesson. The book recommended the lesson format as Launch; Explore; Summarize; Review. This rubric assimilates the Japanese way of teaching. After teaching the basis of the lessons, students are given opportunities to work individually or communicate with other students. Teachers are advised to observe the variability in students' learning process and give feedback to them. Making use of students' report in class not only benefits students by facilitating their understanding, but also creates sense of belonging to a classroom community. At the same time, the issues of differences between students has arisen and students need to learn to accept these differences. Such differences can be resulted from prior mathematical knowledge, educational background, habitual inclination and so on.

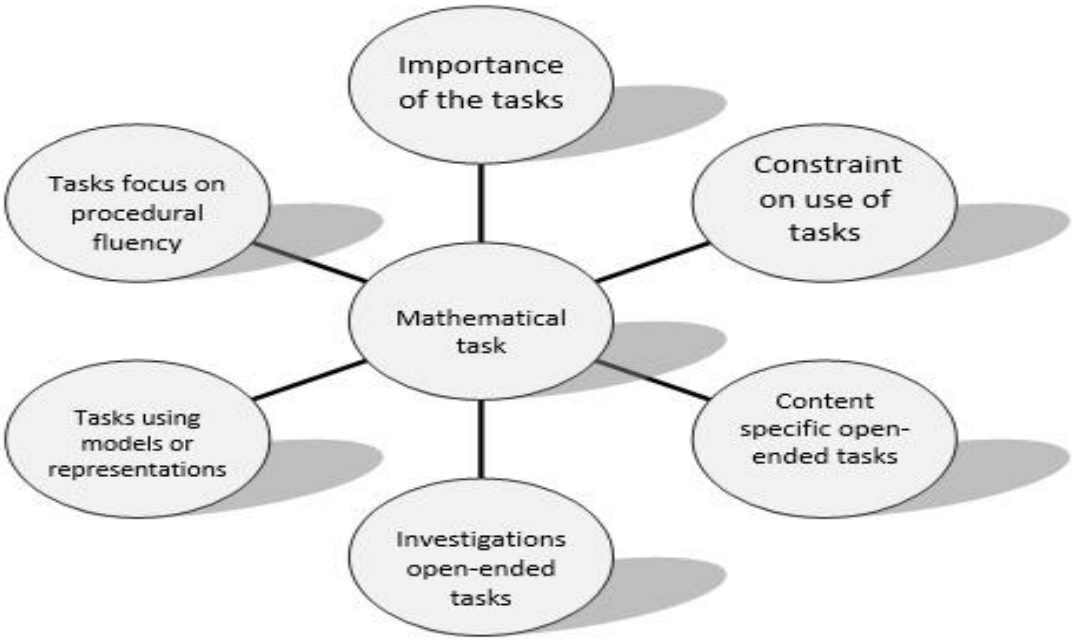


Figure 2.3: Mathematical task

Sullivan, P (2011) argued that the tasks are important to discover students'potential as well as to determine their level of thinking. Without the task, the two mathematical actions discussed previously which are adaptive reasoning and strategic competence cannot be fostered. Ames (1992) debated that the way of designing the tasks by teachers actually acts upon students' interest in mathematics. She further explained that teachers should concentrate on longer term goals which is deep understanding and its general application rather than the results that pleased parents or students. To apply different forms of tasks, the major constraint met is that many studetns avoid risk taking. Sometimes, teachers also reduce the difficulty of the tasks when they observed the students do not give the response as intended.

2-2 Recent Papers / Discoveries

Many researches has studied on various factors that contributing to effective mathematics teaching. Like a study carried out in Brunei Darussalam, it investigate the topic from different perspective of view, such as school administrators belief, teacher

level and student level. From Siti's findings, school administrators viewed that teachers should have enthusiasm and ability to perform their job in mathematics education. However, cooperation and support from different department can ensure teacher effectiveness in classroom. Different challenges were facing by teachers for example, difficulty in obtaining curriculum materials and resources and lack of time to prepare the content of each classes. Besides, Siti's study revealed that professional development received by teachers does not guarantee the quality of teaching. The way of teaching whether is teacher-centred or student-centred can lead to different degree of achievement in teaching goals.

While Bengo (2016) research in Canada discussed the crucial elements in teaching practices. Firstly, qualities of the coach affects the effectiveness in delivering teaching content. Coach should possess certain depth of knowledge in mathematics. Coach who are able to assist diverse learners to identify their problem can allow learners to pick up the main point of the lesson in a short time. Various Instructional strategies applied by coach can enhance the process in learning mathematics. From another viewpoint, factors within school authorities are also taken into consideration in effective mathematics teaching in secondary school. Bengo (2016) found that financial and administrative support is one of the important element to create conducive learning environment for students. To strengthen the skills and knowledge as well as professional development, school administrators should structure the times for teacher to meet coach.

CHAPTER 3: METHODOLOGY

3-1 Research Design 1: Teacher Questionnaire

In teacher questionnaire, some demographic information were obtained. Mathematics teachers were asked to give their opinion on effectiveness of various teaching methods, usefulness of integration of technology into daily lessons, problems faced by them. Besides, they were encouraged to share their experience in engaging students in their teaching and their way of assessment of students.

3-2 Research Design 2: Student Questionnaire

The questions were designed to investigate students' habits, learning attitude and their perception towards mathematics. Most of the questions were 5-points Likert scale questions. The details of this questionnaire will be further discussed in Chapter 4.

3-3 Research Context: Setting

Around 106 students and 29 teachers were participated in this project. The targeted students were Form 2 and Form 4 students. All the teachers and students participated came from Chinese independent high school.

CHAPTER 4: QUESTIONNAIRE DESIGN

4-1 Outline of Student Questionnaire

In the student questionnaire, students were requested to:

(a) Indicate their class, gender, and final examination mathematics marks;

(b) Respond to questions on attending tutorial classes outside the school and their purposes;

(c) Respond to the questions regarding their habits and learning attitude towards mathematics;

(d) Rate the degree on usefulness of mathematics to them; and

(e) Respond to the items concerning their belief and conception in mathematics.

The questionnaire items were set in Chinese as the questionnaire only distributed to students in Chinese Independent High School. As tuition had been seen as a necessity for students to do well, many parents send their children to tuition and the number of tuition centre and enrichment centres registered increased rapidly in recent years. In our questionnaire, we collect data of students attending tuition classes as well as their reasons.

4-1-1 Learning Attitude towards Mathematics

This section comprised of 5-points Likert scale questions on their interest, preference on understanding, confidence, textbooks and classroom learning as well as outside-class learning. The combination of all these factors contribute to the academic achievement in the secondary school stage or any other stages in their lives. To some extent, these psychological factors individually and mutually enable us to predict the students' academic performance.

4-1-2 Perception of Students in Mathematics

Students' beliefs about mathematics can have a substantial impact on their interest, enjoyment and motivation in mathematics classes. Students' mindset towards their mathematical abilities can lead to distinct achievement in mathematics. To

obtain the opinion of students, the belief items were also set in a 5-point Likert scale. The items included to what extent they agree that mathematics problem can have more than one answer or can the problem solved without remembering formulas and so on.

4-2 Outline of Teacher Questionnaire

Some questions regarding the background information had been set, for example from which school they came from, their years of teaching experience, their educational background, the common teaching method they used, and some open-ended questions which instructional strategy they think is useful and effective.

The following parts were divided into 3 sections, which are lower secondary, upper secondary (science), and upper secondary (commence/arts). Teachers were required to fill in the parts they are concerned. In each parts, we asked the teachers to what extent they agree about the effectiveness of current curriculum and the learning outcomes achieved by the students. Teachers were encouraged to share their teaching experience. For example, the topics which were challenging as well as the reasons for it being a challenge.

In the teacher questionnaire, teachers were requested to:

(a) Indicate which method or process that contribute to their mathematics teaching;
(b) Respond to questions on major problems facing by secondary school mathematics teachers;
(c) Respond to questions on the factors that affect the learning effectiveness of students;
(d) Respond to the questions of the main cause of slow learners to fall behind the progress in mathematics; and
(e) Respond to open-ended questions such as how do they access students' performance other than test.

4-2-1 Teaching Methods

Teachers are expected to use effective teaching techniques in order to facilitate the process of students' learning. Regarding pedagogical techniques in mathematics, preferences of teachers are important to address the needs of different

levels of students. In our questionnaire, option such as ‘teacher directed’ , ‘student directed’, ‘Q&A session’, ‘Group discussion’, ‘Homework’, ‘Mathematical software’, ‘Powerpoint, Word, Excel’, ‘Online Video’ and ‘Scientific calculator’ were included and teachers can choose more than one option. As teachers develop their teaching skills, they discovered which methods benefits their student the most. Teacher-directed learning is a long overdue trend in education but still is the most common way of teaching. It is a straightforward teaching techniques which teachers impart the knowledge by clearly explaining the examples or problems to teach a specific concept. On the other hand, student-centred approach is another way that encourage interaction between teachers and students or among students themselves through group work.

4-2-2 Integration of Technology

Technology can be used as a catalyst to assist students who are difficult to understand the content as it enhance the learning process by making concepts come alive through engaging and interactive media. Animations or interesting videos visualise mathematics and lead to better retention and increased student understanding of the concepts. Technology also provides customized learning experiences as the content and support can cater for their individual needs. By integrating software into daily teaching practices, it can have very good impact on student’s mathematics achievement. Although software tools had been improving from time to time in the past decades, the usefulness of the integration of technology was still being questioned.

4-2-3 Perceived Teacher Education

In our questionnaire, teachers were asked to rate the significance of each means for their teaching skill development and professional growth. They were the school learning experience (primary, secondary, college, university and education institution), course outlines, teaching materials, reference books, short courses, talks related to education, and collegiate exchange with other teachers. Objectives of teacher education includes learning latest technique, discover classroom technology, connect with other education professional improve teaching skills as well as gain experience in classroom management. With proper and sufficient teacher education, it helps to boost the self-confidence in the teachers and enable teachers to take appropriate action for the optimum development of different students.

4-2-4 Major Problems Faced by Math Teachers

Besides, teachers were required to rate the relevance of 18 major problems in mathematics education across a 5-point Likert scale. These problems covered :

- Low quality of teaching materials
- Teaching materials do not provide suitable pedagogies
- Content does not cater for every students
- Students/Parents/School stress too much on examination
- Weak foundation in mathematics
- Insufficient preparation time
- The content is too hard/bulky
- Parents only concern about examination
- Students are passive and no patience
- Low motivation/interest among students
- Students do not master the mathematics logical concepts
- Insufficient training
- Unclear learning outcomes
- Too much duty unrelated to teaching
- Uneven level among the students
- The content is not practical

4-2-5 Beliefs on mathematics learning

Next, teachers were asked to rank the factors that affect the learning effectiveness of students from the least influence to the most influence. Those factors include teaching style, parent's guidance, education system, peers competition and students' interest. In attempt to make more of an impact on their students' belief, it is important to note the interaction between teacher belief and student belief. Teachers' beliefs that transmitted to their students might produce more positive dispositions among the students regarding mathematics.

4-2-6 Engagement of Students

Student engagement is closely related to their sustained motivation in pursuing improvement and development in certain area. Their interest in learning mathematics is a key in the process of mathematics teaching. Considering students' affective, behavioural and cognitive engagement, these factors contribute to the efficiency of mathematics teaching. Cognitive engagement which is correlated to the perseverance of students when encountering challenges in mathematics also results in higher levels of mathematics achievement. Behavioural engagement which refers to their participation in different mathematics activities is also an essential elements related to students' achievement. Hence, teachers were ask in an open-ended question for the methods they used to engage students in their mathematics teaching.

4-2-7 Assessment of Students

Evaluation of students' performance is inevitable to the teaching and learning of mathematics. Assessment tells about the overall performance of mathematics teaching and help in designing teaching methods and strategies. Diagnostics evaluation allows teachers to understand the fitness of teaching materials and students' level of development. When levels of teacher instruction and student readiness are matched, information presented by the teachers can be understood by the students. Hence, teachers were required to share their method of assessment of their students in mathematics.

CHAPTER 5: RESULTS AND ANALYSIS

5-1 Results of Teacher Questionnaire

From the data collected, 41.4% of the teachers participated possessed teaching experience less than 6 years. Around 8 of them had been teaching for 6-10 years and 6 of them had teaching experience more than 20 years.

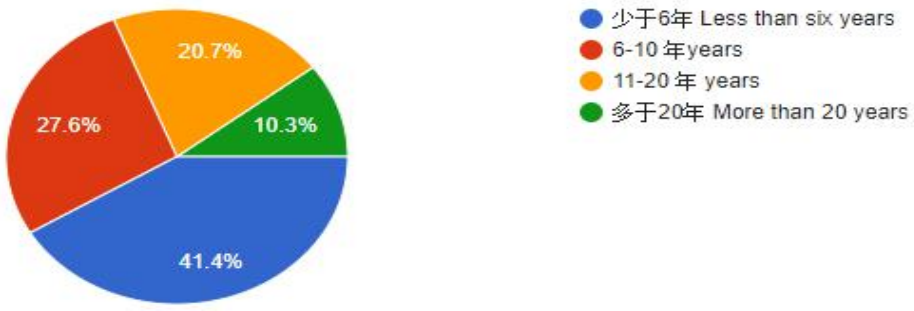


Figure 5.1: Chart showing teachers' year of teaching experiences

In the section on demographic data, we asked the teachers to select their education level and they were allowed to choose more than one option. Majority of them graduated from other degrees, which are degree in actuarial science and degree in physics. Only 3 of them held a bachelor degree in mathematics and 4 of them were degree holder of education. Among the teachers participated, 6 of them pursued their studies until master or above.

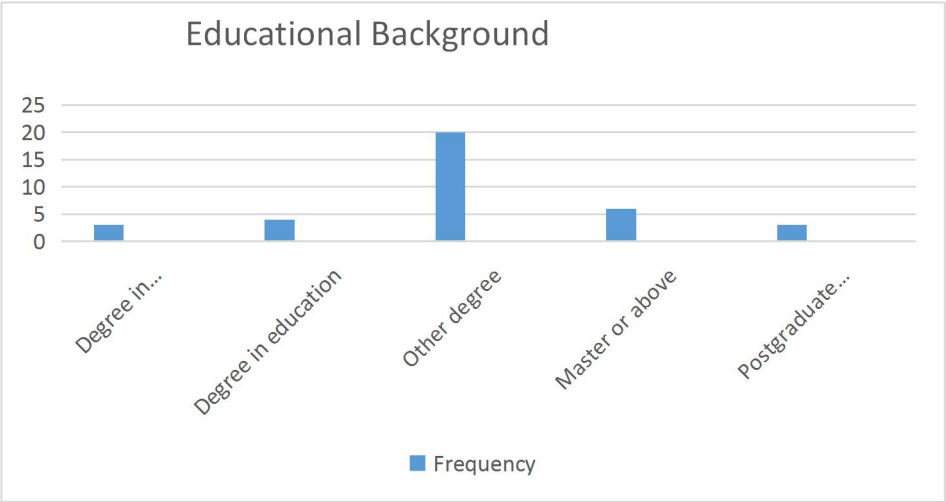


Figure 5.2: Graph showing number of teachers from different educational background

5-1-1 Teaching Methods and Strategies

In this section, teachers were asked to vote for their teaching methods and teachers were allowed to vote for more than one option. In general, the most common use teaching methods are homework and teacher directed. 96.6% of the teachers voted for 'homework' as their teaching methods and followed by 93.1% of the teachers voted for 'teacher directed'. Other than these, Q&A session is also one of the commonly used teaching methods. 21 teachers had selected this teaching method. Nearly half of the respondents used methods such as 'student directed', 'powerpoint, word, excel' and scientific calculator in their process of teaching. Teaching methods such as 'group discussion', 'mathematical software' and 'online video' are less popular and only occupied 24.1% respectively.

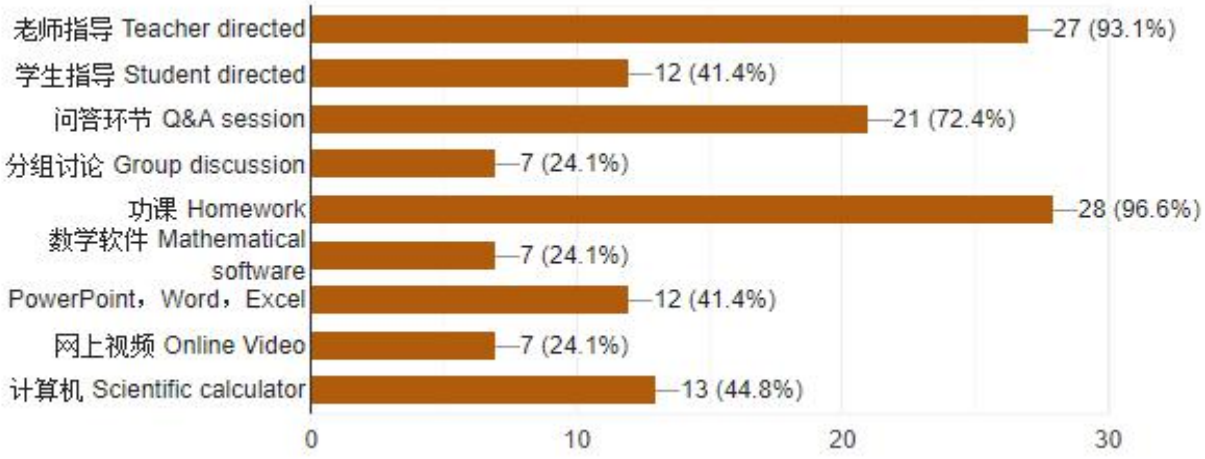


Figure 5.3: Bar graph showing percentage of different teaching methods used by teachers

In teachers' opinion, the most effective teaching strategies are 'teacher directed', 'Q&A session', and 'Group discussion'. Some teachers also commented that they encouraged students to provide explanation to the problem after teaching a topic as a reflection of their understanding. Therefore, they can notice the learning progress of the students and monitoring the content of the next class. Besides, teachers thought that every teaching methods has its usefulness and benefits, no teaching methods are absolutely effective, what is more important is to adjust the methods according to the practical situation in the class.

Based on the practical and successful experience shared by the teachers, some of them thought that one-to-one guidance to weak students are necessary to help those students in understanding mathematics content. This is one of the experience shared by the teachers.

'By using software, student can visualize different representation and statistical literacy in a more meaningful way'

Teachers also mentioned that it is time consuming when they tried to do quiz or activities in the class. Due to insufficient preparation by the students, such quiz and activities could not reach the expected results. Apart from that, in order to a large number of mathematical formulas, repetitive practices allow students to explore and use different techniques to solve questions. Below is the opinion shared by one of the teachers.

'When any teaching methods has been used repeatedly, students will have fatigue on learning and it is difficult to have practical and successful teaching.'

When one effective teaching method is used again and again, students are no longer interested and pay attention to the class. Teachers also shared that to have more group discussion among the students on the spot enable students to learn faster. Peer learning and taking initiative to ask questions can lead to successful teaching.

'When there exists weak students who are willing to pay attention to learn in the class, this is an example of successful teaching.'

Another experience shared by a teacher is to explain a new topic from a basic level to complex level as well as provide guidance step-by-step before students try out themselves.

5-1-2 Views on the Curriculum of Junior Secondary

Aspects	Mean	Mode
Current curriculum can achieve expected outcomes	3.68	Agree (44%)
Capable to teach the content	4.36	Strongly Agree (52%)
Integration of technology into curriculum is helpful	3.88	Agree and Strongly Agree (64%)
Students can achieve learning outcomes	3.2	Neither Agree Nor Disagree (56%)

Table 5.1: Mean and mode of each aspects

In general, 52% of the teachers were confident that their knowledge are sufficient for them to teach the students (mean = 4.36 across 5-point scale). In terms of the expected outcomes of current curriculum, 44% of them think that the expected outcomes are not completely matched with the current curriculum and 56% of them had a neutral viewpoint on achievement of learning outcomes by their students (mean = 3.2) . Current curriculum need to be improved in order to fulfil the learning outcomes. Most of them also have an opinion that usage of technology can be very helpful to their teaching (mean = 3.88).

Teachers also shared the topics which are more challenging for them to teach. These topics include algebra, geometry and set. The reasons for it being a challenge are lack of imagination and procedural fluency among the students, students hard to understand the proof, students do not understand the relationship of the concepts, students do not know the application of the mathematical concepts and students have difficulty in interpreting the requirements of the questions

5-1-3 Views on the Curriculum of Senior Secondary

Aspects	Mean	Mode
Current curriculum can achieve expected outcomes	3.625	Agree (53.8%)
Capable to teach the content	4.25	Strongly Agree (53.8%)
Integration of technology into curriculum	3.625	Agree (69.2%)

is helpful		
Students can achieve learning outcomes	3.375	Neither Agree Nor Disagree (61.5%)

Table 5.2: Mean and mode of each aspects for senior secondary(commence and arts)

Aspects	Mean	Mode
Current curriculum can achieve expected outcomes	3.69	Strongly Agree (62.5%)
Capable to teach the content	4.46	Agree (75%)
Integration of technology into curriculum is helpful	3.77	Neither Agree Nor Disagree (50%)
Students can achieve learning outcomes	3.23	Neither Agree Nor Disagree (62.5%)

Table 5.3: Mean and mode of each aspects for senior secondary(science)

As the syllabus of mathematics for science stream and arts stream are different, there are two parts for the teachers to fill in. In overall, teachers were satisfied with their competence in teaching (mean=4.25 for commence or arts and 4.46 for science). For science stream, teachers had lower satisfaction of their students' achievement (mean = 3.23) as compared arts or commence stream (mean = 3.23).

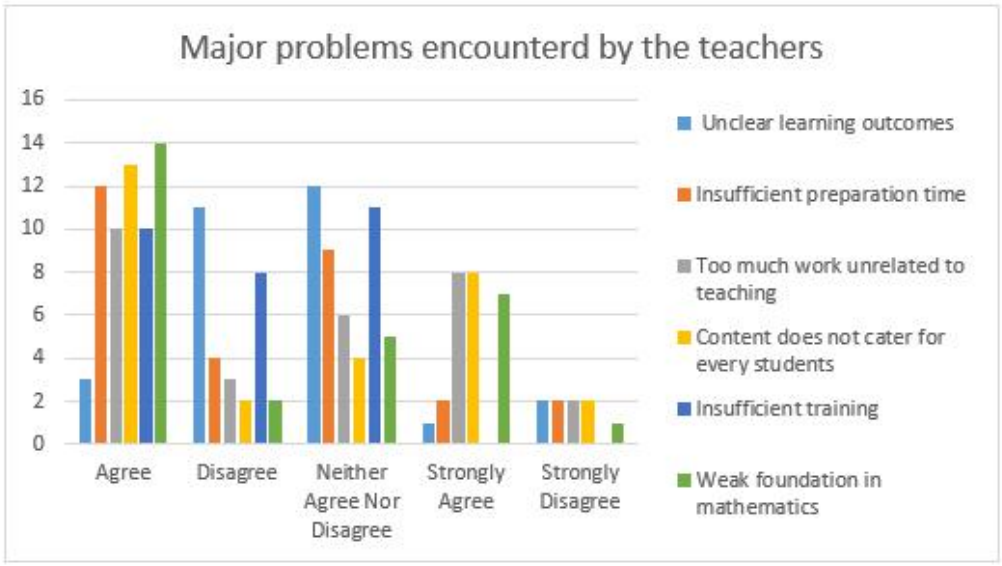
Trigonometry, differentiation and integration were classified as challenging topics by the teachers. They personally viewed that there are many varieties in the content of these topics and the questions of UEC syllabus are tricky and demanding. Students are not able to link and connect one concept to another in trigonometry. Most of the students found the topic difficult to understand and just followed the steps to get the answer. For example, in differentiation and integration, students were able to solve problems without knowing the real concepts of differentiation and integration.

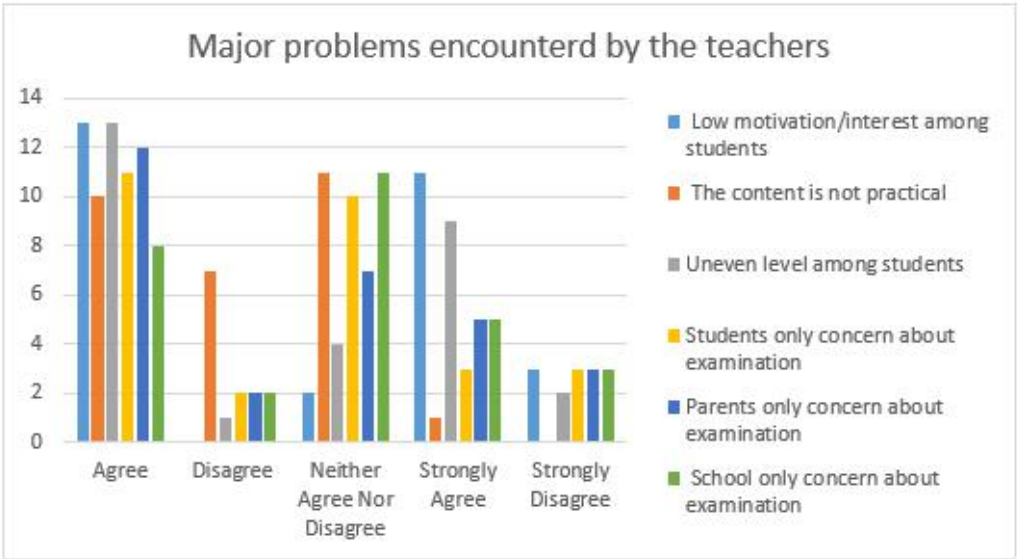
5-1-4 Teachers' Education Background

Teacher thought that what helped them the most is by learning and sharing experience from other teachers(mean = 4.52 across 5-point scale), followed by knowledge from their own experience in the primary and secondary school (mean =

4.41), reference books and teaching materials (mean = 4.24), course outlines (mean = 4.03), knowledge from college or university (mean = 4.00) and short courses (mean = 3.76). Surprisingly, in their opinion, the least helpful ones were knowledge they learnt from education institution (mean = 3.37) and talks related to education (mean = 3.11).

5-1-5 Major Problems Encountered by Teachers





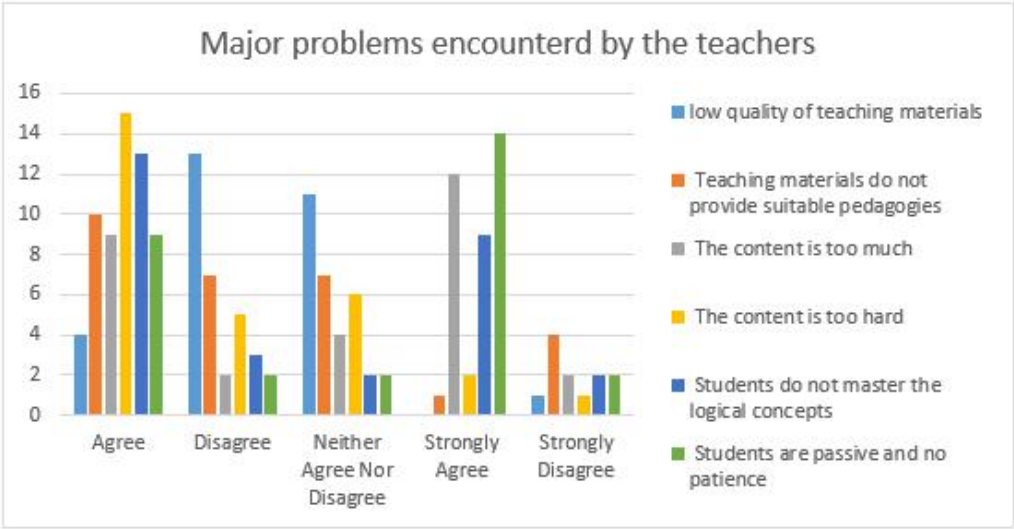


Figure 5.4: Graph showing to what extent the teachers agree with each problem

In the section of major problems encountered by the teachers, problems that are strongly agreed by the teachers are ‘too much work unrelated to teaching’, ‘content does not cater for every students’, ‘low motivation and interest among students’, ‘uneven level among students’, ‘the content is too much’ and ‘students are passive and no patience’. Teachers also agreed that they encountered problems such as ‘weak foundation in mathematics’, ‘insufficient preparation time’ and ‘the content is too hard’.

Teachers had neutral viewpoint on the problems such as ‘unclear learning outcomes’, ‘insufficient training’, ‘the content is not practical’ and ‘students and school only concern about examination’.

On the contrary, teacher disagreed on the problems such as ‘the content is not practical’ and ‘low quality of teaching materials’. They also strongly disagreed that ‘teaching materials do not provide suitable pedagogies’. Other than that, teachers mentioned that large number of students in each class is also one of the major problems.

5-1-6 Learning Effectiveness of Students

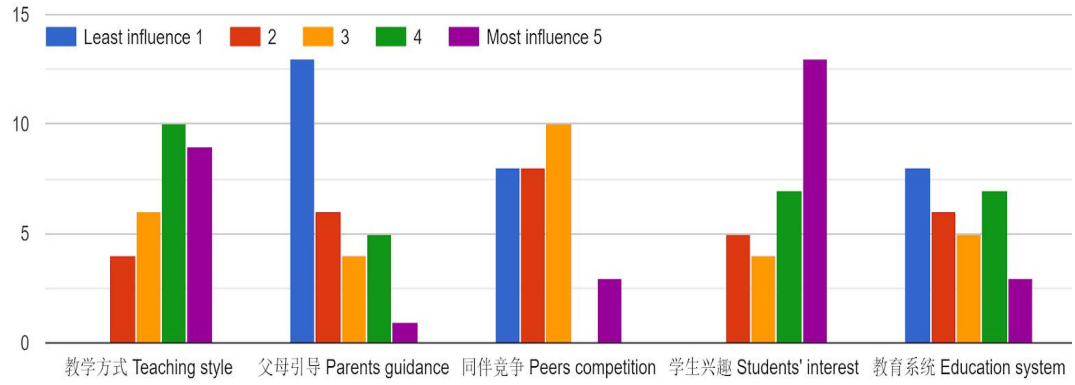


Figure 5.5: Graph showing ratings from teacher on the factor affect the learning effectiveness of students

Teachers were asked to rank the factors that affect the learning effectiveness of students. In their opinion, students' interest affect the effectiveness of a student the most, followed by teaching style and peers competition. From the results obtained, teachers felt that parents' guidance and education system had minimal effect on the learning effectiveness of the students.

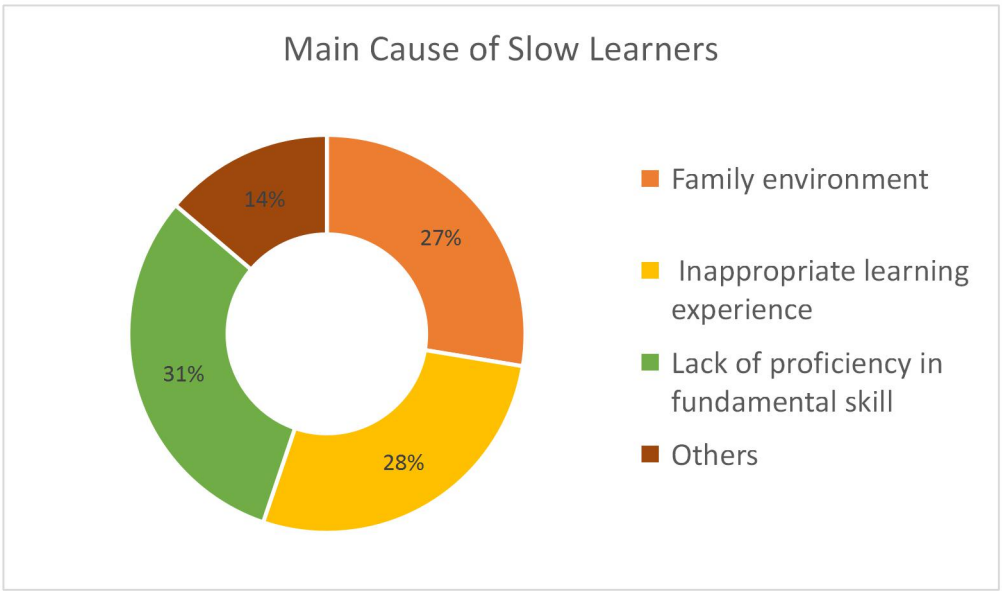


Figure 5.6: Pie chart showing percentage of teachers in rating the main cause of slow learners

Next, teachers were required to choose the main reason that causes the slow learners to fall behind in the progress of mathematics lessons. 31% of the teachers

chose ‘lack of proficiency in fundamental skill’ as the main reason. About 27% and 28% of the teachers chose ‘family environment’ and ‘inappropriate learning experience’ respectively. Other reasons include teachers’ indifference attitude, experience continuous failure, poor learning attitude and presupposition about the difficulty level of the subject.

5-1-7 Engagement and Assessment of Students

In an open-ended question, teachers had shared their experience and ways of engaging students in their mathematics classes. Many teachers mentioned that they encouraged students to take initiative to ask questions and help other students by teaching them. These questions can reflect their level of understanding. By teaching their friends, they can easily find out the point where students like them tends to make mistake and also enhance their understanding. Another way shared by teachers is to invite students to solve the past year questions on the board. At the same time, students were asked to explain the steps of solving the problem to the rest of the students. Below is an interesting way shared by one of the teachers.

‘I will divide students into groups and evaluate their groups according to the points accumulated. For example, a student who correct the mistake made by teacher will obtain points for his/her group. The group which is able solve the problem asked by teachers will also obtain points. In contrast, points will be deducted for the group if one of the group member did not pay attention to the teaching. The purpose of doing this is to improve and strengthen students’ attention in class. ’

Asking students questions at any time can ensure that they focused in the class. Besides, sense of humour is another essential technique that can be used in the classroom to promote engagement of students. A teacher regarded himself as an entertainer of the class as he always provide some related jokes to students. He believed that humour can relieve any stress on learning.

Other than tests, teachers also carried out impromptu tests or verbal assessment to interpret level of understanding of students. By observing students’ attitude and response in the class through Question And Answer session, it tells the effectiveness of the lesson.

5-2 Results of Student Questionnaire

After collecting data from students, factor analysis was performed on mathematics attitude variables. The purpose of doing factor analysis is to reduce the data dimensionality by seeking latent or underlying unobservable variables that are reflected in the manifest or observed variables. In this case, the mathematics attitude variables (manifest variables) are motivation, competence and pleasure. Below are the correlation matrix and rotated factor matrix generated by using all the 22 questions.

Correlation Matrix

		Q1	Q2	Q3	Q4	Q5	Q6	Q7
Correlation	Q1	1.000	.396	-.291	.422	-.256	-.202	.421
	Q2	.396	1.000	-.109	.331	-.276	-.262	.309
	Q3	-.291	-.109	1.000	-.405	.151	.198	-.435
	Q4	.422	.331	-.405	1.000	-.424	-.184	.792
	Q5	-.256	-.276	.151	-.424	1.000	.184	-.331
	Q6	-.202	-.262	.198	-.184	.184	1.000	-.068
	Q7	.421	.309	-.435	.792	-.331	-.068	1.000
	Q8	-.194	-.132	.167	-.230	.063	.203	-.085
	Q9	.107	.135	-.171	-.090	.046	-.124	.023
	Q10	.058	.090	-.027	-.169	.141	.180	-.068
	Q11	.211	.254	-.165	.412	-.329	-.041	.438
	Q12	.176	.301	-.026	.479	-.344	-.108	.376
	Q13	.090	.034	-.063	.054	-.144	-.112	-.003
	Q14	.036	.102	-.085	.313	-.207	.030	.335
	Q15	.399	.294	-.186	.469	-.419	-.052	.501
	Q16	.199	.114	-.166	.032	.077	-.203	.049
	Q17	.502	.430	-.219	.501	-.212	-.225	.515
	Q18	.232	.089	-.066	-.001	.067	-.057	.028
	Q19	-.098	-.167	.219	-.388	.389	.248	-.332
	Q20	-.040	.021	-.178	.222	-.178	-.007	.174
	Q21	-.387	-.372	.333	-.393	.168	.300	-.322
	Q22	-.064	-.101	.129	-.252	.161	.255	-.201

Table 5.4: Correlation matrix

		Q22
Correlation	Q1	-.064
	Q2	-.101
	Q3	.129
	Q4	-.252
	Q5	.161
	Q6	.255
	Q7	-.201
	Q8	.149
	Q9	.042
	Q10	.176
	Q11	-.033
	Q12	-.085
	Q13	.051
	Q14	-.174
	Q15	-.065
	Q16	.063
	Q17	-.147
	Q18	.107
	Q19	.288
	Q20	-.014
	Q21	.249
	Q22	1.000

a. Determinant = .000

Rotated Factor Matrix[a]

	Factor		
	1	2	3
Q4	.733	.422	
Q15	.688		
Q12	.674		
Q7	.672	.364	
Q11	.641		.360
Q5	-.510		
Q17	.479	.363	.455
Q19	-.360	-.340	
Q8			
Q20			
Q21		-.515	
Q6		-.514	
Q3		-.460	
Q1	.340	.440	
Q22		-.348	
Q2	.345	.346	
Q9			
Q10			.527
Q16			.525
Q13			.466
Q14	.426		-.453
Q18			.444

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

Table 5.5: Correlation matrix(continued) and rotated factor matrix

Comments on correlation matrix and rotated factor matrix:

Table 1 exhibited part of the correlation matrix. The correlation matrix showed us how each of the 22 items is correlated with each of the other 21 items. There is one assumption is that the determinant below the correlation matrix should be greater than 0.01. Determinant of value near to 0 indicates at least one of the items is the linear combination of other items in the set (high collinearity) and we are unable to get a factor analytic solution. By looking at the Question 8,9,20 in the rotated matrix, these 3 items had no factor loadings in any of the 3 factors. Hence we excluded Question 8, 9 and 20 from the following factor analysis.

We generated another factor analysis of the remaining questions. The factor analysis includes descriptive statistics, correlation matrix, KMO and Bartlett's Test, communalities, total variance explained, rotated factor matrix and factor transformation matrix.

- Descriptive statistics: This table gave us the mean and standard deviation of each items. The Analysis N refers to how many participants in each item.

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Q1	3.61	1.010	106
Q2	3.17	.951	106
Q3	2.45	1.114	106
Q4	2.77	1.333	106
Q5	3.01	1.276	106
Q6	2.68	1.269	106
Q7	3.06	1.330	106
Q10	3.41	1.406	106
Q11	3.29	.936	106
Q12	1.78	.862	106
Q13	4.25	1.049	106
Q14	1.41	.954	106
Q15	2.82	1.031	106
Q16	4.06	.964	106
Q17	3.24	1.065	106
Q18	3.83	1.019	106
Q19	3.19	1.164	106
Q21	2.21	1.177	106
Q22	3.44	1.086	106

Table 5.6: Descriptive statistics

- Correlation matrix: The matrix tell us how each items are related to each of the other items and the determinant should be greater than 0.0001 to get a factor analytic solution. High correlation of two items for example absolute value greater than 0.60 indicates these 2 items are more likely to be grouped together. On the contrary, 2 items with low correlation usually will not be grouped under the same factor.

Correlation Matrix[a]

		Q1	Q2	Q3	Q4	Q5	Q6	Q7
Correlation	Q1	1.000	.396	-.291	.422	-.256	-.202	.421
	Q2	.396	1.000	-.109	.331	-.276	-.262	.309
	Q3	-.291	-.109	1.000	-.405	.151	.198	-.435
	Q4	.422	.331	-.405	1.000	-.424	-.184	.792
	Q5	-.256	-.276	.151	-.424	1.000	.184	-.331
	Q6	-.202	-.262	.198	-.184	.184	1.000	-.068
	Q7	.421	.309	-.435	.792	-.331	-.068	1.000
	Q10	.058	.090	-.027	-.169	.141	.180	-.068
	Q11	.211	.254	-.165	.412	-.329	-.041	.438
	Q12	.176	.301	-.026	.479	-.344	-.108	.376
	Q13	.090	.034	-.063	.054	-.144	-.112	-.003
	Q14	.036	.102	-.085	.313	-.207	.030	.335
	Q15	.399	.294	-.186	.469	-.419	-.052	.501
	Q16	.199	.114	-.166	.032	.077	-.203	.049
	Q17	.502	.430	-.219	.501	-.212	-.225	.515
	Q18	.232	.089	-.066	-.001	.067	-.057	.028
	Q19	-.098	-.167	.219	-.388	.389	.248	-.332
	Q21	-.387	-.372	.333	-.393	.168	.300	-.322
	Q22	-.064	-.101	.129	-.252	.161	.255	-.201

Correlation Matrix[a]

		Q10	Q11	Q12	Q13	Q14	Q15	Q16
Correlation	Q1	.058	.211	.176	.090	.036	.399	.199
	Q2	.090	.254	.301	.034	.102	.294	.114
	Q3	-.027	-.165	-.026	-.063	-.085	-.186	-.166
	Q4	-.169	.412	.479	.054	.313	.469	.032
	Q5	.141	-.329	-.344	-.144	-.207	-.419	.077
	Q6	.180	-.041	-.108	-.112	.030	-.052	-.203
	Q7	-.068	.438	.376	-.003	.335	.501	.049
	Q10	1.000	.162	-.045	.190	-.316	.018	.278
	Q11	.162	1.000	.410	.334	.122	.519	.245
	Q12	-.045	.410	1.000	.123	.432	.395	-.077
	Q13	.190	.334	.123	1.000	-.110	.164	.316
	Q14	-.316	.122	.432	-.110	1.000	.133	-.284
	Q15	.018	.519	.395	.164	.133	1.000	.144
	Q16	.278	.245	-.077	.316	-.284	.144	1.000
	Q17	.184	.418	.305	.263	-.048	.490	.284
	Q18	.102	.153	-.118	.262	-.252	.080	.223
	Q19	.239	-.224	-.176	.142	-.139	-.344	-.060
	Q21	-.096	-.296	-.226	-.141	-.034	-.220	-.185
	Q22	.176	-.033	-.085	.051	-.174	-.065	.063

Correlation Matrix[a]

		Q17	Q18	Q19	Q21	Q22
Correlation	Q1	.502	.232	-.098	-.387	-.064
	Q2	.430	.089	-.167	-.372	-.101
	Q3	-.219	-.066	.219	.333	.129
	Q4	.501	-.001	-.388	-.393	-.252
	Q5	-.212	.067	.389	.168	.161
	Q6	-.225	-.057	.248	.300	.255
	Q7	.515	.028	-.332	-.322	-.201
	Q10	.184	.102	.239	-.096	.176
	Q11	.418	.153	-.224	-.296	-.033
	Q12	.305	-.118	-.176	-.226	-.085
	Q13	.263	.262	.142	-.141	.051
	Q14	-.048	-.252	-.139	-.034	-.174
	Q15	.490	.080	-.344	-.220	-.065
	Q16	.284	.223	-.060	-.185	.063
	Q17	1.000	.204	-.127	-.387	-.147
	Q18	.204	1.000	.044	-.080	.107
	Q19	-.127	.044	1.000	.242	.288
	Q21	-.387	-.080	.242	1.000	.249
	Q22	-.147	.107	.288	.249	1.000

a. Determinant = .001

Table 5.7: Correlation matrix

- KMO and Bartlett's Test: The purpose of doing these 2 tests is to indicate the suitability of your data for structure detection. Kaiser-Meyer-Olkin Measure of Sampling Adequacy measures the proportion of variance in the variables that might be caused by the underlying factor. High values (close to 1.0) indicates the results of the factor analysis might be useful. While Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix. Identity matrix means that correlations between variables are zero. Value of the significance level less 0.05 is suggested to indicate that a factor analysis might be suitable for your data.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.801
Bartlett's Test of Sphericity	Approx. Chi-Square	657.580
	df	171
	Sig.	.000

Table 5.8: KMO and Bartlett's test

- Communalities: Table of communalities shows the initial communalities before rotation. It represents the proportion of variation in that particular variable that can be explained by the factors. It is computed by summing up the squared loadings for that variable. High values of communalities indicates

- the component represent the variables well while low variable are not well represented.

Communalities

	Initial
Q1	.439
Q2	.337
Q3	.323
Q4	.726
Q5	.389
Q6	.316
Q7	.718
Q10	.336
Q11	.479
Q12	.470
Q13	.336
Q14	.414
Q15	.502
Q16	.328
Q17	.565
Q18	.216
Q19	.401
Q21	.374
Q22	.209

Extraction Method: Principal Axis Factoring.

Table 5.9: Communalities

- Total Variance Explained: Factors refer to the number of variables used in the factor analysis. We had 19 variables in this case. The column of total contains eigenvalues. Eigenvalues are the variances of each variables accounted for. Normally, those eigenvalues greater than 1 are considered as useful to a factor. There are 5 factors which had eigenvalues more than 1. These 5 factors accounted for almost 59.7% of the variability in the original variables. Rotation sums of squared loadings represents the distribution of variance after rotation. The rotated factor model redistributed the variance for each of the factors over the three extracted factors.

Total Variance Explained

Factor	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.092	26.800	26.800	3.391	17.845	17.845
2	2.440	12.840	39.641	2.026	10.663	28.508
3	1.563	8.226	47.867	1.863	9.804	38.312
4	1.169	6.152	54.019			
5	1.077	5.671	59.690			
6	.983	5.173	64.862			
7	.933	4.909	69.771			
8	.785	4.134	73.905			
9	.723	3.805	77.710			
10	.683	3.593	81.302			
11	.557	2.931	84.233			
12	.547	2.879	87.112			
13	.481	2.532	89.644			
14	.441	2.323	91.967			
15	.408	2.145	94.113			
16	.357	1.879	95.991			
17	.305	1.606	97.597			
18	.290	1.527	99.123			
19	.167	.877	100.000			

Extraction Method: Principal Axis Factoring.

Table 5.10: Total variance explained

- Rotated factor matrix: This table is the key for understanding the results of analysis. The analysis had sorted 19 mathematics attitude questions into three overlapping groups of items. The items were sorted in descending order according to their factor loadings for each factors regardless the positive or negative correlation.

Rotated Factor Matrix[a]

	Factor		
	1	2	3
Q4	.697	-.474	
Q7	.686	-.377	
Q15	.664		
Q12	.658		
Q11	.647		.303
Q17	.506	-.353	.445
Q5	-.481		
Q2	.357	-.328	
Q6		.543	
Q21		.509	
Q19		.437	
Q3		.421	
Q22		.418	
Q1	.357	-.404	
Q16			.569
Q10			.524
Q14	.419		-.515
Q13			.444
Q18			.431

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

Table 5.11: Rotated factor matrix

Interpretation of factor analysis:

Principal factor analysis with varimax rotation was carried out to investigate the possible underlying structure for the 22 items of the student questionnaire. The assumptions of normality, linear relationships between pairs of variables were checked. The questions were designed to index three constructs: motivation, competence, and pleasure. The first factor, which seemed to index pleasure has strong loadings on Q2, Q4(I like to think and work on mathematics problems), Q5, Q7(I am interested in mathematics calculations), Q11, Q12(I like to read extracurricular mathematics book), Q15 and Q17. The second factor which seemed to index competence has loadings on Q1, Q2, Q3, Q6, Q19(I have difficulties in understanding the questions), Q21(It is not important to understand the concepts, as long as I can solve the questions in the examination) and Q22(Mathematics is all about substituting values into the formulas). The third factor which seemed to index motivation has loadings on Q10, Q13(I hope that the teaching materials can provide more real-life examples for easier understanding), Q14, Q16, Q18.

5-3 Discussion and Suggestion

It is a commonly seen scenario where students possess procedural fluency in mathematics but they are having difficulty with conceptual understanding. From the response from 106 students, we found that students were agreed that their mathematics teachers will explain the mathematical concepts before introducing the formula (refer to Q16, mean = 4.06). However, very few of them took initiative to read and understand the explanation of the concepts from the teaching materials (refer to Q20, mean=2.65). Reasoning skills are also important in developing students' mathematical abilities. The students knew how to do calculations, but they did not understand the reason of doing such calculations (refer to Q5, mean= 3.01).

Hence, some teaching practices for teaching conceptual understanding are recommended. Students should be asked to justify their process and give self-explanation. Furthermore, teachers should compare alternate solution methods or compare incorrect procedure in order to help students to learn faster and more effective. Problem solving is a building block for learning mathematics as numerous opportunities to connect mathematical ideas are exposed to the students. Problems that focus too heavily on procedural fluency does not promote the ability of students

to come up with original thoughts to solve a mathematical question. Most of the students realised the importance of understanding the concepts instead of practise the procedural fluency for examinations (refer to Q21, mean=2.21).

Students always disregard reality when solving problems because the questions are just a way to practice drills or algorithms (refer to Q2 and Q22, mean=3.17 and 3.44). According to the response from a teacher, UEC questions are challenging and tricky. Some of the students also experience difficulty in understanding the need of question (refer to Q19, mean=3.19). Most of the students have little opportunities to be creative in mathematics as they seldom work on rich problems that allow them to ask ask sub-problems and analyse problems. Although the students agreed that mathematics are highly variable (refer to Q13, mean=4.25), they believed that unless they learnt the correct way of solving the problems, otherwise the problems cannot be solved (refer to Q10, mean=3.41).

Besides, professional meetings and other occasions when teachers come together to work on their practice should be used as opportunities for professional development. Sharing experience and techniques of teaching are essential to improve their effectiveness of teaching. According to the data collected from students, 74% of them attended mathematics tuition. 27% of the students attended the tuition because they do not understand the lesson in the school. One of the reason might the amount of class size is too big. As claimed by a teacher, the amount of class size is around 55 students in a class, which is a challenge for teacher to take care of the progress of every student. Hence, a significant amount of class size should be controlled to ensure quality teaching.

CHAPTER 6: CONCLUSION

In summary, various pedagogical approaches had been used by the mathematics teacher to facilitate their teaching. The effective approaches include Q&A session, group discussion, online videos and so on. Teacher thought that what helped them the most is by learning and sharing experience from other teachers. In their opinion, the least helpful ones were knowledge from education institution and talks related to education. Besides, problems that are strongly agreed by the teachers are ‘too much work unrelated to teaching’, ‘content does not cater for every students’, ‘low motivation and interest among students’, ‘uneven level among students’, ‘the content is too much’ and ‘students are passive and no patience’. Many teachers mentioned that they encouraged students to take initiative to ask questions and help other students by teaching them. Other than tests, teachers also carried out impromptu tests or verbal assessment to interpret level of understanding of students.

Most of the students possess procedural fluency in mathematics but they are having difficulties with conceptual understanding. To overcome this scenario, students should be asked to justify their solution and provide explanation. Comparing alternate solution is one of the effective way to help student have better understanding on a topic with conceptual understanding. Some recommendations for example constant professional meeting and reduce class size were made.

REFERENCES

Ames, C., 1992. Classrooms: Goals, structures, and student motivation. *Journal of educational psychology*, *84*(3), p.261.

Beilock, S.L. and Maloney, E.A., 2015. Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences*, *2*(1), pp.4-12.

Bengo, P., 2016. Secondary mathematics coaching: The components of effective mathematics coaching and implications. *Teaching and Teacher Education*, *60*, pp.88-96.

Ibrahim, Z.B. and Othman, K.I., 2010. Comparative study of secondary mathematics curriculum between Malaysia and Singapore. *Procedia-Social and Behavioral Sciences*, *8*, pp.351-355.

Ismail, S.F.Z.H., Shahrill, M. and Mundia, L., 2015. Factors contributing to effective mathematics teaching in secondary schools in Brunei Darussalam. *Procedia-Social and Behavioral Sciences*, *186*, pp.474-481.

Kementerian Pendidikan Malaysia., 2015. Laporan TIMSS 2015, 11. Available at http://www.moe.gov.my/images/Terbitan/Rujukan-Akademik/pubfile_file_002124.pdf [Accessed 8th August 2018]

National Research Council and Mathematics Learning Study Committee, 2001. *Adding it up: Helping children learn mathematics*. National Academies Press.

Skemp, R.R., 1976. Relational understanding and instrumental understanding. *Mathematics teaching*, *77*(1), pp.20-26.

Sullivan, P. (2011) *Australian Education Review Teaching Mathematics : Using research-informed strategies*.

Swan, M., 2005. Standards Unit-Improving learning in mathematics: challenges and strategies.

Watson, A. and Sullivan, P., 2008. Teachers learning about tasks and lessons. In *The Handbook of Mathematics Teacher Education: Volume 2* (pp. 107-134). Brill Sense.

Fung, F., Tan, C.Y. and Chen, G., 2018. Student engagement and mathematics achievement: Unraveling main and interactive effects. *Psychology in the Schools*, *55*(7), pp.815-831.

Choudhury, R. and Das, D., 2012. Influence of attitude towards mathematics and study habit on the achievement in mathematics at the secondary stage. *International Journal of Engineering Research and Applications (IJERA)*, *2*(6), pp.192-196.

Hoosain, E. and Naraine, B., 1999. Evaluation in the Mathematics Classroom. *Humanistic Mathematics Network Journal*, *1*(21), p.9.

Kpolovie, P.J., Joe, A.I. and Okoto, T., 2014. Academic achievement prediction: Role of interest in learning and attitude towards school. *International journal of humanities social sciences and education*, *1*(11), pp.73-100.

Mata, M.D.L., Monteiro, V. and Peixoto, F., 2012. Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child development research*, *2012*.

Mistretta, R.M., 2005. Integrating technology into the mathematics classroom: The role of teacher preparation programs. *The Mathematics Educator*, *15*(1).

Smith, K., 2014. How teacher beliefs about Mathematics affect student beliefs about Mathematics.

Stipek, D.J., Givvin, K.B., Salmon, J.M. and MacGyvers, V.L., 2001. Teachers' beliefs and practices related to mathematics instruction. *Teaching and teacher education*, *17*(2), pp.213-226.

Ünal, M., 2017. Preferences of Teaching Methods and Techniques in Mathematics with Reasons. *Universal Journal of Educational Research*, *5*(2), pp.194-202.

APPENDIX

班级：_____ 性别： 男 / 女

我的全年数学成绩：

- 80-100
- 65-79
- 50-64
- 0-49

请根据以下问题，选出**一项**最符合你的想法的选项。

1. 当我遇到不会解决的数学题时，我最常用的的办法是
    - 坚持自己寻找解决方法
    - 请教他人但由自己计算
    - 完全由他人帮助
    - 抄录其他人的答案

2. 我有参加学校以外的补习班
    - 有
    - 没有

3. 若有参加补习班，我参加补习班的原因及目的是
    - 学校老师的讲解无法让我明白课程
    - 学习课程以外的知识
    - 朋友参加此补习班
    - 父母要求参加我补习班

	非常不认同 ⟷ 非常认同				
1.数学对我将来进入社会工作很有用处。	1	2	3	4	5
2. 我知道学习过的数学课题的实际用途。	1	2	3	4	5
3.只要有数值计算，我都会使用计算机。	1	2	3	4	5
4.我喜欢思考数学题。	1	2	3	4	5
5.虽然我懂得进行运算，但是我不明白为什么要这样计算。	1	2	3	4	5
6.在学习新的数学课题时，我希望老师	1	2	3	4	5

直接告诉我公式，而不是要求我们去寻找。					
7.我对数学计算感兴趣。	1	2	3	4	5
8.我希望减少一些数学家课。	1	2	3	4	5
9.老师经常要求我们看教科书的解释。	1	2	3	4	5
10.解决数学题必须学过正确的方法，否则 无法解决。	1	2	3	4	5
11.我在数学课时都能专心上课。	1	2	3	4	5
12.我经常阅读数学课外书。	1	2	3	4	5
13.数学是千变万化的。	1	2	3	4	5
14.我经常参加数学课外活动，例如比赛。	1	2	3	4	5
15.我完全明白数学课的内容。	1	2	3	4	5
16.老师经常在介绍公式前先解释概念。	1	2	3	4	5
17.在学校里学到的数学能启发我的思考。	1	2	3	4	5
18.我希望在教科书有更多的生活例子，使我们更容易明白。	1	2	3	4	5
19.我在理解题目需求时有困难。	1	2	3	4	5
20.我会主动看教科书中的定理及解释。	1	2	3	4	5
21.是否明白概念并不重要，只要能计算并应付考试便足够了。	1	2	3	4	5
22.**数学是把数字**带**入公式依法**运**作。**	1	2	3	4	5

An Analytical Study on Effective Mathematics Teaching in Secondary High School

您好！谢谢您抽空填写！这项问卷是为了大学毕业专题研习而设计的，所得资料将用于探讨现行中学数学教育。以下问题主要用来了解老师个人的想法，并没有对错。可用中文或英文填写。一切资料，将予保密。
Greetings! Thank you for sparing your time to complete this! This questionnaire is designed for final year project purpose, all the data collected will be used to analyze the current secondary school mathematics education. The questions below aim to understand the opinion of different teachers and have no standard answers. Both English and Chinese are acceptable. All the information will keep confidential.

* Required

背景资料 Background Information

1. **1.** 学校名字 **School Name** *

_____

2. **2.** 您的教龄 **Your teaching experience** *
Mark only one oval.

- ◯ 少于6年 Less than six years
- ◯ 6-10 年years
- ◯ 11-20 年 years
- ◯ 多于20年 More than 20 years

3. **3.** 您的学历 **Your educational background (**可复选 **Can choose more than one)** *
Check all that apply.

- ☐ 数学学士学位 Degree in Mathematics
- ☐ 教育学士学位 Degree in Education
- ☐ 其他学士学位，即非数学亦非教育 Other degree, except mathematics and education
- ☐ 硕士或以上 Master or above
- ☐ 数学教育文凭（师范）Postgraduate Certificate in Education, specializing in Mathematics
- ☐ 非数学教育文凭（师范）Postgraduate Certificate in Education, other than Mathematics
- ☐ Other: _____

4. **4.** 您使用的教学方法 **The teaching methods you used (**可复选 **Can choose more than one)** *
Check all that apply.

- [ ] 老师指导 Teacher directed
- [ ] 学生指导 Student directed
- [ ] 问答环节 Q&A session
- [ ] 分组讨论 Group discussion
- [ ] 功课 Homework
- [ ] 数学软件 Mathematical software
- [ ] PowerPoint，Word，Excel
- [ ] 网上视频 Online Video
- [ ] 计算机 Scientific calculator

5. **5.** 哪项是您觉得最有效的教学法？**Which strategy do you think is the most effective?** *

6. **6.** 根据您所说的教学法，是否有实际且成功的教学经验与我们分享？ **Based on the strategy mentioned, can you share with us some practical and successful experience?** *

初中 Lower secondary

针对以下各项问题，请圈出最符合你的看法的号码。1 =非常不认同，2=不认同，3=不认同也不赞同，4=赞同，5=非常赞同。
For each of the questions below, circle the response that best characterizes how you feel about the statement, where 1 = Strongly Disagree, 2 = Disagree. 3 = Neither Agree Nor Disagree, 4 = Agree, and 5 = Strongly Agree.

7. **7.** 您今年有教初中数学吗**? Did you teach Form 1 to Form 3 Mathematics subject in this year?**
Mark only one oval.

- ◯ 有，请回答以下问题 Yes, please proceed to answer
- ◯ 没有，请跳过此部分 No, please skip this section *After the last question in this section, skip to question 14.*

8. 根据初中课程大纲：代数、几何、算数、统计、集合，您觉得：Based on the lower secondary course structure: algebra, geometry, arithmetic, statistics and set, you think that:

8. 现有的数学教学内容能达到应有的教学目的 **Current curriculum can achieve expected outcomes**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. 您的知识足以教授这些课程 **You are capable to teach the content**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. 把科技融合进教学会有帮助 **Integration of technology into curriculum is helpful**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

11. 您的学生都能达到课程要求 **Your students can achieve learning outcomes**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. **9.** 请问哪一章的数学教学对老师来说最具有挑战性？**Which topic is the most challenging to the teachers?**

13. **10.** 为什么您会觉得有挑战性？**Why do you feel it is challenging?**

高中理科 Upper Secondary（Science）

针对以下各项问题，请圈出最符合你的看法的号码。1 =非常不认同，2=不认同，3=不认同也不赞同，4=赞同，5=非常赞同。
For each of the questions below, circle the response that best characterizes how you feel about the statement, where 1 = Strongly Disagree, 2 = Disagree. 3 = Neither Agree Nor Disagree, 4 = Agree, and 5 = Strongly Agree.

14. **11.** 您今年有教高中理科数学吗**? Did you teach upper secondary science classes Mathematics subject in this year?**
Mark only one oval.

有，请回答以下问题 Yes, please proceed to answer

没有，请跳过此部分 No, please skip this section *After the last question in this section, skip to question 21.*

12. 根据高中课程大纲：代数、三角、解析几何、统计与概率、微积分，您觉得：**Based on the upper secondary course structure: algebra, trigonometry, analytic geometry, statistics & probabilities and calculus, you think that:**

15. 现有的数学教学内容能达到应有的教学目的 **Current curriculum can achieve expected outcomes**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

16. 您的知识足以教授这些课程 **You are capable to teach the content**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

17. 把科技融合进教学会有帮助 **Integration of technology into curriculum is helpful**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

18. 您的学生都能达到课程要求 **Your students can achieve learning outcomes**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

19. **13.** 请问哪一章的数学教学对老师来说最具有挑战性？**Which topic is the most challenging to the teachers?**

20. **14.** 为什么您会觉得有挑战性？**Why do you feel it is challenging?**

高中文商科 Upper Secondary（Commence/Arts）

针对以下各项问题，请圈出最符合你的看法的号码。1 =非常不认同，2=不认同，3=不认同也不赞同，4=赞同，5=非常赞同。
For each of the questions below, circle the response that best characterizes how you feel about the statement, where 1 = Strongly Disagree, 2 = Disagree. 3 = Neither Agree Nor Disagree, 4 = Agree, and 5 = Strongly Agree.

21. **15.** 您今年有教高中文商科数学吗**? Did you teach upper secondary commence or art classes Mathematics subject in this year?**
Mark only one oval.

有，请回答以下问题 Yes, please proceed to answer
没有，请跳过此部分 No, please skip this section *After the last question in this section, skip to question 28.*

16. 根据高中课程大纲：代数、三角、解析几何、统计与概率、微积分，您觉得：**Based on the upper secondary course structure: algebra, trigonometry, analytic geometry, statistics & probabilities and calculus, you think that:**

22. 现有的数学教学内容能达到应有的教学目的 **Current curriculum can achieve expected outcomes**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

23. 您的知识足以教授这些课程 **You are capable to teach the content**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

24. 把科技融合进教学会有帮助 **Integration of technology into curriculum is helpful**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

25. 您的学生都能达到课程要求 **Your students can achieve learning outcomes**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

26. **17.** 请问哪一章的数学教学对老师来说最具有挑战性？**Which topic is the most challenging to the teachers?**

_____

_____

_____

_____

_____

27. **18.** 为什么您会觉得有挑战性？**Why do you feel it is challenging?**

_____

_____

_____

_____

_____

19. 您认为以下哪项对你的数学教学有帮助？Do you think which of the following contributes to your mathematics teaching?

28. 小学和中学的学习 **Knowledge from primary and secondary school**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

29. 学院或大学的学习 **Knowledge from college or university**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

30. 教育学院的学习 **Knowledge from education institution**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

31. 课程纲要 **Course Outlines**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

32. 教科书 **Teaching Materials**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

33. 参考书 **Reference Books**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

34. 进修课程 **Short courses**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

35. 关于教育的讲座 **Talks related to education**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

36. 同行学习 **Learning from other teachers**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

37. **20.** 您认为以下哪项是目前中学数学老师面临的问题？**In your opinion, which of the following are the major problems facing by secondary school mathematics teachers?** *

Check all that apply.

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
教科书水平低 Low quality of teaching materials	☐	☐	☐	☐	☐
教科书无法提供适合的教学法 Teaching materials do not provide suitable pedagogies	☐	☐	☐	☐	☐
无法应付个别差异 Content does not cater for every students	☐	☐	☐	☐	☐
学生过于注重考试 Students only concern about examination	☐	☐	☐	☐	☐
学生基础弱 Weak foundation in mathematics	☐	☐	☐	☐	☐
准备时间太少 Insufficient preparation time	☐	☐	☐	☐	☐
课程内容太深 The content is too deep	☐	☐	☐	☐	☐
家长过于注重考试 Parents only concern about examination	☐	☐	☐	☐	☐
校方过于注重考试 School only concern about examination	☐	☐	☐	☐	☐
学生被动及缺乏耐性 Students are passive and no patience	☐	☐	☐	☐	☐
学生学习动机低 Low motivation/interest among students	☐	☐	☐	☐	☐
学生无法掌握数学逻辑与概念 Students do not master the mathematics logical concepts	☐	☐	☐	☐	☐
课程内容太多 The content is too much	☐	☐	☐	☐	☐
缺乏教师专业培训 Insufficient training	☐	☐	☐	☐	☐
课程目标不清晰 Unclear learning outcomes	☐	☐	☐	☐	☐
无关教学的工作太多 Too much work unrelated to teaching	☐	☐	☐	☐	☐
学生程度层次不齐 Uneven level among students	☐	☐	☐	☐	☐
内容没有实用性 The content is not practical	☐	☐	☐	☐	☐

38. 其他问题 **Other than stated:**

39. **21.** 请依照您觉得最能影响学生学习效率编排以下选项。 **Rank the following from least to most influence to learning effectiveness of students** *

Check all that apply.

	Least influence 1	2	3	4	Most influence 5
教学方式 Teaching style	☐	☐	☐	☐	☐
父母引导 Parents guidance	☐	☐	☐	☐	☐
教育系统 Education system	☐	☐	☐	☐	☐
同伴竞争 Peers competition	☐	☐	☐	☐	☐
学生兴趣 Students' interest	☐	☐	☐	☐	☐

40. **22.** 以您的经验，以下哪项是造成学生在数学学习进度落后的主要原因？**In your opinion, which is the main cause of slow learners to fall behind the progress in mathematics?** *

Mark only one oval.

- ◯ 家庭环境 Family environment
- ◯ 老师差异态度 Teacher‘s indifference attitude
- ◯ 不好的学习经验 Inappropriate learning experience
- ◯ 数学基础不稳 Lack of proficiency in fundamental skill
- ◯ 学习障碍 Experience continuous failure
- ◯ 上课态度欠佳 Poor learning attitude
- ◯ 预设数学科目难度 Presupposition about the difficulty level of the subject
- ◯ Other: _____

41. **23.** 请问您如何让学生在上数学课时有更多的互动以及参与感？**How do you get students engaged in the mathematics problem solving process in your class?** *

_____

_____

_____

_____

_____

42. **24.** 除了考试，请问您如何评估学生的数学表现？**Other than tests, how do you assess students' performance in mathematics?** *

_____

_____

_____

_____

_____