A Project entitled

Pre-service secondary mathematics teachers' perception about teacher training and their readiness for teaching in the future

Submitted by

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Declaration

I, *Lee Jeffrey Kee Fung* declare that this research report represents my own work under the supervision of *Adjunct Associate Professor Dr. Man Yiu Kwong*, and that it has not been submitted previously for examination to any tertiary institution.

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Abstract

The level of mathematical content knowledge (MCK) and mathematical knowledge for teaching (MKT) of pre-service mathematics teachers have always been concerned as those are the factors of the effectiveness of teaching mathematics. Some studied have also searched for their self-perceptions of readiness to teach secondary mathematics in the future. In this study, pre-service secondary mathematics teachers' perceptions about the efficacy of the teaching training in a Hong Kong university for teaching in the future were evaluated. Their self-perceptions about teaching in the future were also investigated, especially in their MCK, MKT, and general pedagogical knowledge. The study was conducted at a Hong Kong university with a five-year full-time bachelor program for secondary mathematics education. The result indicates that most participants do not feel a significant impact on their MCK and MKT, but their general pedagogical knowledge is improved. They also do not have a strong readiness for teaching in the future, but they feel more prepared to teach junior content rather than others. However, future training is required to strengthen all their MCK, MKT, and other pedagogical knowledge for enhancing their confidence to teach senior content, especially two extended modules.

1. Introduction

Nowadays, a registered teacher's minimum academic qualification in Hong Kong is a local Teacher's Certificate or Post-graduate Diploma/Certificate in Education. Therefore, receiving teacher training in a university for the post-graduate Diploma in Mathematics Education is one of the methods to become a mathematics teacher. In the 2018/19 academic year, there were 554 full-time and part-time undergraduate students in Bachelor of Education who graduated from EduHK. Therefore, it is essential to investigate pre-service teachers' perceptions about the efficacy of the teacher training program received in the university for their future education and investigate whether they are ready to become a registered teacher or not after the program. Moreover, the suggestions for the education program from the pre-service teachers are also essential to be explored. It would affect the university education program's future planning for providing the most effective training for university students to become mathematics teachers in the future.

2. Literature Review

2.1 Teachers' Belief

Prescott and Cavanagh (2006) investigated Sydney pre-service mathematics teacher's conflicts between their beliefs and the theories that learned in the courses. There were 16 pre-service teachers from two universities who participated in this research. There are lots of pre-service teachers in mathematics education who perceive mathematics as fixed and sequential knowledge. The most effective method to learn mathematics is memorizing, using the algorithm, and repeating the procedures. Instrumental learning was more emphasized than relational learning, which means that computational skill would be the main aim in the mathematics curriculum. The knowledge would be unconnected as it was bound by rules, and mathematics teaching is about telling learning is about memorizing.

In Hong Kong, although there are not many researches about the belief of pre-service secondary mathematics teacher, there is some research about the belief of pre-service primary mathematics teacher, which can be referenced. Lo and Anderson (2010) investigated pre-service primary teachers' beliefs about mathematics, Hong Kong curriculum, and teaching practice. There were 152 participants from one teacher education institution and enrolled in a four-year Bachelor of Primary Education with a mathematics major. The participant also included from Year 1 to Year 4, and they finished the same questionnaire. As a result, participants with higher years would generally support the more contemporary mathematical beliefs, such as mathematics is an

interesting subject. Mathematics knowledge would be the result of learners' interpretation and organization of the information. Higher year participants would also have favorable beliefs about the relationship between the social context and mathematics education. About 92% of year 3 and year 4 participants disagreed or strongly disagreed that language learning was more important than mathematics in primary education. However, nearly two-thirds of all year participants had some traditional mathematics belief, such as mathematics is about computation and memorizing the fact.

Therefore, the changes in the pre-service teachers' belief in mathematics education after they entered the mathematics education program in EduHK could be explored to investigate the program's impact.

2.2 Mathematics Content Knowledge (MCK)

Hine (2015) explained that mathematics content knowledge (MCK) means a comprehensive understanding of mathematics, including deep, broad, connected, and thorough knowledge in mathematics. Numeracy, quantitative literacy, computational fluency, and mathematics literacy are the other terms of MCK. They also have the same meaning, which is the person's capacity to identify and understand the role of mathematics in the world. The person would also be able to make mathematical judgements with evidence and involve mathematics to achieve their needs in life. It is essential for the pre-service teachers to enhance their future teaching by

assisting their students in exploring and investigating the mathematics concepts. However, Hine (2015) also showed some research found that serval pre-service teachers did not have comprehensive content knowledge. They would have difficulties in applying and teaching mathematics in the secondary mathematics lesson. Therefore, if a teacher did not have a well-defined MCK, the pedagogical processes would not be benefited effectively. Mathematics content courses would be an effective method to strengthen their MCK, which would be essential for their teaching. These courses would also enhance the preparation for their teaching and representation of the discipline of mathematics to students. However, there is no strong relationship between teachers' MCK and the number of university courses or their grades and scores in the courses. Students' achievements are also not correlated to the number of mathematics contents courses taken by the teachers. There are few mathematics content courses in university related to the mathematics that pre-service teachers will teach in the future.

Tatto et al. (2012) completed a study about policy, practice, and readiness to teach primary and secondary mathematics in 17 countries. For the mathematics content courses related to the school curriculum, the Philippines, Poland, Singapore, Switzerland, and the United States were the five countries in the lower secondary program group with averages of less than 100 contact hours. Norway would be the country with the highest hours, which is about 350 hours. All participants from different countries and universities would complete the test for investigating their MCK. Only 3 out of 10 countries contained a mean score above the international mean.

For the lower and upper secondary group, Botswana was the only country that had more than 400 training hours. Chinese Taipei, Poland, Singapore, and the United States were all less than 100 hours. However, 7 out of 12 counties had a mean score above the international mean under the test.

Therefore, Hine (2015) conducted qualitative research with 20 participants in Australia about pre-service teachers' perception about their readiness on MCK. The result showed that there were varying degrees of preparedness in teaching upper primary and lower secondary mathematics. Less than half of the participants claimed that they were confident in mathematics education. Almost all of them addressed that both content knowledge and pedagogical content knowledge were needed to be strengthened.

In Hong Kong, the Education Bureau (2017) presented a curriculum guide for both junior and senior secondary mathematics learning content. It showed that there are three main strands for both junior and senior secondary mathematics curriculum, which are "number and algebra strand", "measure, shape and space strand" and "data handling strand". There are also two extended parts for senior mathematics: Module 1 Calculus and Statistics and Module 2 Algebra and Calculus. A teacher should have comprehensive content knowledge about these five strands and modules. Therefore, Hong Kong pre-service teachers' perceptions about their readiness for MCK are important to be explored.

2.3 Mathematics Knowledge for Teaching (MKT)

Rosas (2011) illustrated that mathematics content knowledge would represent the general aptitude of a teacher, but mathematics knowledge for Teaching would represent the understanding for teaching mathematics of a teacher. Ball et al. (2008) conducted a conceptual framework for MKT. This framework would include two domains, which are Subject Matter Knowledge and Pedagogical Content Knowledge. Each domain would also comprise three subdomains. The first subdomain for the Subject Matter Knowledge is Common Content Knowledge (CCK), which means the mathematics knowledge and skill applied in the question or setting rather than teaching. For example, teachers would understand the material they teach, and they can realize the students' wrong answers. The second subdomain is Specialized Content Knowledge (SCK), a unique mathematics skill and knowledge for teaching. A teacher would understand decompressed mathematics knowledge that might be taught to students to develop a comprehensive understanding of mathematics for them. For instance, they would understand the meaning of dividing a fraction. The third one is Horizon Content Knowledge (HCK) which is the awareness of the relationship and connection in the span of mathematics topics within the curriculum. Then, the first subdomain of the pedagogical content knowledge is Knowledge of Content and Student (KCS), which is the knowledge that integrate the understanding about students and the understanding in mathematics. Teacher would predict students' thinking and the confusion that may be occurred on students. Knowledge of Content and Teaching (KCT) would be the second subdomain that integrates the understanding of teaching and the

understanding of mathematics. Mathematics knowledge is required when the teacher designs the instruction. They would chunk and sequence the content into instruction and choose appropriate teaching strategies and examples in different learning stages. Finally, Knowledge of Content and Curriculum (KCC) would be indicated when teachers design a range of programs with different teaching material for teaching a specific topic and design some available contradictions for teaching the topic. For example, teachers would know which teaching materials are appropriate for teaching and learning a topic and its effectiveness.

Rosas (2011) explained that pre-service teachers' education training should provide different courses that strengthen their mathematics concepts and knowledge for teaching. Teaching coursework and practicum would be the typical methods that required pre-service teachers to accomplish while they are studying in the training program. These methods would enhance their confidence in writing lesson plans, transferring their belief of learning mathematics from rote to exploring, addressing their importance of being a mathematics teacher, and applying problem-solving skills and processes. The study from Tatto et al. (2012) indicated that the range of the lowest mean of the course hours for mathematics pedagogy in lower secondary groups was from 52 in the US to 163 in Switzerland. Only in Norway conducted more than 300 hours. Only Botswana and the Russian Federation had more than 200 hours of training for the lower and upper secondary group. Most other counties had only about 100 to 138 hours. The study also indicated that the pre-service lower secondary teacher would have some concepts of the

lower-secondary curriculum and lesson planning ability. They could also have a correct evaluation for students' mathematics work in some situations by analyzing students' errors in single or short steps. However, if the mathematical problem is more complex, they may not handle it.

Rosas (2011) conducted a quantitative study exploring Ohio's pre-service teachers' perceptions of readiness to teach mathematical concepts and their preparation for integrating mathematics topics and their instruction. There are ten questions in the survey that participants would rate from 1 to 5 for their readiness in teaching mathematics. It showed that they had adequate preparation to teach, which was level 3 of readiness. Teaching mathematical representation, such as tables and graphs, and using manipulative mathematics are the two items with the highest scores of readiness, which are 3.5 marks. However, teaching connection among mathematical concepts and using exploring learning in mathematics are the lowest two items, with 3.05 and 3.19 marks representatively.

Hine and Thai (2019) also conducted a study investigating an Australia university pre-service mathematics teachers' readiness to teach secondary mathematics in terms of their MCK and MKT. The result indicated that most of them feel confident in their CCK, such that they feel prepared to teach lower secondary school mathematics. However, only 3 and 0 out of 14 participants felt they have SCK and HCK respectively. Additional training was also needed,

especially in HCK and SCK, such that they would feel more confident to teach upper secondary mathematics. There was only 1 participant need none of the further training. For the MKT, the majority of participants felt prepared, especially about their KCS, but only 1 and 0 of 14 participants felt prepared in their KCT and KCC respectively. Therefore, all participants explained that further training in KCC and KCT was required. At the same time, 0 of them need none of the training in MKT. The situation in Hong Kong is also essential to be explored.

2.4 General Pedagogical Knowledge

The study from Tatto et al. (2012) showed that Botswana, the Philippines, Poland, and Singapore were the countries that allocated less than 100 hours for general pedagogy courses in the lower secondary program, and only Chile allocated more than 700. For lower and upper secondary programs, most countries provided more than 100 hours. Only Botswana, Poland, and Singapore provided less than 100 hours. Besides, two kinds of field experience would be provided from different countries, which are the extended teaching practice and introductory field experience. The first one aims students to take responsibility for teaching classes in serval weeks. The second one aims for students to explore the work of education in a short term by observing the school's organization, learning, and assisting teachers' work.

Roble and Bacabac (2016) conducted qualitative and quantitative research about exploring the Philippines' pre-service mathematics teachers' proficiency and preparedness. Besides their

subject matter knowledge, their general pedagogical knowledge would also be examined, including their lesson planning, classroom management, instructional strategies and motivation, communication skill, and questioning skill. They would have both in-campus and off-campus practicum and have class observations from the cooperating teachers to measure their proficiency and preparedness with the consideration of class size, attitude, and learning environment. Although the result showed that pre-service teachers' subject matte knowledge was proficient, their pedagogical knowledge was approaching the proficiency level. It means that their teaching skills were not developed sufficiently. The report also claimed that the university training was adequate, but not sufficient, such that an intensive professional development training program was required for them. Therefore, pre-service teachers' readiness in terms of general pedagogical knowledge would be investigated in this project.

2.5 Summary and Differences of the concepts

Table 1: Summary and Differences of the concepts

Domain	Sub-domain		Definition	Example
Mathematics Content Knowledge (MCK)			A comprehensive understanding of Mathematics with breadth, depth, connectedness, and thoroughness. It is the capability of numeracy, quantitative literacy, computational fluency, and mathematical literacy.	Having a thorough understanding of the Measures, Shape, and Space Strand
Mathematics Knowledge for Teaching (MKT)	Subject Matter Knowledge	Common Content Knowledge (CCK)	The mathematics knowledge and skill that applied in the question or setting rather than teaching.	Knowing **how to find** the slope of a straight line by using the formula of $\frac{\Delta y}{\Delta x}$
		Specialized Content Knowledge (SCK)	The knowledge of knowing the underlying concepts which are connected to the method / technique.	Knowing how to find the slope of a straight line **connects to** the concept of $\frac{vertical\ change}{horizontal\ change}$ or $tan.$
		Horizon Content Knowledge (HCK)	The awareness of the relationship and connection in the span of mathematics topics within the curriculum.	Knowing the formula of $\frac{\Delta y}{\Delta x}$ **is related to** find the equation of a straight line.

	Pedagogical Content Knowledge	Knowledge of Content and Student (KCS)	The knowledge integrates the understanding about students and the understanding in mathematics.	**Knowing** that when finding a slope, **students may make a mistake** of $\frac{\Delta x}{\Delta y}$
		Knowledge of Content and Teaching (KCT)	The knowledge integrates the understanding of teaching and the understanding of mathematics.	Knowing which **teaching strategies** would be used such that students can understand and remember the formula of $\frac{\Delta y}{\Delta x}$ for solving a slope.
		Knowledge of Content and Curriculum (KCC)	The knowledge that design a range of programs with different teaching material for teaching a specific topic	Knowing what **teaching materials** are suitable for teaching and learning the topic of the slope and their effectiveness.
General Pedagogical Knowledge (GPK)			The knowledge and skill of how to teach generally without referring to a particular subject area.	Lesson planning, classroom management, instructional strategies and motivation, communication skill, and questioning skill.

2.6 Further Research in Readiness

Hine (2015) did a qualitative research project about investigating Australian pre-service secondary mathematics teachers' self-perception who was studying for a Graduate Diploma of Secondary Education, about their readiness to begin the position of secondary mathematics teacher. A single with 10 items of the qualitative instrument was used timely and repeatedly in the research. Two questionnaires were also completed by 10 participants, which were used before and after their teaching internship practicum in order to compare their perception changes. As a result, there were different degrees of readiness from the participants for teaching secondary mathematics. Although all of the 10 participants explained that they were prepared in their mathematics content knowledge before and after they had practicum, only three showed that they were ready to teach lower school, upper school, or even specialist gaps. Three important findings were suggested by the responses from participants. Firstly, further training in the mathematics content, especially focusing on upper school content was needed. 4 participants explained that they needed additional training on upper school content and specialist content after the practicum. There were only 4 of them who did not require any additional training on their mathematics content knowledge. Secondly, further mathematical pedagogy training was required. There were 5 of 10 participants who required this kind of training. Only 4 of them did not need any training. Thirdly, the practicum experience would help pre-service teachers confirm their perception of readiness for teaching in the future.

In Hong Kong, Leung (1996) investigated the attitude of pre-service primary teachers towards mathematics teaching. There were 141 year-2 students of the three-year Certificate in Education (Primary) Course of The Hong Kong Institute of Education who participated in the research. The research showed that participants would think mathematics is the one they worry about most in teaching, which contained 4.77 out of 8 marks. They would also not sure what they need to do during teaching mathematics, which contained 4.54 marks. Mathematics teaching strategies and techniques would be the factor that most influence their confidence to teach mathematics, which contained 3.39 out of 5 marks. Principles and theories of mathematics teaching would hold 3.07 out of 5 marks. Therefore, the readiness of pre-service secondary mathematics teachers would be investigated in this project.

3. Methodology

3.1 Context

At the Education University of Hong Kong pre-service secondary mathematics teachers need to complete a five-year full-time bachelor program, which is called Bachelor of Education (Honors) (Secondary) in Mathematics (A5B078). They need to complete at least 39 credit points for mathematics major course, 30 credits for education studies which include both generic studies and pedagogy for mathematics. Moreover, students are required to complete 20 credits for field experience, which is about two teaching practicums in two different secondary schools with about 8 weeks for each. The remaining domain would be about other general

education, final year project, electives or second major, and language enhancement.

3.2 Methods

This study was used both quantitative and qualitative research methods to collect and analyze data.

For the quantitative method, by considering the individual health under the situation of COVID-19, online questionnaires were conducted to collect the data about their perceptions on the efficacy of the education program in EduHK in terms of MCK, MKT, and General Pedagogical Knowledge. The data about their readiness for future teaching in terms of the previous three items would also be collected. The survey participants were the year 5 students who are studying the secondary mathematics education program A5B078. The questionnaire was designed with two parts for the two research questions. Each part would include their self-evaluation on MCK, MKT, and General Pedagogical Knowledge. MCK would involve five strands in the secondary mathematics curriculum. MKT would be about Subject Matter Knowledge and Pedagogical Content Knowledge. Finally, some examples would be included in the general pedagogical knowledge part, such as lesson planning, classroom management, instructional strategies and motivation, communication skill, and questioning skills. The participants rated from 1 to 5 for each item in order to analyze their perceptions. The questionnaire is included in Appendix A.

For the qualitative method, two online interviews were conducted by using an online meeting software, ZOOM for deeply analyzing pre-service teachers' perception on the efficacy of the education program and their readiness of future teaching. After collecting the questionnaires, two interviewees were chosen from those participants in order to discuss the result from their questionnaires. The interview questions are included in Appendix B. The interview questions were taken reference from the research of Hine and Thai (2019).

4. Survey Findings

4.1 Participants

The entire year 5 student population studied in A5B078 was invited to participate in the research. More than half of these program students (20/37) gave informed consent to participate and finished the online survey. From the 20 participants, both numbers of males and females were 10. The participants' gender is displayed in Table 2.

Table 2: Project participants

	Total
Male	10
Female	10
Total	20

4.2 General Information of Participants

4.2.1 Extended Mathematics Curriculum

Considering whether participants took any extended mathematics curriculum in secondary school, most of them with 45% took M2 in DSE, the second high with 30% of them took M1. Only 15% of them did not take any extended curriculum. The remaining 2 of the participants came from Mainland China, such that they did not have the same learning experiences as other participants. The result is shown in Table 3.

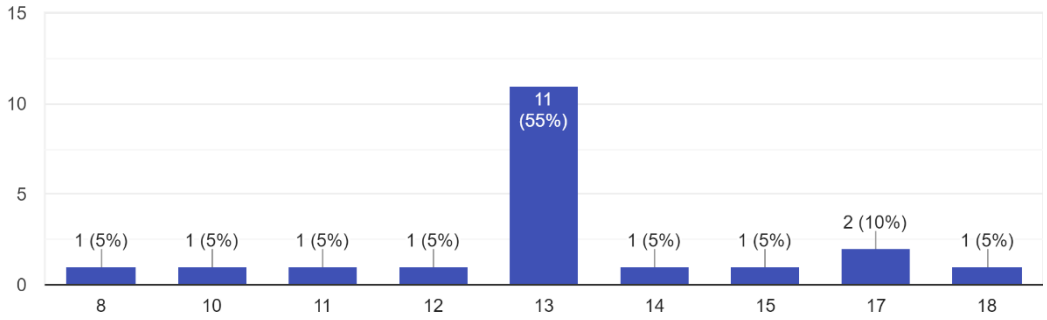
Table 3: Result of taking any extended mathematics curriculum in secondary school

	Percentage (Number)
M2	45% (9)
M1	30% (6)
No extended mathematics curriculum	15% (3)
From Mainland China	10% (2)
Total	100% (20)

4.2.2 Number of Mathematics Courses

For the number of mathematics courses that participants have studied at the undergraduate levels, they took at least 8 courses and at most 18 courses, but there is only one participant for each of them. Most of the participants with 11 of 20, took 13 mathematics courses at the undergraduate levels. The mean number of courses is 13.25. Figure 1 shows the number of courses that participants have studied.

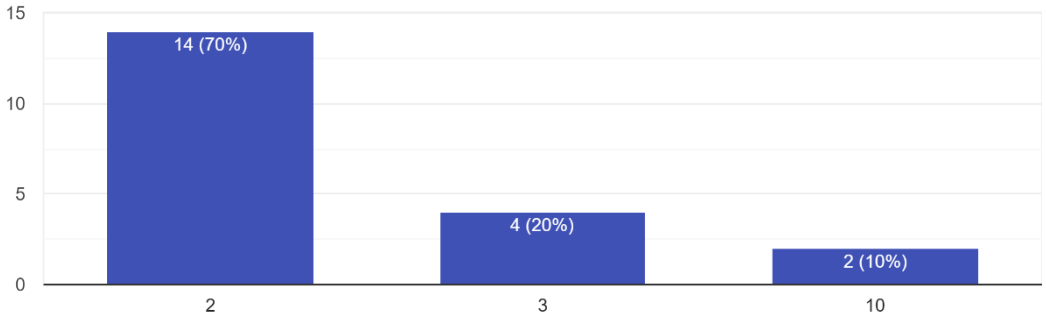
Figure 1: The number of mathematics courses that participants have studied



4.2.3 Number of Mathematics Education Methods Courses

For the number of mathematics education methods courses that participants have studied at the undergraduate levels, they studied at least 2 and at most 10. Most of them with 14 participants studied 2 mathematics education courses. The mean number of courses is 3. The numbers of mathematics education courses are demonstrated in Figure 2.

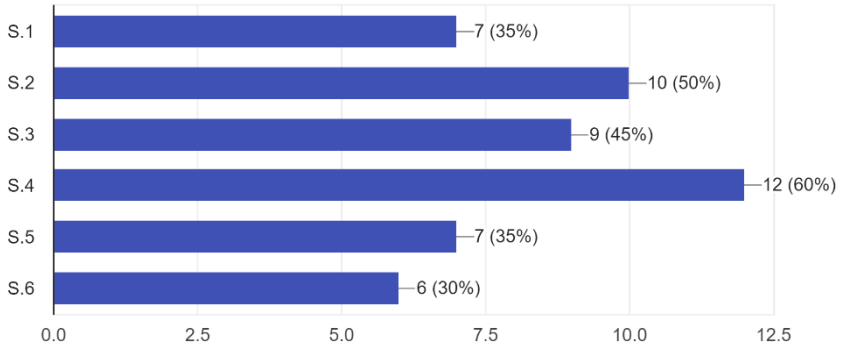
Figure 2: The number of mathematics education courses that participants have studied



4.2.4 Teaching Practicum

The grades that the participants have taught in their teaching practicum were also investigated. Figure 3 shows the overall result. For the junior form, most of the participants with 50% taught F.2 students, F.1 is the form that the least participants have taught, it had 35%. For senior form, participants have more opportunity to teach F.4 students, with about 60%. Only 30% of them have taught F.6 students.

Figure 3: The grades that the participants have taught in their teaching practicum



4.2.5 Past Secondary School Mathematics and University Mathematics Courses Result

The result shows that most of the participants got HKAL: C / HKDSE: 5 / IB: 5 in the past secondary school mathematics, which are about 45%. Only 1 participant got HKAL: A / HKDSE: 5** / IB: 7. While most of the participants had an overall major GPA of 2.70 – 3.39 in university mathematics courses. Only 1 participant got 3.70 – 4.00, and 1 participant had 2.40 – 2.69 for the GPA. Figure 4 and 5 indicate the overall participants' performance in secondary and university mathematics.

Figure 4: Overall participants' performance in secondary mathematics

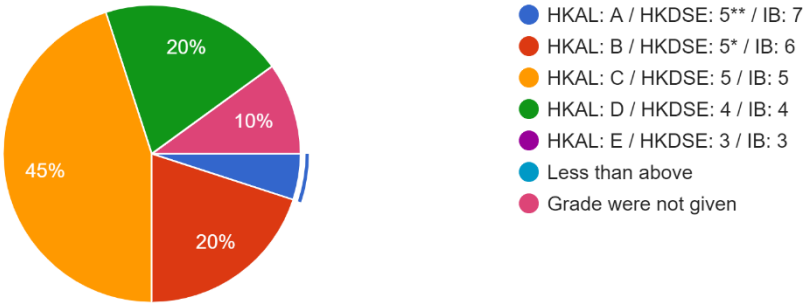
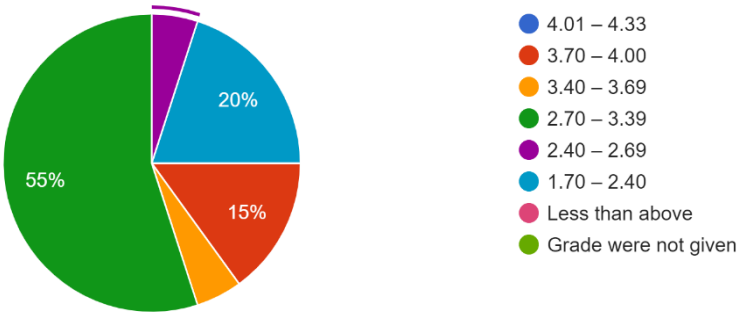


Figure 5: Overall participants' performance in university mathematics



4.3 Efficacy of the education program (After the training in EduHK)

4.3.1 Mathematics Content Knowledge (MCK)

4.3.1.1 For number and algebra strand (Junior Secondary Mathematics Curriculum)

All 20 participants demonstrated the extent to which area of the number and algebra strand in Junior Secondary Mathematics Curriculum they felt a deeper and broader understanding after the training in EduHK. 14 areas were provided for participants to rate from 1 – 5, which 1 represents "Strongly Disagree", and 5 represents "Strongly Agree". Generally, participants agreed the most that they have a deeper and broader understanding in "Linear equations in two unknowns" and "Algebraic expression", and both with the mean of 4.2. "Approximate value and numerical estimation" was the area that they agree the least (mean = 3.65). The mean score

for each area showed the extent of agreement about having a deeper understanding (3.65 < mean < 4.20). Overall, participants felt neutral to agree about having a better understanding of the topics in this strand and their connections (mean = 3.85). Participants also had a similar feeling about applying the knowledge of these topics in teaching in the future (mean = 3.70). All data are shown in Table 4.

Table 4: Evaluation on the efficacy of the program on MCK about Junior number and algebra strand (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Basic computation	3	0	1	8	8	20	3.90	1.34
Directed numbers	3	0	1	5	11	20	4.05	1.40
Approximate value and numerical estimation	3	0	4	7	6	20	3.65	1.31
Rational and irrational numbers	3	0	3	6	8	20	3.80	1.36
Using percentages	2	0	4	5	9	20	3.95	1.24
Rates, ratios, and proportions	2	0	3	7	8	20	3.95	1.20
Algebraic expressions	1	1	1	7	10	20	4.20	1.08
Linear equations in one unknown	1	1	2	6	10	20	4.15	1.11
Linear equations in two unknowns	1	1	2	5	11	20	4.20	1.12
Laws of integral indices	2	1	1	7	9	20	4.00	1.26
Polynomials	2	2	1	7	8	20	3.85	1.31
Identities	2	2	0	6	10	20	4.00	1.34
Formulae	2	1	2	6	9	20	3.95	1.28
Linear inequalities in one unknown	1	2	2	5	10	20	4.05	1.20
I have better understanding of the above topics and their connections.	1	2	2	9	6	20	3.85	1.11
I am able to apply the knowledge of the above topics in teaching in the future.	2	0	4	10	4	20	3.70	1.10

4.3.1.2 For measure, shape, and space strand (Junior Secondary Mathematics Curriculum)

All 20 participants indicated the extent to which area of Junior measure, shape, and space strand they had a broader understanding after the five-year program. 13 topics were provided for participants to rate in the same standard. "Pythagoras' theorem" was the topic that they agreed the most (mean = 4.30), and "Errors in measurement" had the lowest agreement score (mean = 3.40). Generally, participants almost agreed that they had a better understanding of these topics and their connections (mean = 3.95). They also almost agreed that they could apply the knowledge of the above topics in teaching in the future (mean = 3.85). All data are displayed in Table 5.

Table 5: Evaluation on the efficacy of the program on MCK about Junior measure, shape, and space strand (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Errors in measurement	3	1	6	5	5	20	3.40	1.32
Arc lengths and areas of sectors	1	1	6	7	5	20	3.70	1.05
3-D figures	0	1	7	7	5	20	3.80	0.87
Mensuration	2	0	5	7	6	20	3.75	1.18
Angles and parallel lines	2	0	3	8	7	20	3.90	1.18
Polygons	1	0	3	9	7	20	4.05	0.97
Congruent triangles	1	0	5	6	8	20	4.00	1.05
Similar triangles	1	0	5	6	8	20	4.00	1.05
Quadrilaterals	1	1	3	8	7	20	3.95	1.07
Centres of triangles	2	3	4	6	5	20	3.45	1.28
Pythagoras' theorem	1	0	2	6	11	20	4.30	1.00
Rectangular coordinate system	2	1	2	6	9	20	3.95	1.28
Trigonometry	2	0	5	8	5	20	3.70	1.14
I have better understanding of the above topics and their connections.	0	2	2	11	5	20	3.95	0.86
I am able to apply the knowledge of the above topics in teaching in the future.	1	0	3	13	3	20	3.85	0.85

4.3.1.3 For data handling strand (Junior Secondary Mathematics Curriculum)

All 20 participants showed the degree of which area of Junior data handling strand they had a deeper understanding after the training. Participants need to rate for 4 topics in the same method. Participants felt they had a deeper understanding in "Organization of data" compared with other topics (mean = 3.75). "Measures of central tendency" had the least mean scores (mean = 3.65). Basically, the mean scores of these topics were within 3.65 to 3.75. For the item "I have a better understanding of the above topics and their connections" and "I am able to apply the knowledge of the above topics in teaching in the future", they both had identical mean scores of 3.75. Table 6 would demonstrate these data.

Table 6: Evaluation on the efficacy of the program on MCK about Junior data handling strand (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Organization of data	1	1	5	8	5	20	3.75	1.04
Presentation of data	2	0	4	10	4	20	3.70	1.10
Measures of central tendency	3	0	4	7	6	20	3.65	1.31
Probability	1	2	4	8	5	20	3.70	1.10
I have better understanding of the above topics and their connections.	1	2	2	11	4	20	3.75	1.04
I am able to apply the knowledge of the above topics in teaching in the future.	1	2	2	11	4	20	3.75	1.04

4.3.1.4 For number and algebra strand (Senior Secondary Mathematics Curriculum)

All participants also rated for whether they had a broader understanding of senior number and algebra strand after they had almost completed the 5-year training. There were 9 topics of these

strands that were provided for the participants. These topics' mean scores were between 3.15 to 3.95, representing the level from neutral to agree. “Quadratic equation in one unknown” was the topics that they felt having a deeper comprehension the most (mean = 3.95), and “Exponential and logarithmic function” was the topics with the lowest mean value (mean = 3.15). For the overall strand, participants indicated that 3.6 mean scores in having a better understanding of the topics and their connection and 3.7 mean scores for being able to apply the knowledge of these topics in their future teaching. Table 7 would demonstrate the data for this strand.

Table 7: Evaluation on the efficacy of the program on MCK about Senior number and algebra strand (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Quadratic equations in one unknown	1	1	4	6	8	20	3.95	1.12
Functions and graphs	1	1	4	10	4	20	3.75	0.99
Exponential and logarithmic functions	2	2	9	5	2	20	3.15	1.06
More about polynomials	2	1	4	5	8	20	3.80	1.29
More about equations	2	1	3	7	7	20	3.80	1.25
Variations	2	0	6	4	8	20	3.80	1.25
Arithmetic and geometric sequences	2	2	4	9	3	20	3.45	1.16
Inequalities and linear programming	2	0	2	11	5	20	3.85	1.11
More about graphs of functions	2	1	4	10	3	20	3.55	1.12
I have better understanding of the above topics and their connections.	1	1	3	14	1	20	3.65	0.85
I am able to apply the knowledge of the above topics in teaching in the future.	1	1	3	13	2	20	3.70	0.90

4.3.1.5 For measure, shape, and space strand (Senior Secondary Mathematics Curriculum)

All 20 participants expressed their self-evaluation on the program's efficacy on MCK about Senior measure, shape, and space strand with 5 topics. They also rated from 1 to 5 scores. The topic with the maximum mean rating scores is “Equations of straight line” with mean = 4.20. The topic with the minimum mean scores is “Loci” with a mean = 3.40. Thus, the range of the mean rating scores for the topics in this strand was from 3.40 to 4.20. The whole senior measure, shape and space strand, they indicated a mean 3.55 scores for their understanding and better connection. 3.6 scores were shown as their agreement for applying this strand's knowledge in teaching in the future. Table 8 would show the detail of the data.

Table 8: Evaluation on the efficacy of the program on MCK about Senior measure, shape, and space strand (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Basic properties of circles	0	2	4	9	5	20	3.85	0.91
Equations of straight lines	0	1	2	9	8	20	4.20	0.81
Equations of circles	2	0	4	9	5	20	3.75	1.13
Loci	2	2	4	10	2	20	3.40	1.11
More about trigonometry	2	0	5	12	1	20	3.50	0.97
I have better understanding of the above topics and their connections.	1	3	2	12	2	20	3.55	1.02
I am able to apply the knowledge of the above topics in teaching in the future.	1	1	4	13	1	20	3.60	0.86

4.3.1.6 For data handling strand (Senior Secondary Mathematics Curriculum)

20 participants then rated for the topics in the senior data handling strand, which included 4

topics. The mean scores for these 4 topics were within the range from 3.65 to 4.05, which "Measure of dispersion" had the lowest mean (3.65) and "More about probability" had the largest mean (4.05) in this strand. For "I have a better understanding of the above topics and their connections", they rated in the mean of 3.65. For "I am able to apply the knowledge of above topics in teaching in the future", the mean scores were 3.50. The detailed data is shown in Table 9.

Table 9: Evaluation on the efficacy of the program on MCK about Senior data handling strand (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Permutations and combinations	1	0	4	8	7	20	4.00	1.00
More about probability	0	0	4	11	5	20	4.05	0.67
Measures of dispersion	2	1	4	8	5	20	3.65	1.19
Uses and abuses of statistics	2	0	5	7	6	20	3.75	1.18
I have better understanding of the above topics and their connections.	1	1	6	8	4	20	3.65	1.01
I am able to apply the knowledge of the above topics in teaching in the future.	2	1	4	11	2	20	3.50	1.07

4.3.1.7 For Module 1 Calculus and Statistics

After the compulsory curriculum, the extended curriculum was also be rated by all participants. 20 participants indicated the extent to which topics in Module 1 Calculus and Statistics they felt broader understanding after the university training. "Conditional probability and Bayes' Theorem "and "Normal distribution" were the topic that they agreed on the most (mean = 3.55). "Approximation of definite integrals using the trapezoidal rule" was the topic that they agreed

on the least (mean = 3.00). For the whole Module 1, there were about 3.40 mean scores for having a better understanding of the above topics and their connections and 3.20 mean scores for being able to apply the knowledge of the above topics in teaching in the future. Table 10 demonstrates the data about Module 1.

Table 10: Evaluation on the efficacy of the program on MCK about Module 1 Calculus and Statistics (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Binomial expansion	1	3	6	5	5	20	3.50	1.16
Exponential and logarithmic functions	1	2	8	6	3	20	3.40	1.02
Differentiation of a function	1	3	5	9	2	20	3.40	1.02
Indefinite integration	1	3	5	9	2	20	3.40	1.02
Definite integration	1	4	6	7	2	20	3.25	1.04
Approximation of definite integrals using the trapezoidal rule	3	3	7	5	2	20	3.00	1.18
Conditional probability and Bayes' Theorem [P(A|B)]	1	2	6	7	4	20	3.55	1.07
Probability distribution, expectation, and variance	2	1	7	6	4	20	3.45	1.16
The binomial distribution	3	0	5	8	4	20	3.50	1.24
The Poisson distribution	3	0	5	9	3	20	3.45	1.20
The normal distribution	2	1	4	10	3	20	3.55	1.12
Standardization of a normal variable and use of the standard normal table	3	0	5	8	4	20	3.50	1.24
Sampling distribution and point estimates	3	0	7	7	3	20	3.35	1.19
Confidence interval for a population mean	3	1	5	8	3	20	3.35	1.24
I have better understanding of the above topics and their connections.	2	2	5	8	3	20	3.40	1.16
I am able to apply the knowledge of the above topics in teaching in the future.	4	1	5	7	3	20	3.20	1.33

4.3.1.8 For Module 2 Algebra and Calculus

All participants also showed their self-evaluation on the program's efficacy on MCK about Module 2 Algebra and Calculus. They rated for 13 topics that were included in the module. The mean scores for the topics were between 3.00 and 3.50, which "Trigonometric functions" had the lowest scores (3.00) and "Matrices" had the highest scores (3.50). For the whole module, participants felt almost neutral about having a better understanding of the topics in this module and their connections (mean = 3.05). Participants also felt disagree to neutral about being able to apply the knowledge of these topics in teaching in the future (mean = 2.85). All data are shown in Table 11.

Table 11: Evaluation on the efficacy of the program on MCK about Module 2 Algebra and Calculus (1 = Strongly Disagree, 5 = Strongly Agree)

Topic	1	2	3	4	5	Total	Mean	S.D.
Mathematical induction	2	1	7	6	4	20	3.45	1.16
The binomial theorem	3	2	2	9	4	20	3.45	1.32
Trigonometric functions	3	3	6	7	1	20	3.00	1.14
Introduction to e	2	4	5	6	3	20	3.20	1.21
Limits	2	2	7	7	2	20	3.25	1.09
Differentiation	2	2	4	10	2	20	3.40	1.11
Indefinite integration	2	2	8	6	2	20	3.20	1.08
Definite integration	2	3	7	6	2	20	3.15	1.11
Determinants	2	3	5	8	2	20	3.25	1.13
Matrices	1	2	6	8	3	20	3.50	1.02
Systems of linear equations	3	1	5	8	3	20	3.35	1.24
Introduction to vectors	2	2	7	5	4	20	3.35	1.19
Scalar product and vector product	2	2	9	4	3	20	3.20	1.12
I have better understanding of the above topics and their connections.	2	3	9	4	2	20	3.05	1.07
I am able to apply the knowledge of the above topics in teaching in the future.	2	5	9	2	2	20	2.85	1.06

4.3.2 Mathematics Knowledge for Teaching

For Subject Matter Knowledge

4.3.2.1 Common Content Knowledge (CCK)

After participants demonstrated their view on their Mathematics Content Knowledge, they also showed their self-evaluation about the efficacy of the education program on their Mathematics Knowledge for Teaching after they had trained in EduHK. Subject Matter Knowledge was the domain that they focused first. They also showed their view on Common Content Knowledge (CCK) as the first subdomain. There were two main questions in this session, whether they felt they had learnt new Common Content Knowledge and improved in CCK. Participants would rate 8 strands and modules for each of the questions from 1 to 5, which 1 represents "Strongly Disagree" and 5 illustrates "Strongly Agree". Table 12 displays the whole data for this session. For learning new CCK, the mean scores of all strands and modules were all higher than 3 but lower than 4. The highest mean score was 3.85, which was in junior measure, shape, and space strand. The lowest mean score was 3.15, which was in module 2 Algebra and Calculus. For having improvement in CCK, all mean scores were also within a similar range ($3.30 < \text{mean} < 3.85$). Junior number and algebra strand and junior measure, shape, and space strand were the two strands that had the highest mean rating (mean = 3.85). Module 2 Algebra and Calculus also had the lowest mean rating in this question (mean = 3.30).

Table 12: Evaluation on the efficacy of the program on Common Content Knowledge (CCK) (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have learnt new Common Content Knowledge (CCK): The knowledge of **knowing the method / technique for solving a mathematics problem**								
In **number and algebra** strand of **junior** secondary mathematics curriculum	0	1	5	11	3	20	3.80	0.75
In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	0	1	5	10	4	20	3.85	0.79
In **data handling** strand of **junior** secondary mathematics curriculum	0	2	6	9	3	20	3.65	0.85
In **number and algebra** strand of **senior** secondary mathematics curriculum	0	2	3	13	2	20	3.75	0.77
In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	0	1	5	11	3	20	3.80	0.75
In **data handling** strand of **senior** secondary mathematics curriculum	0	2	5	10	3	20	3.70	0.84
In **Module 1 Calculus and Statistics**	2	3	5	8	2	20	3.25	1.13
In **Module 2 Algebra and Calculus**	2	3	6	8	1	20	3.15	1.06
I have improved in CCK.								
In **number and algebra** strand of **junior** secondary mathematics curriculum	0	2	2	13	3	20	3.85	0.79
In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	0	2	2	13	3	20	3.85	0.79
In **data handling** strand of **junior** secondary mathematics curriculum	1	1	3	12	3	20	3.75	0.94
In **number and algebra** strand of **senior** secondary mathematics curriculum	0	2	3	12	3	20	3.80	0.81
In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	0	2	3	12	3	20	3.80	0.81
In **data handling** strand of **senior** secondary mathematics curriculum	1	1	5	10	3	20	3.65	0.96
In **Module 1 Calculus and Statistics**	1	4	4	9	2	20	3.35	1.06
In **Module 2 Algebra and Calculus**	1	5	3	9	2	20	3.30	1.10

4.3.2.2 Specialized Content Knowledge (SCK)

All participants then responded about the efficacy of the education program on Specialized Content Knowledge (SCK), the second subdomain of Subject Matter Knowledge. There were also two similar questions with the previous session, which were about their views on learning new Specialized Content Knowledge and improving in SCK. For both questions, the junior number and algebra strand had the highest mean scores with 3.70 and 3.65 respectively. Module 1 Calculus and Statistics also had the lowest mean rating in these two questions with both 3.30. However, Module 2 Algebra and Calculus had the same lowest rating in the second question, "I had improved in SCK" (mean = 3.30). Table 13 indicates the data for this session.

Table 13: Evaluation on the efficacy of the program on Specialized Content Knowledge (SCK) (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have learnt new Specialized Content Knowledge (SCK): The knowledge of **knowing the underlying concepts which are connected to the method / technique**.								
In **number and algebra** strand of **junior** secondary mathematics curriculum	0	2	5	10	3	20	3.70	0.84
In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	0	4	5	8	3	20	3.50	0.97
In **data handling** strand of **junior** secondary mathematics curriculum	0	3	6	8	3	20	3.55	0.92
In **number and algebra** strand of **senior** secondary mathematics curriculum	1	1	7	8	3	20	3.55	0.97
In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	0	2	8	7	3	20	3.55	0.86
In **data handling** strand of **senior** secondary mathematics curriculum	0	3	7	6	4	20	3.55	0.97
In **Module 1 Calculus and Statistics**	2	2	6	8	2	20	3.30	1.10
In **Module 2 Algebra and Calculus**	2	3	4	8	3	20	3.35	1.19
I have improved in SCK.								
In **number and algebra** strand of **junior** secondary mathematics curriculum	0	2	6	9	3	20	3.65	0.85
In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	0	3	6	8	3	20	3.55	0.92
In **data handling** strand of **junior** secondary mathematics curriculum	1	2	6	8	3	20	3.50	1.02
In **number and algebra** strand of **senior** secondary mathematics curriculum	0	2	7	8	3	20	3.60	0.86
In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	0	3	8	6	3	20	3.45	0.92
In **data handling** strand of **senior** secondary mathematics curriculum	1	2	5	8	4	20	3.60	1.07
In **Module 1 Calculus and Statistics**	1	3	7	7	2	20	3.30	1.00
In **Module 2 Algebra and Calculus**	1	3	7	7	2	20	3.30	1.00

4.3.2.3 Horizon Content Knowledge (HCK)

Horizon Content Knowledge (HCK) was the last subdomain of Subject Matter Knowledge that all participants would evaluate. There were also two questions for asking participants whether they felt they had learnt new HCK and improved in HCK after the 5-year training. As the definition of HCK is about the awareness of the connection between the mathematics topics, the questions were not necessary to be set for specific strands and modules. For the question "I have learnt new HCK", they rated 3.45 as a mean score. For "I have improved in HCK", they rated 3.30 as the mean. The detailed data is indicated in Table 14.

Table 14: Evaluation on the efficacy of the program on Horizon Content Knowledge (HCK) (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have learnt new Horizon Content Knowledge (HCK): The **awareness of the relationship and connection in the span of mathematics topics** within the curriculum.	0	3	7	8	2	20	3.45	0.86
I have improved in HCK.	0	4	7	8	1	20	3.30	0.84

For Pedagogical Content Knowledge

4.3.2.4 Knowledge of Content and Student (KCS)

After evaluating the first domain of Mathematics Knowledge for Teaching, all 20 participants demonstrated their self-evaluation about the education program's efficacy on their Pedagogical Content Knowledge, which is the second domain of Mathematics Knowledge for Teaching. Knowledge of Content and Student (KCS) was the first subdomain that they focused on. Similarly, there were two questions in this session, which were about whether they had learnt new KCS and they had improved in KCS or not. 1 to 5 marks were also be rated for each question by representing "Strongly disagree" to "Strongly agree". Table 15 displays the data for self-evaluation on KCS. It shows that both questions had identical mean rating scores (mean = 3.65). The level was about "Neutral" to "Agree".

Table 15: Evaluation on the efficacy of the program on Knowledge of Content and Student (KCS) (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have learnt new Knowledge of Content and Student (KCS): The knowledge that integrates **the understanding about students and the understanding in mathematics.** Teacher can predict students' thinking and the confusion that may be occurred on students.	0	2	6	9	3	20	3.65	0.85
I have improved in KCS.	0	2	6	9	3	20	3.65	0.85

4.3.2.5 Knowledge of Content and Teaching (KCT)

All participants showed the extent to whether they had learnt new Knowledge of Content (KCT) and improved in KCT. The mean scores of both items were higher than 3 but lower than 4, representing they felt "neutral" to "agree". The first question contained a mean score of 3.55, while the second question obtained 3.70. The data is shown in Table 16.

Table 16: Evaluation on the efficacy of the program on Knowledge of Content and Teaching (KCT) (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have learnt new Knowledge of Content and Teaching (KCT): The knowledge of **knowing what teaching strategies can be used** for helping students to learn the concepts.	1	1	6	10	2	20	3.55	0.92
I have improved in KCT	1	1	4	11	3	20	3.70	0.95

4.3.2.6 Knowledge of Content and Curriculum (KCC)

20 participants self-evaluated the efficacy of the program on their Knowledge of Content and Curriculum (KCC). There were also two similar questions with the previous two sessions for KCS and KCT. For "I have learnt new KCC", it had 3.85 for the mean rating. For "I have improved in KCC", a mean score of 3.75 was obtained. The detail is displayed in Table 17.

Table 17: Evaluation on the efficacy of the program on Knowledge of Content and Curriculum (KCC) (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have learnt new Knowledge of Content and Curriculum (KCC): The knowledge of **knowing what teaching materials can be used** for students to learn the concepts.	1	1	2	12	4	20	3.85	0.96
I have improved in KCC	1	1	3	12	3	20	3.75	0.94

4.3.3 General Pedagogical Knowledge

After evaluating the Mathematics Knowledge for Teaching, all participants had a self-evaluation on the efficacy of the 5-year training on their General Pedagogical Knowledge. 5 skills were concerned in this session (lesson planning, classroom management, instructional and motivation strategies, communication skill, and questioning skill). Two questions were asked for each skill. The questions were about "I have learnt more about (particular skill)" and "My (particular skill) is improved". For both questions, it indicated that lesson planning was the skill that participants agreed the most, which the mean scores were 4.25 and 4.10 respectively. However, communication skill was the skill that its mean scores were the least in both questions. They were 3.90 and 3.85 respectively. The detail is shown in Table 18.

Table 18: Evaluation on the efficacy of the program on General Pedagogical Knowledge (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have learnt more about lesson planning.	0	0	2	11	7	20	4.25	0.62
My lesson planning is improved.	1	1	0	11	7	20	4.10	0.99
I have learnt more about classroom management.	2	0	0	11	7	20	4.05	1.12
My classroom management is improved.	1	1	2	10	6	20	3.95	1.02
I have learnt more about instructional strategies and motivation strategies.	0	1	3	10	6	20	4.05	0.80
My instructional strategies and motivation strategies are improved.	0	1	4	11	4	20	3.90	0.77
I have learnt more about communication skill.	0	2	3	10	5	20	3.90	0.89
My communication skill is improved.	0	3	2	10	5	20	3.85	0.96
I have learnt more about questioning skill.	1	0	2	10	7	20	4.10	0.94
My questioning skill is improved.	0	1	4	8	7	20	4.05	0.86

4.4 The readiness of future teaching (After the training in EduHK)

4.4.1 Mathematics Content Knowledge

After the self-evaluation about the education program's efficacy, all participants also evaluated their readiness for future teaching. Mathematics Content Knowledge was the first item to be considered again. In this session, all participants were asked whether they were ready to teach 6 strands and 2 modules in secondary school. They rated 1 to 5 marks for each strand, which 1 represented "Strongly Disagree" and 5 described "Strongly Agree". Except all strands of junior secondary mathematics curriculum had higher mean rating scores, two extended modules also obtain the least two mean values, which Module 1 had 3.06 and Module 2 got 3.05 only. The junior number and algebra strand and junior measure, shape, and space stand both achieved the highest mean score in this session (mean = 4.40). Table 19 would display the full data.

Table 19: Evaluation on the readiness of future teaching on participants' Mathematics Content Knowledge (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I am ready to teach								
In **number and algebra** strand of **junior** secondary mathematics curriculum	0	0	1	10	9	20	4.40	0.58
In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	0	0	1	10	9	20	4.40	0.58
In **data handling** strand of **junior** secondary mathematics curriculum	0	0	2	10	8	20	4.30	0.64
In **number and algebra** strand of **senior** secondary mathematics curriculum	0	1	1	10	8	20	4.25	0.77
In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	0	0	4	9	7	20	4.15	0.73
In **data handling** strand of **senior** secondary mathematics curriculum	0	1	6	6	7	20	3.95	0.92
In **Module 1 Calculus and Statistics**	4	2	6	5	3	20	3.05	1.32
In **Module 2 Algebra and Calculus**	4	3	7	3	3	20	2.90	1.30

4.4.2 Mathematics Knowledge for Teaching

4.4.2.1 For Subject Matter Knowledge

Mathematics Knowledge for Teaching was the second item for examining participants' readiness for future teaching. For Subject Matter Knowledge, which was the first subdomain, all 20 participants responded to three questions about whether they felt they had Common Content Knowledge (CCK), Specialized Content Knowledge (SCK), and Horizon Content Knowledge (HCK). They rated from 1 to 5, which represented " Strongly Disagree" to "Strongly Agree". They agreed the most that they had CCK in Subject Matter Knowledge (mean = 3.90). However, HCK was the knowledge that obtained the lowest mean value (mean =3.65). The data for the readiness in Subject Matter Knowledge is shown in Table 20.

Table 20: Evaluation on the readiness of future teaching on participants' Subject Matter Knowledge (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have Common Content Knowledge (CCK): The knowledge of **knowing the method / technique for solving a mathematics problem**.	0	1	3	13	3	20	3.90	0.70
I have Specialized Content Knowledge (SCK): The knowledge of **knowing the underlying concepts which are connected to the method / technique**.	0	1	5	11	3	20	3.80	0.75
I have Horizon Content Knowledge (HCK): The **awareness of the relationship and connection in the span of mathematics topics** within the curriculum.	0	1	6	12	1	20	3.65	0.65

4.4.2.1 For Pedagogical Content Knowledge

Pedagogical Content Knowledge was the second subdomain in Mathematics Knowledge for Teaching used to evaluate participants' readiness for future teaching. All participants were asked about their thought of having Knowledge of Content and Student (KCS), Knowledge of Content and Teaching (KCT), and Knowledge of Content and Curriculum (KCC). They rated from 1 to 5 again with the exact representation. The mean scores of these three knowledges were close ($3.70 < \text{mean} < 3.85$). KCC had relatively high scores (mean =3.85), while KCS had the lowest (mean = 3.70). Table 21 illustrates the detailed information in this subdomain.

Table 21: Evaluation on the readiness of future teaching on participants' Pedagogical Content Knowledge (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have Knowledge of Content and Student (KCS): The knowledge that integrate **the understanding about students and the understanding in mathematics**. Teacher can predict students' thinking and the confusion that may be occurred on students.	0	1	5	13	1	20	3.70	0.64
I have Knowledge of Content and Teaching (KCT): The knowledge of **knowing what teaching strategies can be used** for helping students to learn the concepts.	0	1	3	15	1	20	3.80	0.60
I have Knowledge of Content and Curriculum (KCC): The knowledge of **knowing what teaching materials can be used** for students to learn the concepts.	0	1	2	16	1	20	3.85	0.57

4.4.3 General Pedagogical Knowledge

General Pedagogical Knowledge was the last item for investigating participants' readiness for future teaching. Lesson planning skill, classroom management skill, instructional strategies and motivational strategies, communication skill, and questioning skill were concerned in this session. They were asked by "I have (particular skill)". Participants also rated from 1 to 5 for each skill. The range of the mean scores in this session was also small ($3.65 < \text{mean} < 3.75$. Meanwhile, communication skill had the highest mean score, and classroom management skill has the smallest. Table 22 demonstrates the data of participants' rating in these 5 skills.

Table 22: Evaluation on the readiness of future teaching on participants' General Pedagogical Knowledge (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5	Total	Mean	S.D.
I have lesson planning skill.	0	1	6	11	2	20	3.70	0.71
I have classroom management skill.	0	2	7	7	4	20	3.65	0.91
I have instructional strategies and motivation strategies.	0	3	4	9	4	20	3.70	0.95
I have communication skill.	0	3	3	10	4	20	3.75	0.94
I have questioning skill.	0	3	4	9	4	20	3.70	0.95

5. Interview Findings

5.1 Mathematics Content Knowledge (MCK)

Overall, interviewees' testimony similarly reflected the findings from the survey. The interview would be focused on evaluating the efficacy of the education program and their self-perceptions of readiness to teach secondary mathematics in terms of mathematical content knowledge (MCK), mathematical knowledge of teaching, and pedagogical content knowledge. Pseudonyms would be used for two male interviewees (David and Charlie) in this session. Both interviewees showed that most of the major mathematics courses in the education program focused more on two extended modules (M1 and M2) rather than the compulsory part. They both felt the contents were in-depth, and their MCK was enhanced but not significantly improved. They also thought that the knowledge was less applicable in their future teaching.

For instance, David stated:

> There were about 10 mathematics major courses that were related to the secondary mathematics curriculum. It would improve my understanding of each strand or module because these courses' contents were deeper and more difficult than the content I had learnt in secondary school. For example, the courses would enhance my understanding of M1 and M2 more because most of the major courses were related to these two modules. Although I did not take M1 in the past, I learnt the concepts in these courses. However, it was hard to make sure that the courses significantly enhanced my understanding because some contents were too difficult for me to understand and apply in the future.

Charlie gave some examples too:

> All of the major courses' contents were in-depth, but I was sorry that I could not find a significant connection between those contents and the contents in the secondary curriculum. However, “Geometry” was one of the courses that I felt more related to the secondary curriculum. For example, I could learn more about the proof of the angle sum of a triangle, and it would not often be 180° which depended on which type of geometry. Although most of the courses were about M1 and M2, my knowledge in these two areas was not significantly improved. As I studied neither M1 nor M2 in the past, I did not have any foundation in these areas. However, the courses' contents were based on those foundations, and then the professor would teach the underlying concepts. It was hard for me to handle and understand without that knowledge.

Interviewees also demonstrated how they felt ready to teach the junior curriculum in terms of their MCK, but they felt less confident teaching the extended modules. They also thought they need more training in terms of pedagogy instead of MCK. David mentioned that:

> I would feel more ready to teach F.1 to F.4 classes. It was because I felt more confident in the junior contents, and I had more experience in teaching these classes during my teaching practices, such that I thought I could apply what I had learnt in my future teaching. However, I did not have any experience in teaching higher form classes, and I felt I could only solve 80% of the mathematics questions correctly at this moment… actually, the

courses had provided enough content knowledge for me, but I would prefer more mathematics pedagogical courses which we had only two courses about some teaching strategies.

Charlie also shared that:

By considering the factors of preparation time and familiarization for the topics, the junior form curriculum would be my first priority in teaching. M1 and M2 would be the final ones… I thought the courses had taught adequate conceptual and logical knowledge, but I would prefer more training in the application because secondary school students were only required to apply and calculate. For example, some calculator skills could be taught, such that we could teach students how to solve the question by using the calculator.

5.2 Mathematics Knowledge for Teaching

5.2.1 For Subject Matter Knowledge

Two interviewees had different extents of their improvement in Common Content Knowledge (CCK). For instance, a higher degree of improvement was perceived from David:

My mathematics skills were improved after these 10 major courses. Although those courses were challenging for me, they trained my logical thinking and consolidated my prior concepts. My calculation ability was also improved which I had fewer computational errors. For example. I could do differentiation more accurately.

However, Charlie had less confident in improving his CCK:

> If I tried to rate a score for the impact in this area, it would be 2 out of 5. I thought there were only 2 courses that could improve my techniques for solving the questions. They were about probability and discrete mathematics. The courses helped me learn more methods to calculate probability, but other courses seemed to be not related to the secondary curriculum.

Similarly, they had different levels about the growth of their Specialized Content Knowledge (SCK), but both agreed that the underlying concepts were hard to apply in the future. David stated that he had less improvement in this area:

> I knew there were some underlying concepts connected to the methods that I used to solve a problem. For instance, I remembered that there was a course that proved the reason why the sum of the consecutive interior angles on the parallel lines was 180°, but I could not remember the detail of the proof, and I could not prove it immediately. Moreover, I thought those concepts were hard to be applied in my future teaching.

Charlie explained differently:

> Absolutely improved! For example, before entering this education program, I only knew that π was used to calculate circle parameter and area, but now I knew its definition, which was the ratio of a circle's circumference to its diameter. However, I may not be able to

apply these concepts in my future teaching as students were more required and interested in solving questions rather than understanding the secondary curriculum concepts.

For the Horizon Content Knowledge (HCK), they both felt there were some connections in the span of mathematics topics within the curriculum. However, they did not feel familiar with those relationships. For example, David stated:

> I knew there should be some connections between topics, but I could not give you some examples at this moment… and I did not know how many connections should have in the curriculum.

Charles also mentioned that:

> I felt some connections while I studied the mathematics courses… I guessed the concept of the ring in modern algebra might have some relationship with the matrix as they looked similar in their operation, but I did not know whether it was correct or not.

Two interviewees then illustrated a similar extent of readiness in teaching mathematics in terms of their Subject Matter Knowledge. They gave the same priority for the preparedness in CCK, SCK, and HCK. David shared that:

> Knowledge of knowing the techniques for solving a mathematics problem (CCK) would be the first one. Then, it would be the knowledge of knowing the underlying concept (SCK).

> The final one would be the awareness of the relationship and connection between mathematics topics (HCK). As I did not know how much connection should have, I thought this awareness needs to be accumulated after I started my teaching career.

David finally explained more training in SCK was expected:

> Although there were about 10 mathematics courses in the university, which included most of the areas of mathematics, I thought the connection between those contents and the secondary curriculum was inadequate. For example, number theory was related to algebra, but I could not find its relatedness to secondary topics. Therefore, I expected that the courses could emphasize more the connections.

5.2.1 For Pedagogical Content Knowledge

Two interviewees showed that their Knowledge of Content and Student (KCS) was significantly strengthened, especially David showed a strong agreement in this enhancement caused by the teaching practice. He mentioned:

> It definitely was strengthened, and the improvements mainly came from the teaching practice. I could find out what difficulties students would have when I observed them in the lesson. I could also figure out their common mistakes when I checked their homework. However, except the teaching practice, the other courses or programs did not seem to be the attribution of this improvement.

They perceived a significant improvement in their Knowledge of Content and Teaching (KCT) and Knowledge of Content and Curriculum (KCC). For instance, David shared his progress in KCT:

> Although there were only two mathematics pedagogy courses in the 5-year program, all growth in my teaching strategies came from these two courses. For example, I learnt the teaching strategy for teaching circle area by using the triangle area formula in one of the pedagogy courses. These strategies were beneficial that I could use in the future.

Charlie explained his growth in KCC:

> I would rate 4 out of 5 marks for the impact of my knowledge of knowing what teaching material could be used. Some websites and software for teaching mathematics were introduced and learnt in some of the university courses. For example, I learnt Geogebra and applied it in my teaching practice. This software was really useful, and I had not heard before I entered this program.

After that, interviewees demonstrated a similar extent of readiness in teaching mathematics in terms of their Pedagogical Content Knowledge again. The same priority for the preparedness in KCS, KCT, and KCC was shared. Charlie shared that:

> The first priority would be the knowledge that integrates the understanding about students

and the understanding in mathematics (KCS) because two teaching practices provided experiences for me to practice and understand students' needs in learning mathematics. The second one would be the knowledge of knowing what strategies (KCT). The final one would be the knowledge of knowing what teaching materials could be used (KCC). It was because less valuable teaching materials were mentioned or taught detailly during this 5-year program except for Geogebra.

Finally, Charlie demonstrated that more additional training in KCC was required:

I thought I need to know more teaching material that could be used in teaching mathematics. For example, the teaching material designed by EDB could also be introduced in the courses as we might have a high opportunity to use it in the future.

5.3 General Pedagogical Knowledge

Both interviewees showed that they had learnt new General Pedagogical Knowledge, such as classroom management and questioning skill, However, they thought the improvement was slight, but their lesson planning was improved significantly after two teaching practices. For instance, Charlie explained that:

Although I had learnt some classroom management skills and questioning skills in an education studies course, I thought these skills were practical and hard to be improved by the lectures. I primarily practiced and explored these skills during my teaching practice,

especially my lesson planning skill.

David also mentioned that:

> My lesson planning skill was improved most significantly because I could practice during my teaching practice. I could learn from the comments given by my mentors and supervisors after the lesson observation.

After that, two interviewees showed that their readiness for future teaching in terms of general pedagogical knowledge was not high. David shared some of his ideas:

> I did not have a high readiness for future teaching in terms of these skills, especially classroom management skills. As I mentioned before, I thought the skills that I learnt in the education studies course were conceptual for me. Moreover, I only had about one and half months for each of my teaching practice, which was too short for me, and I had less opportunity to experience teaching and interacting with students.

Finally, they both shared that more training in this general pedagogical knowledge was required. Charlie required more training in classroom management:

> I need more training in classroom management especially focused on mathematics classes. I would like to learn how to manage my class when I tried to use different teaching material or activities to teach Mathematics, such as using the tablet, Geogebra, or other technology.

David showed a higher demand for training:

> I thought additional training was required for all general pedagogical skills, except the communication skill… I would like to have more opportunities for teaching practice or observation of in-service teachers' lessons.

6. Discussion

6.1 Efficacy of the education program (After the training in EduHK)

6.1.1 Unclear evidence on the efficacy of the education program

Generally, most of the mean scores in the whole survey session of investigating the education program's efficacy were under 4 but above 3. For a detailed explanation for these scores, 3 represented "Neutral", and 4 meant "Agree".

For their Mathematics Content Knowledge, most of the participants did not agree or disagree that they had a deeper and broader understanding of different units in the junior, senior, or extended modules curriculum after receiving the training in EduHK. Only 11 out of 31 junior units had mean scores higher than 4, and 2 out of 18 senior units had mean scores higher than 4. None of the units in both extended modules were higher than 4. Moreover, all mean scores about their understanding of the topics' connection and their preparedness to apply the knowledge in the future were lower than 4. It showed that most pre-service secondary mathematics teachers did not have a strong feeling about having a better understanding of topics

in the whole secondary mathematics curriculum and their connections. They also did not have a strong belief that they could apply the knowledge of the topics in teaching in the future after the training in EduHK, especially in Module 2 Algebra and Calculus topics (mean = 2.85). Two interviews also demonstrated that participants' MCK was enhanced but not significantly improved. They also mentioned that the knowledge was less applicable in their future teaching. Therefore, there was no clear result that the training in EduHK provided a positive or negative impact on pre-service secondary mathematics teachers' Mathematics Content Knowledge.

For their Subject Matter Knowledge in Mathematics Knowledge for Teaching, when pre-service secondary mathematics teachers were asked about learning new Common Content Knowledge (CCK) and improving in CCK, none of the scores for each secondary mathematics curriculum were higher than 4. Two interviewees also had different extents of the improvement in CCK. It showed an unobvious impact of the training in EduHK on assisting them in learning and improving the method or technique for solving a mathematics problem in different mathematics areas. Simultaneously, a similar result appeared in pre-service secondary mathematics teachers' Specialized Content Knowledge (SCK). None of the scores for each aspect of the mathematics curriculum were higher than 4. Two different levels of growth in SCK were obtained in the interviews too. It demonstrated no distinct influence of the education program on aiding them to learn and improve their knowledge of knowing the underlying concepts connected to the method or technique. Finally, it also showed no evident result of the training on helping them

learn and improve their awareness of the relationship and connection in the span of mathematics topics within the curriculum. Because the mean scores of both questions were also lower than 4 and two interviewees showed that they were unfamiliar with the connection.

For their Pedagogical Content Knowledge in Mathematics Knowledge for Teaching, the scores of all the questions about considering pre-service teachers' Knowledge of Content and Student (KCS), Knowledge of Content and Teaching (KCT), and Knowledge of Content and Curriculum (KCC) were all below 4. Although two interviewees showed more significant improvement in these three areas, they required more training to learn more specific pedagogies and materials for teaching mathematics. To sum up, there was also an unobvious impact on their learning or improving their knowledge that integrate the understanding about students and the understanding in mathematics, their knowledge of knowing what teaching strategies can be used for helping students to learn the concepts, and their knowledge of knowing what teaching materials can be used for students to learn the concepts after the 5-year training.

6.1.2 Weaker efficacy of the education program on teachers' MCK in two extended modules

If the education program's efficacy on pre-service teachers' Mathematics Content Knowledge is focused, two extended modules (M1 and M2) had relatively low means scores than other compulsory parts of the mathematics curriculum. The mean score of being able to apply the knowledge of M2 topics in teaching in the future was also the lowest in this session (mean = 2.85). Interviews then illustrated that even most of the major courses were about M1 and M2, there was no significant impact on pre-service teachers' understanding in these two modules. The reasons might include the difficulties of the courses, the pre-service teachers' learning background, and the relatedness between the course contents and the secondary curriculum. Therefore, it showed that after the 5-year program and compared with the compulsory mathematics curriculum, pre-service teachers might not have a better understanding of the topics in two extended modules and their connections. They might not have the confidence to apply the knowledge of these two extended modules in their teaching in the future, especially in M2.

6.1.3 Better in CCK and Weaker in HCK

By comparing three subdomains of Subject Matter Knowledge, the mean scores about the program's efficacy on Common Content Knowledge (CCK) were relatively high than the other two subdomains. In contrast, the mean scores for Horizon Content Knowledge (HCK) were relatively low. Thus, it illustrated that the education program was more able to assist the pre-service teacher in learning and improving the knowledge of knowing the technique for solving a mathematics question. However, pre-service secondary mathematics teachers were weaker in recognizing the relationship and connection in the span of mathematics topics within the curriculum.

6.1.4 Learning new KCC and improving in KCT

By comparing three subdomains of Pedagogical Content Knowledge, the mean score about the program's efficacy on learning new Knowledge of Content and Curriculum (KCC) was higher than the other two subdomains. It meant that the program was more able to help pre-service teachers learn new knowledge about the teaching materials to assist students in learning mathematics. For instance, one interviewee also mentioned that Geogebra was a useful teaching material that he had learnt in this program. Although the mean score for learning new Knowledge of Content and Teaching (KCT) was the lowest between these three subdomains, the mean score for improving in KCT was the highest. It showed that even pre-service teachers might feel they did not learn new KCT as much as the other two knowledge. They thought they

had more improvement in knowing what teaching strategies can be used for aiding students to learn the concept. Another interviewee shared the same situation that his teaching strategies for mathematics were strengthened by studying the two mathematics pedagogy courses.

6.1.5 Noticeable positive impact on lesson planning skill

For their General Pedagogical Knowledge, there was a more evident impact from the education program than the previous knowledge. When pre-service teachers were asked by "I have learnt more about (particular skill)", all scores for the skills were higher than 4, except the instructional strategies and motivation strategies. However, when they were asked whether they had improved, all scores for the skills were lower than 4, except the lesson planning skill. Both interviewees also explained that their lesson planning skills had the most significant growth because of their teaching practice experiences and their supervisors' comments. Thus, it can only clearly show that the education program can positively influence pre-service teachers' lesson planning skills. They felt more about learning new pedagogical knowledge, but they felt less confident in their application.

6.2 The readiness of future teaching (After the training in EduHK)

6.2.1 Uncertain readiness of future teaching

Overall, most of the mean scores in the whole session of examining pre-service teachers' readiness for future teaching were below 4. The mean scores above 4 were only obtained in their readiness to teach compulsory secondary mathematics curriculum part in terms of their Mathematics Content Knowledge. As mentioned before, 3 represented "Neutral" and 4 represented "Agree". Thus, it showed that pre-service teachers did not have a strong feeling about being ready or not ready in terms of their Subject Matter Knowledge, Pedagogical Content Knowledge, and General Pedagogical Knowledge. However, they relatively feel prepared to teach compulsory secondary mathematics curriculum part in terms of their Mathematics Content Knowledge.

6.2.2 More ready to teach junior rather than two extended modules

For future teaching readiness in terms of pre-service teachers' Mathematics Content Knowledge, most of the mean scores of being ready to teach compulsory secondary mathematics curriculum were higher than 4, except the senior data handling strand. The mean scores of being prepared to teach junior mathematics curriculum were also relatively high than the senior curriculum. Meanwhile, the mean scores of being ready to teach two extended modules were the lowest between the compulsory strands and extended modules. The mean score for Module 2 was also lower than 3 (mean = 2.90). Two interviewees demonstrated junior contents were their first

priority for teaching secondary curriculum, but two extended modules were the last priority, which was considered by the preparation time, their familiarization for the topics, and their teaching experience. It showed that pre-service teachers were more ready to teach junior mathematics. However, they were less confident to teach two extended modules, especially Module 2 Algebra and Calculus, after the training in EduHK.

6.2.3 More ready in CCK and less prepared in HCK

By comparing the readiness of pre-service teachers' future teaching in terms of Subject Matter Knowledge, it had a similar result in the session about the efficacy of education programs in terms of their Subject Matter Knowledge. Common Content Knowledge had the highest mean score (mean = 3.90), and Horizon Content Knowledge had the lowest (mean = 3.65). Two interviewees gave the same order of their readiness in terms of Subject Matter Knowledge, which was also equivalent to the survey result. These results also consolidated that pre-service teachers were more ready to teach in the future because they knew the methods for solving mathematics problems, rather than the awareness of the relationship and connection in the span of mathematics topic after 5-year training.

6.2.4 Similar readiness in term of KCS, KCT and KCC

By comparing the readiness of pre-service teachers' future teaching in terms of Pedagogical Content Knowledge, all mean scores between Knowledge of Content and Student (KCS), Knowledge of Content and Teaching (KCT), and Knowledge of Content and Curriculum (KCC) did not have a large difference. KCC contained a relative high score (mean = 3.85) and KCS got a relative low rating (mean = 3.70). It can only demonstrate that pre-service teachers had a similar level of readiness in this three knowledge. If their readiness were estimated specifically by this result, they might be more ready to teach by applying different teaching materials to help students learn the mathematics concepts. However, they may not have as much confidence to teach as they did not have a high understanding of their students' thinking and confusion in learning mathematics. However, the results in the interviews were different from the results in the survey. Two interviewees shared that they had the most confidence in understanding students' thinking as they learnt from the teaching practice. Still, they were less ready to teach by using suitable teaching materials because they did not learn adequate materials for teaching mathematics. Thus, we could only conclude that pre-service teachers had similar readiness in terms of Pedagogical Content Knowledge.

6.2.5 Less ready in classroom management

For their readiness in term of their General Pedagogical Knowledge, the range of the mean scores were small. However, their readiness in terms of having classroom management skills was relatively low. The interviews also showed a similar result that their readiness in terms of classroom management was the lowest. The main reasons were that the knowledge they learnt from the courses was not practical, and they had inadequate experience in managing a class. They also required more training in classroom management, such as more observations of in-service teachers' lessons. It meant that even there was no significant difference between pre-service teachers' readiness for future teaching in terms of different general pedagogical knowledge, but they did not have much confidence in their classroom management skills after the training in EduHK.

7. Limitation

Although the sample size was about half of the targeted number of participants (20/37), the statistical power can be increased if the sample size was larger. Moreover, the small sample size may cause the discussions in this research to obtain a risk of Type II error, which was about accepting a wrong null hypothesis. Therefore, further research should be conducted in the future in order to ensure and update the pre-service secondary mathematics teachers' perceptions about the efficacy of teacher training in EduHK and their readiness for teaching in the future.

8. Conclusion

This paper investigated the self-perceptions of pre-service secondary mathematics teachers about the efficacy of teacher training in EduHK and their readiness for teaching in the future in terms of MCK, MKT, and General Pedagogical Knowledge. The literature that has already discussed this knowledge was required and trained for a mathematics teacher. Both survey and interview results showed in this research showed a similar phenomenon. The teaching training did not have a significant impact on pre-service teachers' MCK and MKT. They also had uncertain readiness for teaching in the future, especially teaching two extended modules, having weak HCK, feeling unconfident in classroom management, etc. In particular, participants demonstrated more training was required, especially about the relatedness between university contents and secondary school contents, specific pedagogies and teaching materials for teaching mathematics and classroom management skills.

9. References

1. Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of teacher education, 59*(5), 389-407.

2. Hine, G. S. (2015). Strengthening pre-service teachers' mathematical content knowledge. *Journal of University Teaching & Learning Practice*, *12*(4), 1-14.

3. Hine, G. S. (2015). Self-perceptions of pre-service mathematics teachers completing a Graduate Diploma of Secondary Education. *Issues in Educational Research*, *25*(4), 480-500.

4. Hine, G., & Thai, T. (2019). Pre-service mathematics teachers' self-perceptions of readiness to teach secondary school mathematics. *Mathematics Teacher Education and Development*, *21*(2), 64-86.

5. Leung, K. [梁景信]. (1996). Pre-service teachers' attitudes towards mathematics and mathematics education. (Thesis). University of Hong Kong, Pokfulam, Hong Kong SAR. Retrieved from http://dx.doi.org/10.5353/th_b3010651

6. Lo, W. Y., & Anderson, J. (2010). Beyond the Curriculum: The Mathematical Beliefs of Pre-Service Primary Teachers in Hong Kong. *Mathematics Education Research Group of Australasia*, 657-664.

7. Prescott, A. E., & Cavanagh, M. (2006). An investigation of pre-service secondary mathematics teachers' beliefs as they begin their teacher training. In *Conference of the Mathematics Education research Group of Australasia*. MERGA, 424-431.

8. Roble, D., & Bacabac, M. (2016). Teaching proficiency and preparedness of pre-service secondary mathematics teachers: Its implications to actual practice. *American Journal of Educational Research*, *4*(16), 1184-1190.

9. Rosas, C. E. (2011). Pre-service teachers' perception and beliefs of readiness to teach mathematics. *Current Issues in Education*, *14*(1), 1-23.

10. Tatto, M. T., Peck, R., Schwille, J., Bankov, K., Senk, S. L., Rodriguez, M., ... & Rowley, G. (2012). *Policy, Practice, and Readiness to Teach Primary and Secondary Mathematics in 17 Countries: Findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-MM)*. International Association for the Evaluation of Educational Achievement. Herengracht 487, Amsterdam, 1017 BT, The Netherlands, 1-295.

11. The Education Bureau. (2017) Supplement to Mathematics Education Key Learning Area Curriculum Guide: Learning Content of Junior Secondary Mathematics. Hong Kong: The Curriculum Development Council, 1-48.

12. The Education Bureau. (2017) Supplement to Mathematics Education Key Learning Area Curriculum Guide: Learning Content of Senior Secondary Mathematics. Hong Kong: The Curriculum Development Council, 1-82.

10. Appendix

Appendix A – Questionnaire Questions

Part 1 - Efficacy of the education program (After the training in EduHK)

Mathematics Content Knowledge

1 For number and algebra strand (Junior Secondary Mathematics Curriculum)

a. I have a deeper and broader understanding of the following area:

Strand	Unit	Rating
Number	Basic computation	1 — 2 — 3 — 4 — 5
	Directed numbers	1 — 2 — 3 — 4 — 5
	Approximate value and numerical estimation	1 — 2 — 3 — 4 — 5
	Rational and irrational numbers	1 — 2 — 3 — 4 — 5
	Using percentages	1 — 2 — 3 — 4 — 5
	Rates, ratios, and proportions	1 — 2 — 3 — 4 — 5
Algebra	Algebraic expressions	1 — 2 — 3 — 4 — 5
	Linear equations in one unknown	1 — 2 — 3 — 4 — 5
	Linear equations in two unknowns	1 — 2 — 3 — 4 — 5
	Laws of integral indices	1 — 2 — 3 — 4 — 5
	Polynomials	1 — 2 — 3 — 4 — 5
	Identities	1 — 2 — 3 — 4 — 5
	Formulae	1 — 2 — 3 — 4 — 5
	Linear inequalities in one unknown	1 — 2 — 3 — 4 — 5

b. I have a better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

2 *For measure, shape, and space strand (Junior Secondary Mathematics Curriculum)*

a. I have a deeper and broader understanding of the following area:

Strand	Unit	Rating
Measure	Errors in measurement	1 — 2 — 3 — 4 — 5
	Arc lengths and areas of sectors	1 — 2 — 3 — 4 — 5
	3-D figures	1 — 2 — 3 — 4 — 5
	Mensuration	1 — 2 — 3 — 4 — 5
	Angles and parallel lines	1 — 2 — 3 — 4 — 5
Shape	Polygons	1 — 2 — 3 — 4 — 5
	Congruent triangles	1 — 2 — 3 — 4 — 5
	Similar triangles	1 — 2 — 3 — 4 — 5
	Quadrilaterals	1 — 2 — 3 — 4 — 5
	Centres of triangles	1 — 2 — 3 — 4 — 5
	Pythagoras' theorem	1 — 2 — 3 — 4 — 5
Space	Rectangular coordinate system	1 — 2 — 3 — 4 — 5
	Trigonometry	1 — 2 — 3 — 4 — 5

b. I have better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

3 *For data handling strand (Junior Secondary Mathematics Curriculum)*

a. I have a deeper and broader understanding of the following area:

Strand	Unit	Rating
Data Handling	Organization of data	1 — 2 — 3 — 4 — 5
	Presentation of data	1 — 2 — 3 — 4 — 5
	Measures of central tendency	1 — 2 — 3 — 4 — 5
	Probability	1 — 2 — 3 — 4 — 5

b. I have better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

4 *For number and algebra strand (Senior Secondary Mathematics Curriculum)*

a. I have a deeper and broader understanding of the following area:

Strand	Unit	Rating
Number and Algebra	Quadratic equations in one unknown	1 — 2 — 3 — 4 — 5
	Functions and graphs	1 — 2 — 3 — 4 — 5
	Exponential and logarithmic functions	1 — 2 — 3 — 4 — 5
	More about polynomials	1 — 2 — 3 — 4 — 5
	More about equations	1 — 2 — 3 — 4 — 5
	Variations	1 — 2 — 3 — 4 — 5
	Arithmetic and geometric sequences	1 — 2 — 3 — 4 — 5
	Inequalities and linear programming	1 — 2 — 3 — 4 — 5
	More about graphs of functions	1 — 2 — 3 — 4 — 5

b. I have better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

5 *For measure, shape, and space strand (Senior Secondary Mathematics Curriculum)*

a. I have a deeper and broader understanding of the following area:

Strand	Unit	Rating
Measure, Shape, and Space	Basic properties of circles	1 — 2 — 3 — 4 — 5
	Equations of straight lines	1 — 2 — 3 — 4 — 5
	Equations of circles	1 — 2 — 3 — 4 — 5
	Loci	1 — 2 — 3 — 4 — 5
	More about trigonometry	1 — 2 — 3 — 4 — 5

b. I have better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

6 *For data handling strand (Senior Secondary Mathematics Curriculum)*

a. I have a deeper and broader understanding of the following area:

Strand	Unit	Rating
Data Handling	Permutations and combinations	1 — 2 — 3 — 4 — 5
	More about probability	1 — 2 — 3 — 4 — 5
	Measures of dispersion	1 — 2 — 3 — 4 — 5
	Uses and abuses of statistics	1 — 2 — 3 — 4 — 5

b. I have better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

7 *For Module 1 Calculus and Statistics*

a. I have a deeper and broader understanding of this area.

Strand	Unit	Rating
Foundation Knowledge	Binomial expansion	1 — 2 — 3 — 4 — 5
	Exponential and logarithmic functions	1 — 2 — 3 — 4 — 5
Calculus	Differentiation of a function	1 — 2 — 3 — 4 — 5
	Indefinite integration	1 — 2 — 3 — 4 — 5
	Definite integration	1 — 2 — 3 — 4 — 5
	Approximation of definite integrals using the trapezoidal rule	1 — 2 — 3 — 4 — 5
Statistics	Conditional probability and Bayes' Theorem [P(A|B)]	1 — 2 — 3 — 4 — 5
	Probability distribution, expectation, and variance	1 — 2 — 3 — 4 — 5
	The binomial distribution	1 — 2 — 3 — 4 — 5
	The Poisson distribution	1 — 2 — 3 — 4 — 5
	The normal distribution	1 — 2 — 3 — 4 — 5
	Standardization of a normal variable and use of the standard normal table	1 — 2 — 3 — 4 — 5
	Sampling distribution and point estimates	1 — 2 — 3 — 4 — 5
	Confidence interval for a population mean	1 — 2 — 3 — 4 — 5

b. I have better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

8 For Module 2 Algebra and Calculus

a. I have a deeper and broader understanding of this area.

Strand	Unit	Rating
Foundation Knowledge	Mathematical induction	1 — 2 — 3 — 4 — 5
	The binomial theorem	1 — 2 — 3 — 4 — 5
	Trigonometric functions	1 — 2 — 3 — 4 — 5
	Introduction to *e*	1 — 2 — 3 — 4 — 5
Calculus	Limits	1 — 2 — 3 — 4 — 5
	Differentiation	1 — 2 — 3 — 4 — 5
	Indefinite integration	1 — 2 — 3 — 4 — 5
	Definite integration	1 — 2 — 3 — 4 — 5
Algebra	Determinants	1 — 2 — 3 — 4 — 5
	Matrices	1 — 2 — 3 — 4 — 5
	Systems of linear equations	1 — 2 — 3 — 4 — 5
	Introduction to vectors	1 — 2 — 3 — 4 — 5
	Scalar product and vector product	1 — 2 — 3 — 4 — 5

b. I have better understanding of the above topics and their connections.

1 — 2 — 3 — 4 — 5

c. I am able to apply the knowledge of the above topics in teaching in the future.

1 — 2 — 3 — 4 — 5

Mathematics Knowledge for Teaching

1. For Subject Matter Knowledge

Question	Rating
a. I have learnt new Common Content Knowledge (CCK): The knowledge of **knowing the method / technique for solving a mathematics problem**	
i. In **number and algebra** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
ii. In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iii. In **data handling** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iv. In **number and algebra** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
v. In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vi. In **data handling strand** of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vii. In **Module 1 Calculus and Statistics**	1 — 2 — 3 — 4 — 5
viii. In **Module 2 Algebra and Calculus**	1 — 2 — 3 — 4 — 5
b. I have improved in CCK.	
i. In **number and algebra** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
ii. In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iii. In **data handling** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iv. In **number and algebra** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
v. In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vi. In **data handling strand** of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vii. In **Module 1 Calculus and Statistics**	1 — 2 — 3 — 4 — 5
viii. In **Module 2 Algebra and Calculus**	1 — 2 — 3 — 4 — 5

c. I have learnt new Specialized Content Knowledge (SCK): The knowledge of **knowing the underlying concepts which are connected to the method / technique.**	
i. In **number and algebra** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
ii. In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iii. In **data handling** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iv. In **number and algebra** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
v. In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vi. In **data handling strand** of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vii. In **Module 1 Calculus and Statistics**	1 — 2 — 3 — 4 — 5
viii. In **Module 2 Algebra and Calculus**	1 — 2 — 3 — 4 — 5
d. I have improved in SCK.	
i. In **number and algebra** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
ii. In **measure, shape, and space** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iii. In **data handling** strand of **junior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
iv. In **number and algebra** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
v. In **measure, shape, and space** strand of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vi. In **data handling strand** of **senior** secondary mathematics curriculum	1 — 2 — 3 — 4 — 5
vii. In **Module 1 Calculus and Statistics**	1 — 2 — 3 — 4 — 5
viii. In **Module 2 Algebra and Calculus**	1 — 2 — 3 — 4 — 5
e. I have learnt new Horizon Content Knowledge (HCK): The **awareness of the relationship and connection in the span of mathematics topics** within the curriculum.	1 — 2 — 3 — 4 — 5
f. I have improved in HCK.	1 — 2 — 3 — 4 — 5

2. For Pedagogical Content Knowledge

Question	Rating
a. I have learnt new Knowledge of Content and Student (KCS): The knowledge that integrate **the understanding about students and the understanding in mathematics.** Teacher can predict students' thinking and the confusion that may be occurred on students.	1 — 2 — 3 — 4 — 5
b. I have improved in KCS.	1 — 2 — 3 — 4 — 5
c. I have learnt new Knowledge of Content and Teaching (KCT): The knowledge of **knowing what teaching strategies can be used** for helping students to learn the concepts.	1 — 2 — 3 — 4 — 5
d. I have improved in KCT	1 — 2 — 3 — 4 — 5
e. I have learnt new Knowledge of Content and Curriculum (KCC): The knowledge of **knowing what teaching materials can be used** for students to learn the concepts.	1 — 2 — 3 — 4 — 5
f. I have improved in KCC	1 — 2 — 3 — 4 — 5

General Pedagogical Knowledge

Question	Rating
1. I have learnt more about lesson planning.	1 — 2 — 3 — 4 — 5
2. My lesson planning is improved.	1 — 2 — 3 — 4 — 5
3. I have learnt more about classroom management.	1 — 2 — 3 — 4 — 5
4. My classroom management is improved.	1 — 2 — 3 — 4 — 5
5. I have learnt more about instructional strategies and motivation strategies.	1 — 2 — 3 — 4 — 5
6. My instructional strategies and motivation strategies are improved.	1 — 2 — 3 — 4 — 5
7. I have learnt more about communication skill.	1 — 2 — 3 — 4 — 5
8. My communication skill is improved.	1 — 2 — 3 — 4 — 5
9. I have learnt more about questioning skill.	1 — 2 — 3 — 4 — 5
10. My questioning skill is improved.	1 — 2 — 3 — 4 — 5

Part 2 - Readiness of future teaching (After the training in EduHK)

Mathematics Content Knowledge

Question	Rating
1. I am ready to teach **number and algebra strand**. (**Junior Secondary** Mathematics Curriculum)	1 — 2 — 3 — 4 — 5
2. I am ready to teach **measure, shape, and space strand**. (**Junior Secondary** Mathematics Curriculum)	1 — 2 — 3 — 4 — 5
3. I am ready to teach **data handling strand**. (**Junior Secondary** Mathematics Curriculum)	1 — 2 — 3 — 4 — 5
4. I am ready to teach **number and algebra strand**. (**Senior Secondary** Mathematics Curriculum)	1 — 2 — 3 — 4 — 5
5. I am ready to teach **measure, shape, and space strand**. (**Senior Secondary** Mathematics Curriculum)	1 — 2 — 3 — 4 — 5
6. I am ready to teach **data handling strand**. (**Senior Secondary** Mathematics Curriculum)	1 — 2 — 3 — 4 — 5
7. I am ready to teach **Module 1 Calculus and Statistics**.	1 — 2 — 3 — 4 — 5
8. I am ready to teach **Module 2 Algebra and Calculus**.	1 — 2 — 3 — 4 — 5

Mathematics Knowledge for Teaching

For Subject Matter Knowledge

Question	Rating
1. I have Common Content Knowledge (CCK): The knowledge of **knowing the method / technique for solving a mathematics problem**.	1 — 2 — 3 — 4 — 5
2. I have Specialized Content Knowledge (SCK): The knowledge of **knowing the underlying concepts which are connected to the method / technique.**	1 — 2 — 3 — 4 — 5
3. I have Horizon Content Knowledge (HCK): The **awareness of the relationship and connection in the span of mathematics topics** within the curriculum.	1 — 2 — 3 — 4 — 5

For Pedagogical Content Knowledge

Question	Rating
1. I have Knowledge of Content and Student (KCS): The knowledge that integrate **the understanding about students and the understanding in mathematics.** Teacher can predict students' thinking and the confusion that may be occurred on students.	1 — 2 — 3 — 4 — 5
2. I have Knowledge of Content and Teaching (KCT): The knowledge of **knowing what teaching strategies can be used** for helping students to learn the concepts.	1 — 2 — 3 — 4 — 5
3. I have Knowledge of Content and Curriculum (KCC): The knowledge of **knowing what teaching materials can be used** for students to learn the concepts.	1 — 2 — 3 — 4 — 5

General Pedagogical Knowledge

Question	Rating
1. I have lesson planning skill.	1 — 2 — 3 — 4 — 5
2. I have classroom management skill.	1 — 2 — 3 — 4 — 5
3. I have instructional strategies and motivation strategies.	1 — 2 — 3 — 4 — 5
4. I have communication skill.	1 — 2 — 3 — 4 — 5
5. I have questioning skill.	1 — 2 — 3 — 4 — 5

Appendix B – Interview Questions

1. Describe the impact of the training on you in terms of your belief about teaching and learning Mathematics.
    a. About mathematics
    b. About mathematics education
2. Describe the impact of the training on you in terms of Mathematics Content Knowledge.
    a. In number and algebra strand of junior secondary mathematics curriculum
    b. In measure, shape, and space strand of junior secondary mathematics curriculum
    c. In data handling strand of junior secondary mathematics curriculum
    d. In number and algebra strand of senior secondary mathematics curriculum
    e. In measure, shape, and space strand of senior secondary mathematics curriculum
    f. In data handling strand of senior secondary mathematics curriculum
    g. In Module 1 Calculus and Statistics
    h. In Module 2 Algebra and Calculus
3. Describe your readiness to teach secondary mathematics students in terms of Mathematical Content Knowledge.
    a. In number and algebra strand of junior secondary mathematics curriculum
    b. In measure, shape, and space strand of junior secondary mathematics curriculum
    c. In data handling strand of junior secondary mathematics curriculum
    d. In number and algebra strand of senior secondary mathematics curriculum
    e. In measure, shape, and space strand of senior secondary mathematics curriculum
    f. In data handling strand of senior secondary mathematics curriculum
    g. In Module 1 Calculus and Statistics
    h. In Module 2 Algebra and Calculus
4. In what area(s) of Mathematical Content Knowledge do you feel you require further training?

5. Describe the impact of the training on you in terms of Mathematics Knowledge for Teaching.
    a. Common Content Knowledge (CCK).
    b. Specialized Content Knowledge (SCK).
    c. Horizon Content Knowledge (HCK).
    d. Knowledge of Content and Student (KCS).
    e. Knowledge of Content and Teaching (KCT).
    f. Knowledge of Content and Curriculum (KCC).
6. Describe your readiness to teach secondary mathematics students in terms of the Mathematics Knowledge for Teaching.
    a. Common Content Knowledge (CCK).
    b. Specialized Content Knowledge (SCK).
    c. Horizon Content Knowledge (HCK).
    d. Knowledge of Content and Student (KCS).
    e. Knowledge of Content and Teaching (KCT).
    f. Knowledge of Content and Curriculum (KCC).
7. In what area(s) of Mathematics Knowledge for Teaching do you feel you require further training?
8. Describe the impact of the training on you in terms of General Pedagogical Knowledge.
9. Describe your readiness to teach secondary mathematics students in terms of General Pedagogical Knowledge.
10. In what area(s) of General Pedagogical Knowledge do you feel you require further training?