香港教育大學

The Education University of Hong Kong

Honours Project entitled

Views about STEM Education:

A Study of Pre-service & In-service Primary Teacher in Hong Kong

Summitted by

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Declaration

I, Chan Hin Yau, declare that this research report represents mt work under the supervision of Dr WAN Zhi Hong and that it has not been submitted previously for examination to any tertiary institution.

Chan Hin Yau

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Abstract

This study will investigate both pre-service and in-service teachers' perception and practice towards STEM education in Hong Kong primary school to find out the challenges might be faced, and suggestions could be made. The purpose of this research is to help current and future educator to understand the macro-view of whole Hong Kong and rethink the possible and suitable methods in teaching STEM.

20 participants will be included in this study by the exponential non-discriminative snowballing sampling method. Semi-structured interview will be conducted with the participants.

Keywords: STEM/STEAM Education

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Section 1. Introduction

1.1 Research Background

In recent years, the development trend in STEM education has been emphasized in Hong Kong primary schools, especially in the subject of General Studies. In the 2015 STEM Policy Address, STEM education was first proposed to be promoted in Hong Kong Education and it was further improved shown in 2016 Policy Address (Education Bureau, 2016). Apart from nurturing learners' interest and building up solid knowledge bases in each discipline, the government aims to enhance learners' abilities on knowledges and skills integration and application across all STEM disciplines. Not only students' creativity, collaboration and problem-solving skills are nurtured, but also their innovation and entrepreneur spirit, which are required in the 21st century. Through the promotion of STEM education at schools, it is aimed to cultivate Hong Kong's versatile talents that equipped with different types of knowledge and skills, leading to the increasing local competitiveness in global perspective as learners' motivation and achievements in STEM areas is vitally important towards the economic health of a country in long term (Lennon, Moriarty & Zivkovic, 2014).

STEM education are commonly some project-based learnings which give learners chance to investigate real-world issues and challenges. STEM applications let them make planning, design and trial-and-error to figure the solution out. Besides, projects in STEM education stimulates learners to cultivate a thorough understanding of related knowledge and topics, that provides them a base to have higher quality works. What's more, it allows leaners to link the classroom learning with the daily life around them and also the surrounding world (Forrester, 2013). By integrating all disciplines under STEM education, learners have the chances to involve with the issues which can trigger their versatile abilities in solving real-life problems.

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However, the base of STEM education in Hong Kong built up does not have a long history while not all teachers are familiar with the teaching mode, even for the teachers who are responsible for STEM teaching. Different teachers have different understanding, thus leading to different practice on it. Their perception might be affected by the personal view, own value, the school policy and whether they have attended any teachers' training. That not only creates the difference between teachers, but also large range of learning outcomes for the students.

1.2 Research Objectives

Due to the uncertainties on teachers' understanding and students' outcomes towards STEM education, this study will investigate both teachers' perception and practice towards STEM education in Hong Kong primary school. It will discuss both pre-service and in-service teachers' point of view in order to find out the difference between the teachers with and without STEM training in the tertiary education, as well as the possible changes in the coming future. It analyzes the data collected from different schools' teachers with the aim to develop a better understanding toward current Hong Kong STEM education environment. The purpose of this research is to help current and future educator to understand the macro-view of whole Hong Kong and rethink the possible and suitable methods in teaching STEM.

1.3 Research Questions

1. What are their understandings of STEM learning?
2. How do they perceive the values of STEM learning?
3. How do they think about integrating cross-disciplinary STEM learning with disciplinary STEM learning?
4. What are the challenges they expected?

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5. What are the supports they required?

Section 2. Literature Review

2.1 Definition of Integrated STEM Education

STEM refers to science, technology, engineering, and mathematics respectively, four distinct fields. These disciplines are interdependence and interrelated. All of these disciplines share some similar features, which might be the reason why they are combined into STEM. Also, Sanders (2009) stated that STEM Education has to be connected with the fields of social studies, arts, and humanities. Thus, STEM education refers to multidiscipline and standard-based in school education that all teachers use integrated approach to teach and support students' learning, especially for the science, technology, engineering, and mathematics discipline related teachers. The discipline-specific content is emphasized on its dynamicity but not in separated (Merrill, 2009). From the investigation of past research, no specific definition of STEM education is widely agreed in the perspectives of theoretical and practice (Martín-Páez et al., 2019). The current consensus reached on the 'STEM' usage tends to relate to the sense of integration of the four disciplines in different methods and levels rather than treat them as independent items (Honey et al. 2014). Moreover, STEM applications are the learning which are project-based, giving students opportunities to explore problems surrounding them and deal with the challenges.

2.2 Importance, Aims and Core Values of STEM Education

STEM education provides learners chance to get planning, designing and figure the solutions out when facing problems. Learners learn complicated scientific concepts during their engagement

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in STEM experiences. What's more, they become skilled at the methods on collaborating with their partners to resolve issues and achieve the targets set (Nesbitt, 2013). By making use of technology and engineering combined with mathematics and science in STEM activities, student turns into an enthusiasm learner with more excitement and confidence towards learning as these all make school subjects become meaningful and relevant to their life. Also, activities in STEM education can boost up comprehensive understanding of the issues for the leaners and hence empower them to work in higher quality. Besides, it let students connect the classroom learning with daily life and the surrounding world, which makes them gain chances to involve with meaningful topics related to the real-life and thus trigger their ability in problem-solving (Barbato, 2013).

In macro view, literature review concluded that integrated STEM education can have the functions on: 1) keeping viability and competitiveness in the economy globally (Akgunduz, 2016), 2) increasing achievements in STEM areas (Han et al., 2014), 3) raising student motivation in learning STEM (Nugent el at., 2010), 4) increasing graduation rates and reducing dropout rates (Havice, 2013) and 5) maintaining scientific innovation (Rincon & George-Jackson, 2014). Study investigated by Han et al. (2014) found that students with low performance benefited more than high and middle performing students if project-based learning was integrated into STEM education at schools. Moreover, learners engaged in engineering disciplines under STEM outperformed in terms of conceptual knowledge, designing ability and also higher-ordered thinking skills (Fan & Yu, 2015).

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In conclusion, STEM literacy is the forms as human knowledge, inquiry skills and designing, and the attitude on how STEM cultivate our mindset and attitude on daily issues', which is the general aim of STEM education.

2.3 Development and Practice of STEM Education in Other Countries

STEM Education has been developing in different countries. From the findings of Park & Erduran (2020), it shows that there are varieties in aims, values and practices of STEM Education in the research and documents in USA, Korea and Taiwan. Yet, there is two common topics were identified among these three countries. The first one is the general underrepresentation of mathematics. Three components are rarely addressed in the analyzed document: (1) the specific goals of mathematics which are different from sciences, (2) the practices mathematics professionals regularly involve in and (3) the way practices help achieving the goals in science. Next theme is overemphasized on science-engineering intersection, that leading to the ignorance of science-specific goals, values and practices in the standards. Compared to the similarities between science and engineering, their differences were represented less evidently.

In England and Wales, design and technology has been excluded. These components are frequently marginalized and their potential not realized (Bell, 2016) in spite of the importance in supporting the development of STEM literacy effectively. As a consequence, design and technology are not viewed as having equal position of the STEM disciplines of mathematics and science (Benken and Stevenson, 2014). STEM educational planning and schools' associated funding are focused primarily on science and mathematics (Morgan, 2014). As for the teachers, they usually do not receive any formal STEM training and "self-taught" knowledge of STEM (Bell, Morrison-Love, Wooff & McLain, 2017).

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2.4 Teachers' Current Perception of STEM Education in Hong Kong Primary Schools

In the research targeted at Hong Kong teachers, it was found that almost half of the teachers are not ready for STEM education (Geng, Jong, Chai, 2019). They lack knowledge in STEM (Cavlazoglu and Stuessy, 2017; Fore et al., 2015) and not familiar with the whole processes. Teachers have multiple concerns about the STEM Reform in Hong Kong, that Information, Management, and Consequence are peak concern categories. The access of teaching resources and funding, class and instructional implementation, and teacher training development are considered as urgent needs from the teachers' concerns' perspective. This study also hinted that the current obstacles in promoting STEM education are the availability of corresponding lesson designs, the support and resources, the tasks and processes of implementing STEM education, and teachers' professional development. The data collected shows that the current perception of STEM education is in a negative way in terms of knowledge, management and resources. Teachers are the one who teach students. If teachers do not have confidence in STEM education, the quality of teaching and the learning achievement for students would definitely be lower, leading to the unsuccess of STEM education development in Hong Kong primary school.

2.5 Development and Practice of STEM Education in Hong Kong Primary Schools

Currently, STEM education is being promoted as a vitally important step on strengthening learners' innovative mindset in Hong Kong (EDB, 2016). The focal point is to improve the creativity, innovative mindset, problem-solving skills and relevant concepts of the students by their participation in STEM teaching and learning (Freeman et al. 2014). From the document, Hong Kong Education Bureau (EDB) aims at enhancing students' integrated knowledge and skills by dealing with daily life issues, designing and implementing innovative ideas. At the end, STEM education nurtures students as a lifelong learner in science and technology discipline

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(EDB, 2016) that helps students face the challenges in 21st century. In macro, STEM educations bring up talents from different skills levels and area, leading to higher global competitiveness in Hong Kong. Two curriculum designs are set in Hong Kong STEM education: 1) Science-based STEM Education 2) Cross-disciplined STEM Education. Through the document, it could be observed that EDB would like to develop STEM education mainly in the lesson of General Studies. In the process, students have to make use of the theoretic framework of Designing Cycle. In the realistic situation, Hong Kong primary school are providing opportunities for students to have the real-life problems exploration through taking parts in projects and trying to carry out interdisciplinary learning which connect with different subject disciplines as possible, but it is still in developing stage.

3. Methodology

3.1 Research Orientation

This research will be analyzed based the investigation on teacher's perception and practice towards STEM in Hong Kong. Qualitative research method will be applied in order to obtain in-depth information and opinion in the area of STEM education.

3.2 Research Method

Interview, a qualitative approach, would be adopted to have detailed exploration on the perception and practice of Hong Kong teachers in STEM education. 18 teachers, who are in-service or preservice, were invited to have an interview. The study interviews 10 pre-service teachers who study General Studies Education (see table 1) and 8 in-service General studies teachers from different local primary schools (see table 2). The goal of interviewing in-service and pre-service primary teachers was to understand the difference on personal value of STEM

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education in terms of current support from tertiary education and school and the effect from teaching experience. It is believed that the value of STEM education would be influenced by the view of the pre-service teachers in the future. The data collected used to investigate the possibility of improving the current STEM education. By understanding the concerns and needs from different stages' teachers, more data could be analyzed to solve the current problem. Their participations were voluntary with the clearly understanding of the research purpose and the data dealing. Due to the difficulty in finding teachers to be interviewed, the exponential non-discriminative snowballing sampling method was applied in this study so as to collect data to analyze and draw the conclusive result.

Table 1: Overview of the Background of 10 Pre-service Teachers Participants

Studying Year	
Year-5 student	9
Year-3 student	1
Studying Subject	
General Studies	10
Chinese	4
Mathematics	3
STEM	3
Computer	1
Visual Art	1
English	1
Counseling	1
Teaching STEM Experience	
5 Years	1
4 Years	2

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3 Years	3
2 Years	3
1 Years	1
0 Years	0

Table 2: Overview of the Background of 8 In-service Teachers Participants

Workplace Position	
General Studies Panel	3
Mathematics Panel	1
Teachers	4
Teaching Subject	
General Studies	8
Mathematics	5
Computer	2
Chinese	4
Visual Art	1
Physical Education	1
Teaching Years	
>20 Years	1
15-20 Years	1
10-15 Years	1
5-10 Years	3
<5 Years	2
Major in General Studies During Tertiary Education	
Yes	1
No	7

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3.3 Data Collection

The in-depth face-to-face interview runs around 20-30 minutes. Interview encourage the respondents to elaborate their ideas with detailed reasons, express feelings and share their experiences in Cantonese. 9 major questions are designed for the interview (See Table 3) and follow-up questions would be raised referring to the participants' responses.

Table 3: Main Interview Questions

Information Questions:	
1	How many years of STEM teaching experiences do you have?
2	How many years of General Studies teaching experiences do you have?
3	What is your workplace position at school?
Key Questions:	
1	What is STEM Education to you? How is it important towards students?
2	What are the STEM teachers' requirements?
3	What are the areas that you value most when teaching STEM in General Studies lesson? Why?
4	Are you confident in teaching STEM? Why?
5	How is STEM education implemented in your school in terms of hardware and software?
6	How do you organize activity, like cross discipline?
7	What are the challenges in teaching STEM based on your experience?
8	Do you think the support from school and government enough in STEM education? Why?
9	How can the current situation be improved?

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3.4 Limitation

Constrained by the limited sample size and sample composition, only few interviewees' data from specific schools are collected, which leads to questions on the validity and generalizability of the study. The result only represents some teachers but not the whole view from pre-service teachers and in-service teachers participating STEM Education in Hong Kong.

3.5 Data Analysis

Coding, the analysis method, would be used for moving from description to interpretation. In the process of data analysis, the segments of text data would be broken down into smaller units, and then the data would be examined, compared, conceptualized, and categorized (Strauss & Corbin, 1990, p. 61). A specific label would be given to a piece of text that contains an idea or a piece of information. Then the label would be generalized into three categories. The three categories include: (a) The Nature of STEM Education, (b) Current Implementation Mode and (c) Challenges in STEM Education. This paper is in accordance with these categories to have finding and analysis.

The verbatim quotations from participants would only be translated from Cantonese into English. That ensures the reliability of the data from the idea of the interviewees.

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Section 4: Finding and Analysis

4.1 The Nature of STEM Education

To figure out the difference between the perception of teachers towards STEM Education and the current implementation mode, the value emphasized in STEM Education and the STEM teachers' requirement would be first be discussed.

Table 4: The Nature of STEM Education from the perspective of teachers

Value towards students	**Frequency**
Problem-solving ability	**17**
Creativity	**12**
Application capability	**9**
Life-related / Reflection on life	**8**
Higher learning motivation / Arousing students' interest	**6**
Subject knowledge	**5**
Willingness to try	**5**
Collaboration skill	**4**
Logical thinking skill	**3**
Comprehensive skill	**2**
Explore their potential	**1**
Critical thinking skill	**1**
Teachers' Requirement	**Frequency**
Subject knowledge	**13**
Creativity	**10**
Willingness to learn / try / take challenge / Be open-minded / Not afraid to make mistakes	**8**
Pay attention to emerging technology / Be sensitive / Keep enriching ourselves	**5**
Nurture students' ability / Suitable instructional design	**3**
Scientific knowledge	**3**
Programming knowledge	**3**
Problem-solving ability	**3**
Patience	**2**
Collaboration skill	1

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In the interview as depicted in Table 4, it assesses both General Studies pre-service teacher and in-service teachers' perception of the nature of STEM Education in terms of the value towards emphasized in lesson and the requirement that STEM teachers need. The findings showed that the most important value in STEM Education are problem-solving skills, creativity, application capability and life-related / reflection on life. Also, STEM teachers require subject knowledge, creativity, willingness to learn, try and take challenge and pay attention to emerging technology.

Nearly all interviewees (17 out of 20) agreed that problem-solving skills should be emphasized in STEM Teaching, which means this element is the key value in STEM Education. The reason mentioned in the interview are quoted below:

> *'I believe problem-solving skills is the value that students could really apply in real life scenarios, assisting them to solve the real-life problem. This is the goal of learning.'*
>
> *-Participant J*
>
> *'I think STEM Education is used to offer opportunities towards students to find out the problem existing in real life, and then figure out the solution by applying students' problem-solving skills and trial and error.'*
>
> *-Participant G*

The high importance of problem-solving skills is due to its closeness towards life, which is even a life skill. Students are expected to be more conscious to the surrounding living environment and the world. Thus, it is mentioned that the most ideal STEM learning method is to let students create their own solution by applying both their creativity and subject knowledge taught in the

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General Studies lesson or other related subjects like Computer lesson and Mathematics lesson. Some schools mentioned by interviewees will set up scenarios asking students solve the problems existed.

Creativity is said to be a special element in STEM Education. Compared with the traditional subjects, students have more space and degree of freedom to create and present their own idea. In the traditional subject, specific methods are taught to solve problems or students are required to recite different kinds of knowledge, but in STEM Education students would be provided some thinking methods, then students could base on these skills to add on their ideas that create a solution or a product that solves problem. Innovation is frequently used as a process that creativity could be inferred and developed in current school curriculum. It is also hoped that students would be competent in the future to create innovation to improve the world quality and international competitiveness.

> *'The knowledge learnt from textbook is limited, also in current education students are mainly required to recited knowledge but not applying problem-solving skill or their creativity.'*
>
> *-Participant F*
>
> *'Students are expected to use their creativity to prepare own experiment materials and have own design.'*
>
> *-Participant O*
>
> *'The problem-solving thinking skills would first be taught, then students would use these thinking skills as a starting point to create their own solution.'*

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-Participant Q

The application ability and life-relatedness are also emphasized by some interviewees. The findings showed that teachers believe that if the skills learnt in other related subjects or in STEM Education are not applicable and not related to real life case, the effectiveness of learning would be low. Also, it is becoming increasingly clear that real-life situations and applying knowledge by hands-on learning help to promote engagement and motivation (e.g., Kuo 2014).

> *'STEM Education must be life-related and provide chance for students to apply their subject knowledge, so that students could use these skills in the future.'*
>
> *-Participant G*

To cope with the needs in STEM Education, teacher must be competent in subject knowledge as mentioned by the interviewees (13 out of 20). Due to the nature of STEM Education, it involves different subject knowledge or skills, like Science, Technology, Mathematics and Engineering. The findings showed that both pre-service teachers and in-service teachers concern their own academic background and the related knowledge and skills, this is highly correlated to their self-efficacy which will be mentioned later in the study. Participants illustrated that STEM teachers do not have the need to be good at all areas, but they should at least have basic knowledge at all. Some participants even mentioned that science knowledge and technology skills are essential elements that teachers required because of the higher proportion in primary curriculum.

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'If there is STEM lesson in the future, I am not familiar with science, how can I hold a project with the students? I could only teach about the part I am familiar. To be a successful teacher, we need to know the things in STEM and have to be willing to learn the knowledge in other areas.'

-Participant P

'I think teacher should at least have science knowledge as STEM Education involves more in science, computer and mechanical elements. If the teacher is not familiar with it, students must not be learnt and understand, and the teacher cannot design a good STEM lesson for students too.'

-Participant L

The teachers' requirement is also related to the value emphasized on students. With the hope to nurture students' creativity, teacher have to be self-equipped. By having the same characteristics, students could learn from the thinking skills of the teachers and teachers could give out the suitable direction for students to make reference. In addition, the creativity of teacher provides teachers inspiration on planning STEM-related lesson. Teachers have to be open-minded to accept challenge that might be faced in the teaching and keep on trying new things like emerging technology due to the changing environment. The technology or teaching areas are unstable and have fast transition from year to year. Thus, enriching related new knowledge is a must for STEM teachers.

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'STEM Education is life-related and close to current technology development. Therefore, teachers have to update ourselves frequently. Our mindset would also affect students thinking and degree of freedom.'

-Participant G

4.2 Current Implementation Mode

All the primary schools stated in the interview are implementing STEM Education. This is also the situation in Hong Kong. The difference between schools is on the implementation level, the school-based curriculum arrangement and whether training is given to teachers or not. The training provided is highly correlated to the teachers' understanding and teaching on STEM Education, thus affecting how student receive the value of STEM Education. As for the curriculum arrangement, it could be observed that the degree of importance the school has been valued in STEM Education and the policy and goal of different schools.

Table 5: Current STEM Education Implementation Mode in Primary Schools

Teachers' STEM Learning	**Frequency**
Self-learning / Reading online resources	**6**
Teacher training / STEM workshop	**5**
Curriculum officer / STEM coordinator integrate the STEM teaching	**3**
Sharing from teachers / collaborative lesson study	**3**
EDB training course / seminar	**1**
Curriculum Arrangement	**Frequency**
General Studies	**13**
Outsourcing	**9**
STEM workshop / STEM Day / Project-based Learning	**9**
Competition	**6**
Interdisciplinary	**5**

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Interest class	**5**
Afterschool activity / Post-examination activity	**4**
Computer lesson	**3**
Insufficient degree of implementation / Lack of STEM activities	**2**
Independent subject	**2**
Mathematics lesson	**1**
Parents STEM Experience Day	**1**
Visit and observe	**1**

Self-learning or self-reading online STEM resources is mentioned by some of the teachers. Due to the nature of STEM Education and the academic background or ability of the teachers, teachers would not be familiar with all the areas including in STEM Education, like Science, Technology, Engineering and Mathematics. Thus, both pre-service teachers and in-service teachers have to learn more to enrich themselves. Some interviewees stated that no training is provided by school, so they have to study by themselves through reading online resources, like some coding applications and methods.

> *'If the STEM activity hold is mainly based on science theory, I would surely be capable as I am major in General Studies in tertiary study. Yet, if it involves with technology, like the coding application 'Scratch', I am totally unfamiliar with it, I have to learn it by myself before teaching. Some teachers have the same case with me, they also need to have self-study before lesson but actually not all teachers are willing to have such contribution.'*
>
> *-Participant O*

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Some schools would provide teacher training or STEM workshop to related teachers to enhance their understanding towards current implementation of STEM Education in Hong Kong schools. These trainings are provided to General Studies teachers or related subject panels to join, but not for all teachers as mentioned by the interviewees. After those talks, specific teachers would share to other teachers. The content of the talk includes: the development modes at other schools and some STEM Education theories. One interviewee stated that her school would hold the STEM workshop regularly like on Teacher Development Day to let all teachers experience what STEM is and develop related skills.

'The talk is mainly discussed some STEM theories. For example: Fluency in creative thinking theory.'

-Participant F

'I have joined some talks but not so many. The talks might be hold by some external agencies, not all teachers but some teachers can join those talks. Subject panels would share the information to other teachers when they are back. For me, I have joined the talks which is about how to develop STEM Education.'

-Participant Q

'The implementation is well-planned at my school. We emphasized on STEM Education development, thus have a lot of funding used in equipment and training. We have regular teacher workshop for teachers, like outsourcing external agency to hold STEM

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Experience Day in Teacher Development Day that develop our colleagues some related technology skills.'

-Participant R

The method of integrating the STEM curriculum by STEM coordinator or curriculum officer is also be used at some schools. STEM coordinator is responsible for choosing suitable STEM competition and then assign other colleagues to be the leading teacher to teacher and help the students. Furthermore, interviewee illustrated that the specific teacher would be responsible in collecting and preparing related materials and information, like the teaching method. For some cases, teachers would have collaborative lesson study that the sharing from teachers can provide insight and idea for other less-skilled teachers. As for the teachers who are interested in STEM Education, it is stated that they would join EDB training course or the seminar from professor in voluntary basis.

'For our school, if there is a teacher, with liberal arts background, not familiar with the topic, the responsible teachers would do the research and the collection of information. Therefore, teachers would have enough teaching materials and information to be followed. There is not the need to self-imagine the teaching strategies. If the topic is about problem-solving, the responsible teachers would be the group of problem-solving while if it is related to General Studies, General Studies Panel would be responsible for the instructional methods.'

-Participant Q

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General Studies Lesson take the highest proportion in the STEM Education implementation. It is common that STEM elements would be involved into related topics in General Studies. Most schools use experiment as the main approach to engage science elements and the process of problem-solving. Throughout the lesson, some interviewees explained that some elements like technology and mathematics would also be engaged, yet they are only the role of assistant while science is still the main theme in this kind of STEM activities. The finding shows that the STEM activities held in General Studies lesson is mainly led by science.

Our school add in STEM elements in General Studies lesson, our focus is not innovating a real product but involve STEM elements in the curriculum to stimulate students' thought. For example, we would add in coding element in General Studies lesson. When we learn the reaction time of brain, the progress of how brain react to a stimulation, we would emphasize that writing code is similar to our function of brain. The way we accept stimulation is like we enter an instruction to the computer, and then the computer would function the mission. This can link up the relationship between General Studies and technology.'

-Participant Q

'We have Water Rocket and Parachute competition in General Studies Lesson.'

-Participant P

'Our school will hold STEM activity once a year for each grade. We have designed a STEM Learning Booklet according to the General Studies topic involved in that grade.

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Also, General Studies teachers are responsible to implement. For example, primary five students have to use the principle of closed circuit to design a product that involves STEM elements, like vacuum cleaner. Primary six students have to use the principle of lever to design a product to solve the rubbish collection problem at school.'

-Participant L

Outsourcing is also a common way to give out STEM lesson. Interviewees expressed that their school invites external agency to teach specific STEM interest class or hold STEM Day at school. There are mainly two reasons: convenience and higher level of difficulties for top student to learn. It has been mentioned that current teachers are not capable for 'high level' STEM courses, for instance: coding course like mbot, microbit, lego. Therefore, top students in STEM Education will be chosen for joining some advanced classes taught by external teachers. One interviewee indicated that using money to buy service, students can then learn new things. Those top students would also be chosen to join different kinds of STEM competition. In these competitions, students are required to innovate, design and create a device to solve the problem assigned in the task. They are commonly related to the technology like audrino, mircobit.

'Current STEM Education is focus on technology like mBot and microbit, we, the teacher really not familiar with them, this is the reason why we need outsourcing.'

-Participant L

'Our school will choose top students to join the outsourcing advanced class once a week, like lego and coding.'

-Participant Q & N

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Apart from General Studies Lesson, interviewees stated that STEM workshop, STEM Day and project-based learning is also a usual way for school to implement STEM Education. These launching mode usually link with interdisciplinary. Different subjects will cooperate to hold a one-off project for one grade of students, some schools hold it for a day while some is a week or a month. As mentioned by the interviewees, General Studies, Computer and Mathematics teachers would be involved, Visual Arts lesson does not engage in these schools. Students have to first learn specific topic in different lessons before the STEM Day. Inside the project, students are required to use different elements taught in corresponding lesson to solve the problem. This launching mode usually has innovation process involved and need to design a product.

> *We have interdisciplinary project every single grade. For instance, the construction of parachute needs to measure (Mathematics), control microbit sensor to count time (Computer) and trial and error (General Studies). Every academic subject will teach the essential elements inside project, students could then solve the problem after integrating and applying the knowledge.*
>
> *-Participant P*

4.3 Challenges in STEM Education

Based on the perception of pre-service and in-service teachers and the current mode in implementing STEM Education, some challenges in primary school STEM Education existed. In order to enhance the effectiveness of STEM Education, schools have to deal with these problems. Three areas (teacher self-efficacy, curriculum and resource) will be discussed below.

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Table 6: Challenges in STEM Education

Teacher Self-efficacy	**Frequency**
Lack of Ability / Academic Background	**14**
Lack of Experience	**5**
Lack of Preparation / Nature of STEM	**5**
Depends on School Level / Policy	**3**
Curriculum	**Frequency**
Deviation on curriculum goal / No lesson goal	**14**
Too much intervention from teachers / parents	**6**
Exam/Test-oriented	**6**
Competition-oriented	**6**
No regular lesson / Not systematical / short-term / lack of coordination	**4**
Not value on STEM Education	**3**
Cannot / difficult to engage the STEM elements in current lesson	**2**
Only teach top students / Not every students can learn STEM	**2**
One-sidedly emphasize on General Studies lesson	**1**
Resource	**Frequency**
Teaching time	**9**
STEM talent	**8**
University Training	**8**
Teacher Training	**7**
STEM-related Hardware / Equipment	**4**
Cost / Funding	**2**
Example / Guideline	**1**
Space / Site	**1**
Application time on funding / planning	**1**

Teachers is the major and essential resources during the implementation of STEM Education. The learning result of students depends on how teacher teach. Table 6 first summarizes the reasons affecting teacher self-efficacy in teaching STEM. The finding shows the major reason is the lack of ability and academic background. STEM Education has been developing for few years,

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for some schools and teachers are still at the developing stage. Teachers notice that there must be some elements inside STEM, they are not familiar with or even weak at. Especially for the current in-service teachers, the interviewees expressed that they did not study related areas or STEM before. Some interviewees have no idea what STEM Education is when it is first be implemented. It is found that only two teachers are highly confident in teaching STEM Education, most of the teachers (12) have moderate confidence just depends on the level they have to taught and 4 teachers have no confidence. Since they are not confident in teaching STEM, some teachers choose to outsource the advanced course while some teachers do more research before the lesson.

> *'Our school focus on science and technology in STEM Education, as no teacher knows engineering related knowledge and skills. I am responsible for leading students in robotic competition originally, but I chose to outsource to external teacher to teach them at last. Recently, we had a project on vacuum cleaner, which needs to understand the basic concept of vacuum cleaner like air pressure. I have to learn by myself. When the information is too in-depth, I would tell my students that I do not understand too as I am not with this background. Just learn together with the students.'*
>
> *-Participant L*

> *'I am not major in this area or study related course. When the school started to implement STEM Education, I actually do not understand what is happening. Hong Kong STEM Education is so different from the STEM Education in overseas, thus I have found for the direction for three years.'*

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-Participant Q

In terms of STEM curriculum related problem, teachers (14) revealed that there is deviation on curriculum goal or even no lesson goal in current Hong Kong primary school. There are serval cases stated by the interviewees. First, too rely on technology development or innovation. The finding shows that some schools use different kinds of technology hardware to be the main equipment in the project, for instance: microbit, mbot, robot etc. Teachers expressed that student have less opportunities to use their creativity and thinking skills to solve some real-life problem, but just create some science innovation or using technology. Second, some interviewees mentioned that their schools are working on STEM Education, but actually they are just some Computer lesson or General Studies project. The change is only on the name we called. Thirdly, there is not a goal set at their school. One interviewee stated that teachers only aim at finishing the STEM booklet, there is not a clear result or goal required to be achieved.

> *'General Studies teachers are required to do the debriefing with students after the project, like the difficulties met and how they solve the problem. Yet, there will not be any result or achievement need students shown at the end of the project. Completing the STEM booklet is equal to the completion of a STEM course. Especially for the senior students, they are just kept on playing mbot but not giving chance for students to think more.'*
>
> *-Participant N*

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Aside from the unclear goal of STEM Education, this finding shows that there is too much intervention from teachers or parents (6) during a STEM project. It is common that students have to create different innovation as a final product in the activity. Yet, due to the limited time in the lesson or the design of the competition, the products made by the students usually have the involvement from external help. As mentioned by the interviewees, some ideas are created and designed by the teachers. When the work is brought back to home, parents would help them to finish or do some corrections. Thus, at last only part of the product is finished by the students. Furthermore, the launching mode in Hong Kong Education system is too exam/test-oriented (6) or competition-oriented (6). Some interviewees expressed that the skills used in STEM project have to be test and count as a mark in the transcript. They required students to recite the skills or knowledge in the project, and then produce the same or similar task in the examination. Also, some schools focus on joining STEM competition, which is not match with the significance of learning STEM. The interviewees expressed that school would like to use it as a proof on their school development on STEM Education.

> *'Hong Kong Education system emphasizes on students' result, but actually the skills valued in STEM is difficult to be assessed or do not have the essentiality to be assessed, for example: problem-soling skills and creativity. I have heard that some schools need to have examination on STEM, like using Scratch to finish a task which has been done in the lesson already. This is nonsense.'*
>
> *-Participant K*

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'Not only my school, but many cases in Hong Kong, do not engage STEM into the curriculum for real. Most of the goal is to join and win the competitions. I have led some STEM competitions. I have found that the people joining the competition is the teachers but not the students. Teachers create and introduce the idea to the students and the students present the product. It is not a good direction that students just copy the thought from teachers. Also, the course and competition become more difficult compared to the past. For example: primary six students have to use Arduino to make a refrigerator. The focus on STEM Education is totally wrong.'

-Participant N

As for the resources used in STEM Education, the main concerns are lack of teaching time (9) and lack of STEM talent (8). In Hong Kong, the lesson schedule is tight due to the content of curriculum. There is less time could be used as STEM project. School would prefer to use the time to finish the original curriculum in different subjects. The limit teaching time leads to serval problems which are (1) no regular STEM lesson can be launched, (2) students have less autonomy to finish their own project, (3) increase the amount of intervention from teachers and parents and (4) increase the workload of teachers. The interviewees also illustrated that there is shortage of STEM talent at their school. Teachers who are not STEM background are confused in implementing STEM activities owing to their low understanding, leading to higher pressure and unwilling to do the implementation. The reasons behind are because of the job recruitment and lack of university training (8) and teacher training (7). Some schools require the teachers without related background to teach STEM while not recruit enough STEM new teachers. In-service teachers stated that although EDB and the school hope to promote STEM Education, but

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there is not related training for teachers to join. One in-service teacher stated that should recruit the fresh graduate from General Studies major as they have more sense and knowledge in STEM Education. Yet, the pre-service teachers who are major in General Studies mentioned that the university training is not enough or is only based theory. Some pre-service teachers expressed that they learnt the STEM knowledge and skills from other courses, like STEM minor, and part-time/internship.

'School would not provide training for teachers due to the budget. They would rather choose to use the budget to update equipment and hardware.'

-Participant P

'The problem is existed in 'people'. Not every colleague knows STEM, this would only lead to waste of resources. For example, our school has mBot and micro:bit, but some colleagues are totally unfamiliar with these tools, how can they apply them into the STEM curriculum? Also, the number of General Studies background is low at our school, this is the reason why it is difficult to launch successfully.'

-Participant L

'I think the university training provided is offer us chances to try different tools, instead of putting into practice. Most of time we, the students, need to gain teaching experience from parttime. As for the STEM minor I am studying, this course aims at learning thinking skills and trial on most updated technology. The programme in university seldom teaches us how to apply this hardware to teach STEM.'

-Participant H

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Section 5: Discussion

Since there is insufficient research on the success and failure of implementing STEM Education in Hong Kong primary school, this paper highlights some advantages, and focus on the challenges and improvements could be made for current situation. Discussion will be start with (1) comparison with other countries and followed by the analyze of the teachers' perception reveals the needs in certain areas: (2) curriculum, (3) assessment, (4) resources and (5) culture.

5.1 Comparison on STEM Education with other countries

To start with, the curriculum in Hong Kong is consisting of the components in STEM Education more evenly than USA, Korea and Taiwan. It has been illustrated that mathematics in STEM education are not emphasized while the differences between science and engineering are rarely represented (Park & Erduran, 2020). In Hong Kong by analyzing the data collected and the literature review, every component inside STEM Education could be observed that school are trying to involve all in a project-based learning but with different proportion and sometimes just focus on technology or science only in specific discipline. Secondly, Hong Kong has been focused more on technology discipline and not only represent the similarity between science and engineering. In England and Wales, design and technology has been neglected (Bell, 2016), which leads to limited funding and resources are given on these two components (Morgan, 2014). Technology in Hong Kong like coding has been observed that they are one of important elements school working on. Yet, as same as England and Wales, the components in design like art are not involved much in most of Hong Kong schools. As for the funding and resources, the interviewees in Hong Kong have expressed that government has offered a funding for them which would not be limited by the activities designed or the aims set by the school, in this

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perspective it is better than other countries by having enough funding. Overall, not only the teachers in Hong Kong, but in most of the countries (Bell, Morrison-Love, Wooff & McLain, 2017) usually do not receive formal training but they have to study STEM by self-learning.

5.2 Curriculum: Interdisciplinary / project-based / clear goal and planning

Interdisciplinary should be taken into practice in STEM Education. Serval situations existed in Hong Kong primary school have been collected from this research. It shows that the responsibility of implementing STEM education has been highly focus on certain subject teachers, especially for General Studies. Honey et al. (2014) stated that STEM Education is the integration of the four disciplines rather than treat them as independent items, nevertheless, some of Hong Kong primary schools are implementing like the latter one. To deal with the pressure and effective on division of labor, interdisciplinary has been highly suggested by the interviewees. The nature of STEM Education includes the high coverage of knowledge and skills from different areas. By having interdisciplinary cooperation, every colleague can contribution the things they are good at and familiar with. Computer teachers can handle the part of technology concept and hardware while General Studies teachers can be responsible in science theory. It is a practice that making the knowledge exchange between teachers, which provides more insight into the STEM project created. The resource and time used would be saved. Increasing the involvement of different subjects can enhance the students' exposure and application towards subject knowledge and skills, that is the goal of STEM Education. To implement the plan mentioned above, a position of STEM panel should be set up to integrate the current school-based curriculum and cooperate the contribution could be made or learnt in

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different subjects. By having the collaboration between teachers, the effectiveness, coverage and wideness would have a great difference.

Project-based learning is the ideal mode in the launching of STEM Education. It has been mentioned that STEM should not be an individual subject in primary school as it involves the knowledge that primary school students are not capable to learn, for instance: engineering. The mode of project-based learning provides chance for students to have self-directed learning and more learning autonomy based on the topic provided by the teachers. By connecting the classroom learning with daily life and the surrounding world, students gain chances to involve with topics related to the real-life and thus trigger their ability in problem-solving (Barbato, 2013). The setting allows students first have observation about the surrounding and society. After self-figuring out the problem, the learning motivation would thus be enhanced and student would understand the relationship between the project learning and life situation. The subject knowledge learnt, the ability in application and problem-solving can then be practiced.

Clear goal and all-rounded planning should be set up before implementation. A clear objective can allow teachers to understand what they should achieve and what should be done. Teachers become skilled at the methods after achievements on the targets set and the collaboration with their partners to resolve issues (Nesbitt, 2013). The goal should not just be created according to the achievement of competition. Or else, the situation on deviation of STEM Education goal would still be existed. All members inside the school should understand the significance of STEM Education is on the ability of problem-solving and the relationship with life event. Then the curriculum would not be lean to technology or competition based.

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5.3 Assessment: no assessment or assessment on skills only

Assessment has been used for measure students' understanding and achievements, which could assist teacher to adjust their teaching methods and level (Bransford, J.D.; Brown, A.L.; Cocking, R.R., 2000). Yet, in STEM Education, the interviewees expressed that no assessment should be included or only the skills in problem-solving, creativity and thinking skills should be assessed. STEM education is being promoted as a vitally important step on strengthening learners' innovative mindset in Hong Kong (EDB, 2016). STEM Education should give more space and autonomy to students, there should not be many limitations that reduce the opportunities one students' thinking and trial and error, or else it would violate the meaning of STEM Education. The result tested cannot directly show the ability of students due to the standard set. Oppositely, the result might affect students' motivation and pressure in learning STEM. It is believed that students learn according to their interest without assessment would have a better performance. When there is standard set, the materials and ideas would limit the creativity of the students.

5.4.1 Resource: Knowledge Enhancement by training

Teacher training and university training should be provided in long-term and not theoretically. Both pre-service and in-service concern the related training provided is practical or not. No matter the training included in university or at primary school, it has been mentioned that they are usually some theories (e.g., thinking skills) or some trials on STEM equipment (e.g., micro:bit). During the training on teachers' technology usage, not only ICT integration has been investigated, but also pedagogical issues, ways to measure and improve teachers' ICT integration proficiency (Hsu, 2017). What teachers need are the methods to apply these theories into real teaching practice and some real situations happened in STEM teaching. The training could be

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about the application of some STEM hardware in specific topics and give teaching experience to the participants. This direction could give more insights to the educators. University training has been highlighted by some in-service teachers as the fresh graduate could bring in new technology and teaching strategies learnt from university programme, that creates difference in a existing school curriculum.

5.4.2 Resource: Sharing information / lesson examples / teaching materials

Apart from the STEM training, the interviewees stated that new information, lesson examples and teaching materials in STEM could be provided to the teachers, especially some overseas teaching examples. Currently, teachers in Hong Kong have pressure in being creative to design different STEM activities. At the same time, other countries have already had lots of success products and examples (Struyf, De Loof, H., Boeve-de Pauw, J., & Van Petegem, P., 2019). By having updated and diversified actual STEM teaching cases, teachers could take reference, modify and reform into a better version. This could lead to decrease in stress level and providing more insights for Hong Kong teachers. Not only the activities design could become better for students but also the teaching methods. The interviewees expressed that all they need is the actual learning content insight but not what STEM elements should be included inside a document. Providing some platforms and examples in different schools create a better sharing phenomenon in Hong Kong STEM culture.

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5.5 Culture: Sharing culture

To further create a supporting environment in Hong Kong primary schools, sharing culture should be set up. Connection is not just as a collaborative form of making, but also sharing ideas and methods within a common domain of practice or what has been called a community of practice (Wenger, 1998). A position should be built up as integrating STEM Education at a school. They are responsible to give helps to related colleagues or collect updated information for teachers to refer to. More collaboration should be promoted between teachers, like sharing the information and ideas they have got, leading to a clear direction in STEM Education implementation and reduction in teachers' misunderstanding towards STEM. The effectiveness and implementing pace could thus be stable and got improvements.

Section 6: Conclusion

This research has been worked on the teachers' perception of current STEM Education in Hong Kong, analyzed the challenges have been faced and suggested the methods of improvements. Based on this study, further research could be done on the investigation of assessment of STEM Education. This might contribute to a more favorable STEM learning environment in Hong Kong schools in the future.

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Reference

Akgunduz, D. (2016). A research about the placement of the top thousand students in stem fields in turkey between 2000 and 2014. *EURASIA Journal of Mathematics, Science & Technology Education*, *12*(7), 1365–1377.

Barbato, S. A. (2013). Viewpoint, NDPC/N Quarterly Newsletters, 24(1),8.

Bell, D. (2016). The reality of STEM education, design and technology teachers' perceptions: A phenomenographic study. International Journal of Technology and Design Education, 26(1), 61–79.

Bell, Morrison-Love, D., Wooff, D., & McLain, M. (2017). STEM education in the twenty-first century: learning at work—an exploration of design and technology teacher perceptions and practices. International Journal of Technology and Design Education, 28(3), 721–737.

Benken, B. M., & Stevenson, H. J. (2014). STEM education: Educating teachers for a new world. Issues in Teacher Education, 23(1), 3–9.

Bransford, J.D.; Brown, A.L.; Cocking, R.R. How People Learn: Brain, Mind, Experience, and School; *National Academy Press:* Washington, DC, USA, 2000.

Cavlazoglu, B., & Stuessy, C. (2017). Changes in science teachers' conceptions and connections of STEM concepts and earthquake engineering. *The Journal of Educational Research*, 110(3), 239–254.

Education Bureau (December 2016). Report on Promotion of STEM Education Unleashing Potential in Innovation.

Fan, S. C., & Yu, K. C. (2015). How an integrative STEM curriculum can benefit students in engineering design practices. *International Journal of Technology and Design Education*. Advanced online publication.

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Not for publication or further reproduction.

Fore, G. A., Feldhaus, C. R., Sorge, B. H., Agarwal, M., & Varahramyan, K. (2015). Learning at the nano-level: Accounting for complexity in the internalization of secondary STEM teacher professional development. *Teaching and Teacher Education*, 51, 101–112.

Forrester, P. G. (2013). Relevance in Education Fosters Success in Life, NDPC/N Quarterly Newsletters, 24(1), 1.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., et al. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410–8415.

Geng, J., Jong, M. S.-Y., & Chai, C. S. (2019). Hong Kong Teachers' Self-efficacy and Concerns About STEM Education. The Asia-Pacific Education Researcher, 28(1), 35–45.

Han, S., Capraro, R., & Capraro, M. M. (2014). How science, technology, engineering, and mathematics project-based learning affects high, middle, and low achievers differently: the impact of student factors on achievement. *International Journal of Science and Mathematics Education*, *13*(5), 1089–1113.

Havice, B. (2013). Integrative stem education—developing innovators, educating creative learners, *NDPC/N Quarterly Newsletters, 24*(1), 2.

Honey, M., Pearson, G., & Schweingruber, H. (2014). STEM integration in K-12 education. Washington: National Academy Press and National Research Council.

Hsu, S. (2017). Developing and validating a scale for measuring changes in teachers' ICT integration proficiency over time. *Computers & Education,* 111, 18–30.

Kuo, B.-C. (2014). Teachers' collaborative problem solving teaching competency project. Retrieved on March 7, 2015, from https://sites.google.com/site/cpswebsite2014/

The Education University of Hong Kong Library
For private study or research only.
Not for publication or further reproduction.

Lennon, E., Moriarty, B., & Zivkovic, M. (February,2014). Taking it to the next interface level: advancing game design for higher education stem applications. Frontiers in Education Conference, Madrid.

Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J., & Vílchez-González, J. M. (2019). What are we talking about when we talk about STEM education? A review of literature. Science Education, 103(4), 799–822

Merrill, C. (2009). The future of TE masters' degrees: STEM. Louisville: Paper presented at the meeting of the International Technology Education Association.

Nesbitt, B. J. (2013). Up for the Challenge *NDPC/N Quarterly Newsletters, 24*(1), 4.

Morgan, N. (2014). Secretary of State for Education speaks about science and maths at the launch of Your Life campaign.

Nugent, G., Barker, B., Grandgenett, N., & Adamchuk, V. I. (2010). Impact of robotics and geospatial technology interventions on youth stem learning and attitudes. *Journal of Research on Technology in Education*, *42*(4), 391–408.

Park, Wu, J.-Y., & Erduran, S. (2020). The Nature of STEM Disciplines in the Science Education Standards Documents from the USA, Korea and Taiwan. Science & Education, 29(4), 899–927.

Rincon, B. E., & George-Jackson, C. E. (2014). STEM intervention programs: funding practices and challenges. *Studies in Higher Education*, *5079*(May), 1–16.

Sanders, M. (December/January 2009). STEM, STEM education, STEMAnia.

Strauss, A. & Corbin, J. (1990). Basics of Qualitative Research: Grounded Theory Procedures and Techniques. Newbury Park, CA: Sage Publications.

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Struyf, De Loof, H., Boeve-de Pauw, J., & Van Petegem, P. (2019). Students' engagement in different STEM learning environments: integrated STEM education as promising practice? International Journal of Science Education, 41(10), 1387–1407.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* New York, NY: Cambridge University Press.

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Appendix 1: Transcript of Participant A (Pre-service Teacher)

受訪者 A 的背景資料
修讀科目：主修常識，副修數學
教學經驗：3 年 STEM 教學經驗，實習、課外活動班

訪問者：過往有什麼教授 STEM 的經驗？
受訪者：我曾於學習中心教授 STEM 的課程，例如砌機械人、入校進行課外活動班 Mircobit 班、單次性入學校舉辦 workshop、教授 Online course 做 STEM 手工等。科學方面比較少，大多是經大學的 project，找我們成為學生導師。例加曾經參加資優教育學院的一個計劃是教授 science topic，例如關於真空和壓力，以及關於水的知識，中間有用 STEM 的元素去令課題有更多動手實驗和給學生探索的空間。

訪問者：什麼是 STEM?對學生有何意義？
受訪者：我對 STEM 教育沒有一個很清楚的想法。我覺得都推行了可能近十年，最近大家對 STEM 都有已有嘅想法、模式和觀念。對我而言 STEM 是由四個範疇組成，利用四個方面的知識，令學生可以融合不同的科目，學習到新的技能，配合到未來的發展，是一個需要的科目。

訪問者：任教 STEM 的教師需要具備什麼條件？
受訪者：我認為推行 STEM 的教師需要願意嘗試，要擁有創新的思維。因為在 STEM 的課程之中，大家可能都未曾嘗試過，可能只是將一些想法，過去亦未必有成功的例子，要逐步逐步去經過修改，才能成為一個較為完善的方案。另外教授 STEM 需要更多的合作，例如跨學科教學，未必一位導師擁有的能力或相關的知識可以主導整個計劃。所以導師應願意去嘗試、保持創新的思維和需要與人合作。

訪問者：在常識科 STEM 教學之中，你最重視哪個範疇？
受訪者：我認為本科知識最重要，因為作為一位教師本科知識的根基較好才能有信心去教導學生。例如一些題目如水火箭或者實驗，我自己都未曾嘗試過的時候就會擔心未必教授到學生。需要有些原理及知識背景才能於學生發問時可以回應他們。

訪問者：對你而言有多大信心可以推行 STEM?
受訪者：中度，有些 topic 我有教授過，信心就會比較大。另外我認為教授 STEM 很視乎未來學校重視什麼，學校推行 STEM 的方式，可能有些學校注重比賽，有些學校可能會想培養學生一些創意思維和個人素質。

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訪問者：假如你日後推行 STEM 時有不熟悉的課題時會怎麼辦？
受訪者：我會視乎安排，只有我一人去負責還是整個常識科組去負責，假如是後者我就能與其他老師去做課研和探討，組成一些觀課的學習小組，就能令我有更大的信心去推行 STEM。

訪問者：教授 STEM 時遇到什麼困難？
受訪者：入學校最大的困難是，每個學生的能力都不一，學校未必每一個年級完成一個 STEM 課程，而是將幾個年級的學生組成一組，例如四至六年級一起完成一個課外活動班，有些學生能力較為資優，而且較為感興趣，他們學習能力較快，或會認為基本的知識已經認識，需要等候其他人的進度。另外例如學習 Microbit 時，有學習能力較低的學生他們會感到很困難，特別是在 covid 的期間，特別難去幫助這些學生，而那些很快上手的學生就像離開了課堂一樣，已經無法專心。

訪問者：學生有問題時，你是否都能回應？
受訪者：暫時大多問題都能解答。因為我在課堂前會準備更多，以及我暫時教授的 STEM 課程的學識水平不會太高。例如 IT 和 Engineering，需要砌機械人，我教授的課程比較入門就能暫時應付。

訪問者：大學給予的 STEM 培訓足夠嗎?
受訪者:不足夠,我在大學沒有修讀任何關於 STEM 的學科或課程,但有參與一些 STEM Team。我學習 STEM 的方式主要透過工作 part-time 去教授和參加 STEM Internship。在 Internship 期間，公司會教授一些相關知識，亦能透過教學經驗去讓自己學習。

訪問者：現實中推行 STEM 與你理想中有何出入？
受訪者：我認為 STEM 應是以 project-based 形式推行。例如讓學生先由基本的資料及背景理解，而最後應有一個成品出來，讓學習變得快樂一些。根據自己教班的經驗，我發現時間十分倉猝，學生未必能自己準備得很好，甚至到課程後半時段，學生的作品變成了很多導師的幫忙才能完成他們的 project。暫觀現況，學校看來暫時難以將 STEM 真正融入學科之中。

訪問者：需要學校什麼支援？
受訪者：如果由老師規劃一個課程，可能多年都不變，例如每年都會玩水火箭。我認為需要更多的資源和撥款，例如邀請校外的導師，與校外一些機構合作，讓學生融入STEM做木工，趣味性會更大，亦能彌補教師的技術上的不足和時間規劃的限制，減輕教師負擔。讓教師亦能有更多時間為校本課程每年再作修改，添上更多創意。

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Appendix 2: Transcript of Participant B (Pre-service Teacher)

受訪者 B 的背景資料
修讀科目：主修常識，副修中文和輔導
教學經驗：3 年 STEM 教學經驗，實習、課外活動班

訪問者：過往有什麼教授 STEM 的經驗？

受訪者：我之前曾經參加 program，教授中學生及高小的同學「機關王」，他是利用 Lego 積木砌滑柆，他們需要分組，每一組能否完成特定的任務。最主要的目的是希望他們學習斜台和槓桿原理。這個計劃是在學校中完成，是一整級一起做的活動。主要我的工作是向學生講解當中的原理和如何完成這個「機關王」的遊戲，另外我亦是一個輔助的角色，親身協助學生，例如有時候學生未能完成，就會給予一些建議，令他們能完成斜台。

訪問者：STEM 教育是什麼？

受訪者：我覺得 STEM 教育字面上是指由科學、技術、工程和數學四個方面結合一起的，主要是希望培訓學生的創意思維，和他們理解和創作能力。能幫助學生思考當學生上課時學習了一個知識點，例如槓桿原理，他們就要思考如何透過實際的工具來實驗，並同時運用這些原理。某程度上很幫助學生啟發思考和學習將已學習的知識運用在日常生活之中。

訪問者：任教 STEM 的教師需要什麼條件？

受訪者：首先他要對知識點很清晰。他需要對某些科學原理要有基本的知識，更甚他需要知道更多的科學背景。其次他需要具備創意和很有耐性，因為以我之前的經驗為例，學生很容易做到一半就想放棄，你需要備有些推動力，和給予一些 hints 幫助他們完成 tasks，從而讓學生在過程中學習到解難的能力。

訪問者：常識科的 STEM 重視什麼範疇？

受訪者：我認為自己比較着重思考和解難方面的能力。因為我認為 STEM 與常識科的不同之處在於，常識科有時在上堂時較為死板，STEM 比較有趣，不單止坐在班房聽教師的講解，更重要的是他們需要落手落腳去完成一些產品，或許思考一個方法去解決一個困難，所以更加注重的是如何運用之前所學的知識，將其運用出來成為自己想完成的項目。思考過程和思考模式能啟發他們將一個問題解決，按部就班，甚至與他人協作的能力。我認為這些都比本科知識更加重要。

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訪問者：現實與理想的差別？
受訪者：正面來說，學生的反應比我想像中好，因為我過往認為STEM會否對學生而言過於困難，很難去接觸。但是以我的教學經驗，學生不抗拒學習STEM，而且他們很有興趣去學習有關知識。而與理想中有出入的地方是資源不足，例如我以之前實習的學校為例，他們沒有撥出很多資源投放於推行STEM，亦沒有舉辦很多活動，特別是常識科的STEM上。他們一年只有一至兩次有關STEM的活動，已經算很多了。因此我認為他們STEM的課時及資源較少。

訪問者：學校硬件上的支援？
受訪者：我的實習學校沒有硬件上的支援。較為多的是網上資源，如教學片段，以及外判給一些機構教授，如將模型車供應給學校，讓學生嘗試體驗。

訪問者：你有多大信心推行STEM?
受訪者：中度。我認為自己雖然是主修常識科，都有涉獵少量STEM的課程，但一切都是有學生自行彈性參加。對於常識科的教師來說都有一個基本的教授STEM的能力，至少我能夠知道STEM需要教授什麼和涉及什麼範疇。而我認為自己不夠信心的地方是因為自己向學生推行STEM的經驗不足。希望將來能有更多的時間與學生一起進行STEM的活動，這樣的話我相信自己會有更大的信心去教授STEM。

訪問者：困難的地方？
受訪者：學生有時候會問及一些問題是我自己沒有準備過的，例如有學生曾問我斜台到40米那麼高時會發生怎樣的情況，我自己一直都沒有想過這般的問題，所以我會猶豫，我自己都需要思考一段時間，然後就會根據個人經驗和知識去推斷再回應學生。這時我就會認為自己準備不足，需要再做好啲才能有信心回應學生。

訪問者：有什麼方法改善以上情況？你需要什麼支援？
受訪者：我認為作為因為常識科老師STEM亦是一個大趨勢。我認為在大學的時候，特別是常識科，可以撥更多關於STEM的課時和培訓。至少樣修讀常識科的學生知道STEM是什麼，才能更容易上手。否則只能夠視乎學生的求知欲有多強。

訪問者：你需要什麼類型的STEM培訓？
受訪者：例如3D printing。如何利用一些硬件去教導學生，大學可以教我們在什麼課題如何運用這些硬件或實驗去教授。現在大多時候都是靠我們自己去探索，我認為可以給予多一點的guidelines。另外大學有時會出一些研究，這些研究與準教師很有關係，可以運用這些研究去設計一些教材給予準教師，讓準教師將來能利用這些資源去推行STEM給學生。

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訪問者：以跨學科形式推行STEM重要嗎?
受訪者：我認為重要，因為始終常識科的課程課時很緊迫，常識科包含的實在太廣太多，要撥出課時於推行STEM時會有難度。我知道有現職教師教授現有課程時，時間已經不夠，所以跨學科的形式能夠當教授某些課題時能夠與其他學科結合，如數學科，就能省卻當中知識上重疊的時間，這樣就能令各科的老師都有更多的時間專注於自己的其他課題。

訪問者：根據你以往的教學經驗，你認為整體的配套及支援足夠嗎？如何改善現況？
受訪者：我認為暫算足夠。最重要的是視乎學校願意推行STEM與否，我有聽其他現職教師說學校並不重視STEM，而是在乎人文學科或語文學科，他們就撥較少的資源於這方面，但亦有些學校較重視STEM，希望有更多學生發揮潛能在數理或解難能力方面，他們自然會撥出更多的資源。對於這些願意發展並推行STEM的學校的硬件和軟件都足夠，亦有很多外在機構，例如青協，都有一些工作坊給予老師和學生去參與，學校因此能選擇外判給其他機構。當學校希望自己的老師自行教授，亦會提供硬件給教師進行3D printing、microbit的教學。所以我認為整體而言資料尚算足夠。

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Appendix 3: Transcript of Participant C (Pre-service Teacher)

受訪者 C 的背景資料
修讀科目：主修常識，第二主修中文
教學經驗：2 年 STEM 教學經驗，實習、課外活動班

訪問者：你過往有推行STEM的經驗嗎？
受訪者：我實習是實習常識科，在實習期間亦有在常識課時滲入STEM的活動，例如有做過羅馬炮架，是個有STEM元素的實驗。另外亦有在NGO教授過STEM的活動班，例如科學實驗和砌機械人。

訪問者：STEM教育是什麼？對學生有何意義？
受訪者：我認為STEM教育對我而言有兩個方面：第一是學習不同有關科學、科技等的知識。而令一個層面是學習解難的能力，例如STEM是很講求遇到問題我們要學會利用不同的方法去思考如何將問題解決。因此我認為另一個方面是培養解難能力。

訪問者：任教的教師需要具備什麼條件？
受訪者：第一是教師對STEM的知識是足夠，不足的話難以教得較為深入。亦要懂得利用什麼方法去教導學生，因為即使我有豐富的STEM知識，如果我不懂如何表達或將其融合於學科即常識科之中，對學生而言亦無法有效推動STEM。第二是老師思想需要開放，因為推行STEM時通常不只一個答案，亦沒有標準答案，有時候老師也未必清楚答案，反而學生能夠提供另類的意見，較為保守的老師可能未必願意接受他未知的事項。因此作為一個推行STEM的教師要有一個開放的心態。有時候學生可能反而正確，而教師未必清楚。

訪問者：常識科中推行STEM最重視什麼範疇？
受訪者：我認為有兩個範疇須注意。第一是安全，因為推行時很多時候需要涉及科學實驗或電子器材，例如3D printer。教師需要確保學生使用時的安全。第二是需要給予學生更多嘗試的機會，我們不能將每個步驟都清晰呈現給他們，應要將部份步驟讓學生自行嘗試和決定要怎樣做，這樣對學生的學習會有更好的效果。

訪問者：現實與理想的出入？
受訪者：始終在學校推行STEM時都需要作一個評核，都需要做功課或有些學校甚至需要計分。很多時候推行STEM時都需要一個成果和結果，但是我認為推行STEM時結果並不是最重要，而是過程，去觀察學生如何思考和創意能力。大多香港學校太注重成果對於推行STEM並不理想。

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訪問者：你有多大信心任教？
受訪者：我沒有太大信心任教。因為我對推行STEM的知識不足，亦都不掌握如何令學生明白STEM的要點，自己可能表達得不夠好。

訪問者：有什麼困難？
受訪者：有時候學生問的問題我本身自己都不會。例如我在實習的時候，有學生詢問有關太空的問題，我對這範疇並不熟悉，我的知識只限於教科書上。當學生問及書本以外的知識，而我沒有作那方面的備課，就未能解答他們。我就會嘗試讓學生自行上網搜集資料，或是我陪伴學生一起去學習。

訪問者：大學？你需要什麼支援？
受訪者：我認為在大學時學校有提供不同的課程讓我去體驗STEM，例如3D printing和microbit，但我認為缺乏的是學校純粹讓我經歷或體驗這些硬件，但是卻沒有教導我如何去教。所以我認為大學應在這方面提供不同的課程和資源。

訪問者：跨學科重要嗎？
受訪者：我認為跨學科有好處及壞處。好的是學生並不會單單局限於單一的學科，這樣就能一次過學習不同範疇的知識，亦能將其融合在一起。但難度在於教師在籌備的時候需要花費更多的時間，原本只需要單一科目的教師，以跨學科形式推行STEM時就需要不同的科組去進行課研，對教師要花費的時間和壓力就會增加。

訪問者：根據你的教學經驗，學校是如何推行STEM?
受訪者：以我的實習學校為例，他只提供教科書讓我思考如何教授常識科和中間插入STEM元素。而硬件方面，例如我有時想多一些實驗或活動，但是學校沒有這種儀器或工具，作為不是主導STEM推行的教師，就難以去要求學校撥出資源。因此有些學校資源都較少。

訪問者：如何改善資源少的問題？
受訪者：我認為首先學校需要預先計劃來年或更長的時間的活動和目標，提早購入或預備這些工具，那麼當我們舉辦STEM的活動時隨時就能有工具運用。

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Appendix 4: Transcript of Participant D (Pre-service Teacher)

受訪者 D 的背景資料
修讀科目：主修電腦，第二主修常識
教學經驗：2 年 STEM 經驗，實習、課外活動班

訪問者：你曾經如何教授STEM?
受訪者：我在中小學都教授過STEM課程，小學主要教授scratch、mircobit，中學有教授過python，programming，亦有做過機械人的帶隊教練，會帶學生外出比賽。

訪問者：STEM是什麼？有什麼意義？
受訪者：我認為推行STEM最有趣的地方是跨學科，它並不是Science堂只有Science，電腦科只有電腦，而是將一個活動融合四個方面的知識，跨學科能夠令學生用更多的創意去學習新科技和新的知識。這是STEM的特別之處。對學生而言，他們上課時可能會學習到一些比較抽象和難以觀察的知識，或是一些較為虛無的概念，他們就能夠透過STEM將不同的知識串連在一起，例如一些科學知識連繫到電腦科時，就能更容易明白、了解當中的關連性，並有機會運用出來。推行STEM時大多活動較為新穎和有趣，以學生就能以較輕鬆及愉快的形式去學習困難的STEM元素，例如Coding。

訪問者：任教的教師需要什麼條件？
受訪者：首先最重要的是老師需要具備創意的思維，不能太死板，需要不停去發掘新的方法、教材、教具去引導學生去完成當中的目標和活動。例如過去教授programming是text-based的，現在你用scratch拉block就能完成同樣效果。作為推行STEM教師需要注意新興的科技去幫助學生。另外，教學應從傳統的一個對全班的單向教學，應變成與學生之間的互動學習。教學不能只靠講述，而是需要給予學生親身嘗試，否則成效不大。

訪問者：常識STEM，重視哪個範疇？
受訪者：我認為解難能力和本科知識都十分重要。首先STEM的活動大多是提出一些難題，然後提供學生材料，讓學生去解決問題。過程中沒有標準答案，亦沒有指定的指引讓他們他們完成任務，很多時候是靠學生的探索和摸索去做一些實驗，而去解決問題。例如我曾嘗試請學生利用一些材料保護雞蛋然後將雞蛋從高空拋下，需要學生保持雞蛋完整，學生都需要利用他們的解難能力，而我們的角色只是在於引導他們自己去幫助自己找出解決方法。另外作為常識科老師，一方面需要讓學生享受過程時，亦需要學習到當中的知識。假如你對本科知識亦不熟悉的時候，或是於課程是沒有清晰講解，忽略了本科知識的重要性，活動的意義就會失去，並不是一個學習活動而是一個玩樂活動。例如我曾舉行水火箭的活動，活動中途及完結時我亦會作

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講解和反思，讓學生理解到當中的科學原理：加壓和作用，將一些物理元素加入當中。這樣才能有效幫助學生學習。

訪問者：現實與理想的差別？
受訪者：我認為一定有些出入的地方。首先，部份老師例如我自己都不敢自稱培訓非常好，始終作為老師我們大多只專注個別科目。而STEM涉及不同範疇，必定難以精通各項。而且大多學校都將STEM歸類為課外活動，而上課時的S、T、E、M會各有各教，因此我認為推行上很難成為一個跨學科、常規性的學習活動。另外在資源方面，一些基本硬件學校都能提供，但當需要成本較高的資源時，例如玩機械人，讓學生嘗試不同的Engineering，本地中小學就未必願意撥出資源讓全級的學生參加。根據我的經驗，學校最多只能讓大概十多個學生去嘗試。雖然情況未至於到對待差異，但是資源始終不足以應付更多的學生去嘗試。我亦嘗試過教授機械人時，學生一來沒有自己的機械人硬件，二來沒有比賽場地去嘗試，這樣推行STEM其實很多方面都未能發展。

訪問者：你信心大嗎？
受訪者：中度。本身自己都有一些推行STEM的經驗，大概理解STEM教育的原意，知道當中的學習目標。但是有時候師生比例較大，例如我需要一個人教授30人的有關Microbit班別，分組時都需要親身入組去作幫忙和觀察進度，我便很容易分身不暇，最終會因為時間不足而令教學效果欠佳。而且時間不足，課堂可能只有半至1小時，在恆常的時間表內亦不會出現STEM的常規課堂，因此能做到的頗有限。而資源方面，我曾要求學校開設更多進階的機械人班，但是學校未能提供資源、教材和未能安排時間，就會規限了推行STEM的進度。

訪問者：自身教授時的困難？
受訪者：我本身主修電腦，所以熟悉的主要會是Technology和Engineering，Science方面的知識就會較弱。當需要教授一些較為深入的Science概念，我便沒有信心如修讀科學背景的老師般教授得到。

訪問者：大學提供的支援夠嗎？
受訪者：大學的課程在教授寫lesson plan時很少會提及跨學科的教學，只會以獨立一科去作教學。沒有機會讓我們去嘗試以跨學科的形式去組織活動，亦沒有教授我們如何integrate各科知識去成為一科或一個活動。我認為大學在這方面的培訓可以更多。

訪問者：跨學科重要嗎？

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受訪者：我認為推行STEM教育時，以跨學科的形式十分重要，因為始終STEM就是融合Science、Technology、Engineering和Mathematics於一身，我認為要完整推行STEM最理想即是將四個項目都能integrate於課程內，跨學科就是最好的辦法，甚至是必須的。

訪問者：根據你的教學經驗，學校是如何推行STEM?
受訪者：有些學校資源豐富，會將很多資源撥落STEM的課程，但暫時就我的觀察，性質都不算認真，而是一個課後活動。學校是否真的將STEM成為該校的課程，或是有課程的評核就很少。我認為推行STEM原本是能幫助學生學習的方法之一，現時的做法就像只是一個課外遊玩的活動，順便學一些知識。我認為學校應更重視STEM教育的發展。而硬件方面，學校有撥出資源於不同科目，但是各科有各自的素材，而不是跨學科，我認為這不是STEM。例如之前我曾入校教授STEM的課程，當時就是於電腦科學習Scratch，課程名稱雖然叫STEM，但是卻只是在運用Technology，未能達到STEM的原意。而活動前中後，亦沒有特別的講解，只會教授如何使用，學生並不明白學習到的重點是什麼，與其他學科有何關連性，他們很少時候提及關聯性，令到雖然課程叫STEM，但一切都很分散。

訪問者：資源足夠嗎？
受訪者：我認為這幾年資源已有更多，以往可能只有少部份學生能夠參與其中，到現在成本夠低的STEM的教材基本上成班都能接觸得到。但是我認為亦有改善的地方，例如師生比例需要提高，讓更多的老師去教授大班，或將學生拆開成為小班教學，因為推行STEM老師的角色不是單方面講解，而是需時常親自入組去觀察進度如何，去協助他們。另外，有些學生進度較慢，師生比例低時，學生會不知所措，老師亦未能即時察覺他的需要，甚至沒有時間幫助他。整體而言，如果要有效推行STEM，我認為可以將每個學科的課時撥出，讓STEM成為一個跨學科的常規課程，這樣對學生才是最好。

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Appendix 5: Transcript of Participant E (Pre-service Teacher)

受訪者 E 的背景資料
修讀科目：主修常識，副修 STEM 教育和英文
教學經驗：2 年 STEM 經驗，實習、課外活動班

訪問者：教授STEM的經驗？
受訪者：實習時，我有教授熱的傳導，每位學生會得到一份小冊子，然後需要學生製作保暖瓶，當中需要運用STEM的元素。需要在家運用不同物料嘗試，然後在課堂上進行實驗。校外有教授Robotic STEM課程和Scratch Jr.，主要嘗試解難。

訪問者：STEM是什麼？意義？
受訪者：讓學生去接受挑戰，運用解難能力和發揮創意。因為STEM的活動與主科不同之處在於較為接近生活難題。

訪問者：常識STEM老師具備條件？
受訪者：首先要有科學知識，其次是創意。我認為STEM較貼近科技和科學，需要學生完成實驗，假如老師沒有這方面的背景知識，就難以解答學生問題。而老師的創意思維亦會影響學生能發揮出的潛能，學生會因為老師願意接受而用於創作。

訪問者：常識中的STEM重視什麼範疇？
受訪者：解難能力。我認為推行STEM教學時大多都沒有標準答案，當學生遇到難題時，例如原來這種物料不可行，就需要思考替代方案，找出問題所在。

訪問者：現實與理想？
受訪者：時間不理想。一班內有30個學生，即是在連堂，亦未能讓大部份學生展示成品，並解釋自己的創作過程和原因。

訪問者：信心？
受訪者：低。我認為自己實踐的經驗比較少，實習時很少機會接觸STEM。

訪問者：教授中遇到什麼困難？
受訪者：能力不足。曾經嘗試過與學生砌機械人，但過程中遇到問題，我就需要花很多時間與學生一起找出答案。這些事先到不能準備，因為我並不能準備所有步驟讓學生跟隨我做。因此我的經驗不足會導致未能處理突發情況。

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訪問者：大學課程培訓足夠嗎？
受訪者：常識科的課程於STEM培訓一般，而且沒有實踐機會，因此只能靠自己參加不同的計劃去學習和獲得經驗。而STEM教育的課程中，比起常識科我能選擇不同的選修課，例如機械、音樂、課堂上的創意教學。我認為常識課是主要學習科學和人文知識，而副修STEM教育令我明白在什麼情況應用什麼方法融入STEM。我們需要進行不同的project和書寫教學計劃。當中亦會學習一些硬件的運用，例如makeymakey。

訪問者：大學需要給予更多支援嗎？
受訪者：要，現時較缺乏推行STEM教育的實習。我期望能得到到校實習的機會，例如一星期一節。

訪問者：有教授如何將STEM融入於教學之中？
受訪者：不多。不會告訴我們於哪個課題可以怎樣應用，而是教授了教學法後需要我們去思考適合放入於哪個課題之中。例如：創意教學法SCAMPER。

訪問者：學校應用跨學科形式推行STEM嗎？
受訪者：以跨學科的形式是好的。可以讓學生於不同學科都能體驗STEM教育，而不是只放重常識科。另外，我認為要因應題材，例如常識科教授的全球暖化，當中涉及了不同元素，例如數學科的溫度，這時候利用跨學科學習就能對學生的學習成果最有幫助。

訪問者：學校怎樣推行STEM?
受訪者：我的實習學校會於Other Learning Experience時段舉辦STEM課程，一星期會有一節，學生只參與一個學期。而課程的選擇是老師挑選給學生，老師大多挑選拔尖學生。課程是外聘校外導師，主要教授編程軟件。並不是去解決難題，亦不會有成品。

訪問者：硬件和軟件？
受訪者：學校有撥款去翻新STEM Room，設有很多手提電腦，讓每位學生都有電腦去學習。亦有擺放機械人，讓學生在星期六的課外活動時學習。

訪問者：整體香港環境資源足夠嗎？
受訪者：足夠。教育局有撥款，使用彈性，學校能利用這筆資金去規劃校內STEM設備或作推行計劃。

訪問者：過往合作推行STEM教育的老師會有能力不足的問題嗎？

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受訪者：他們通常會透過共備去一起探討和解決問題。所以不會因為能力不足而造成困難。

訪問者：香港STEM教學的好與壞？

受訪者：好的是教育局有給予撥款，亦願意去推行。但是沒有一個框架讓學校知道 STEM 教育需要教授什麼。坊間亦沒有教科書或課程大綱，學校大多使用校本課程，自行設計。如果能夠將不同學校的案例分享，整合成一個網頁或小冊子，會更好。現時教育局亦有提供一些事例，但數量較少。因此學校在推行 STEM 時，老師亦沒有足夠的時間去將 STEM 的本質展現與教學之中。

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Appendix 6: Transcript of Participant F (Pre-service Teacher)

受訪者 F 的背景資料
修讀科目：主修常識，第二主修中文
教學經驗：4 年 STEM 經驗，實習、課外活動班

訪問者：如何教授STEM?
受訪者：Microbit、3D printing、mBot、AI。

訪問者：什麼是STEM?
受訪者：推行STEM教育主要訓練學生解難，先要有問題，然後學生要着手解決，當中亦涉及邏輯思維、創意力和解難能力。對學生而言，平常在課本上學習到的知識都很有限，亦很少時候能夠涉及解難能力和創意，主要靠背誦。STEM教育就能幫助學生反思生活中有什麼問題需要去改善。

訪問者：STEM教師需要具備什麼條件？
受訪者：首先在學識上，需要對STEM四個範疇熟悉，老師應該上training或需已學習有關STEM教育的知識，才去推行才是最好。另外，老師應與學生一樣需要有解難能力和創意力，在教授的同時亦能向學生展現思考的過程，學生就能有很大得着。

訪問者：STEM元素融入常識科中？
受訪者：有。STEM教育講求解難能力，我在實習的時候，曾教授測試水的形態變化，需要進行實驗，實驗進行期間需要運用STEM的思考過程。會先有問題出現，學生要預測當中出現的情況，完成實驗後老師亦會與學生作反思，並在再作改良。雖然STEM的元素未能充分運用於常識科，主要集中於Science和Mathematics，但有融入STEM教育的核心，即解難能力。

訪問者：根據過往經驗，現實與理想？
受訪者：設計STEM活動的時候預期學生能很快思考到解決辦法，和自主性較高。實際運行時，學生程度不足和投入程度不一。能力較弱的學生頻率較高，能力較高的學生會主動表現自己，分享自己的作品給予其他同學觀賞。他們的滿足感大。但能力較弱的學生很容易跟不到課程節奏，就會變得被動。

訪問者：信心？
受訪者：視乎學校要求。如果學校初步發展STEM教育，我會有較大的信心，因為初始是對推行STEM教育的要求未必高，我有能力發展比較初階的課程。但假如學校已有較長推行STEM教

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育的歷史，他們發展已成熟，我的教班經驗和大學課程的知識未必幫助到學校，他們可能已有這般的知識。都學校要求高，以我的能力未達到要求，信心就會低。

訪問者：困難挑戰？
受訪者：有些學生能力和自主性不足，老師與學生的互動就會較少，學生亦有機會未能完成任務。當每個同學手上都有一個機械人，學生就會容易忽視老師的講解，未能達到STEM教育的目標。

訪問者：有些現職老師認為師訓時應有培訓，修常識科時有幫助你STEM教育的發展嗎？
受訪者：一般，甚至不太足夠。五年教育本科課程內只有一至兩個課程是有涉及STEM教育的學科，內容亦太少和較為初步簡單。所以很多STEM的技能和知識都是靠自學或自行報讀大學舉辦的STEM課程。

訪問者：需要怎樣的支援？
受訪者：知識上。我希望大學本科課程會有專門學科教授不同platform的coding，例如scratch、python。亦希望大學會有培訓和實習機會，專門讓我們教STEM會更好。因為老師吸取經驗才能教得好。

訪問者：如何推行最好?
受訪者：Project-based。跨學科不是不好，他能在不同的學科將STEM元素融入，在本科學習時能有更多機會接觸STEM。不過在執行上，當老師需要討論如何將STEM元素融入科目時，開會的時間和動員人數非常多，主科老師會感到吃力。反而找一Team的老師專門推行STEM教育，舉辦Project-based的活動讓學生參與會更好，學生會有明確的目的和清晰了解STEM教育中的意義。最理想甚至將STEM變成獨立一門學科，有一個STEM Week或者STEM Day都可以。

訪問者：實習學校如何推行STEM教學？
受訪者：第一次實習學校，會將STEM獨立成科，學生每個星期都會有數節課上STEM，他們將本來電腦科、常識課的課時刪減，然後騰空成STEM科。所以學生每個星期都會學習STEM中的技巧。第二次實習學校，沒有STEM科，會於常識科的實驗中加入STEM元素，但我並不認為這是STEM教育，純粹他們自稱STEM。在培訓方面，我實習的時候亦有參與學校給常識科老師參加的STEM講座，而學校定期亦有舉辦。

訪問者：為什麼會說學校是自稱STEM?
受訪者：我曾參與保溫的實驗，利用不同保溫物料去測試保溫能力。過程中有涉及Science元素，例如熱的傳遞的原理，數學方面，是觀察溫度計和溫度轉變，即是減法的運用。Technology和

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Engineering就沒有。我認為是用STEM去包裝一個常識科的實驗。而當中最涉及STEM元素的是後來亦有一個改良的環節，需要學生找出實驗中的漏洞，並在進行測試。這個過程就涉及解難。

訪問者：老師Talk?
受訪者：創意思維。他講解創意力的理論，如流暢力。

訪問者：整體香港應如何改善？
受訪者：在老師培訓上，大學的課程應該投放更多於STEM培訓，讓準教師能為日新月異的課程和科技作好準備。好的地方是很多學校都在發展STEM教育，除了學校老師教授外，亦會校外聘請STEM的公司到校舉辦興趣班。整個風氣都很好。不過學校對老師的培訓就需要更多。

訪問者：配套足夠？
受訪者：我知道教育局網上亦有STEM的教案，但是未必跟上現況，例如AI都比較少，但大都是關於邏輯思維訓練。我認為教育局能夠提供更多範例讓老師去參考。

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Appendix 7: Transcript of Participant G (Pre-service Teacher)

受訪者 G 的背景資料
修讀科目：主修常識，第二主修數學
教學經驗：5 年 STEM 經驗，實習、課外活動班

訪問者：STEM教學經驗？
受訪者：我在校內校外都教授過STEM教育。主要教授科技的應用，例如microbit、scratch、dash & dot。亦有協助STEM工作坊的進行，例如教大舉辦給小學生參與的環保智能家居日營。

訪問者：STEM教育是什麼？其實對學生又可以意義？
受訪者：我認為STEM教育是讓學生有機會從日常生活之中找出問題或麻煩之處，然後透過自己的解難能力及嘗試，去找出解決方法。對學生而言，他們能夠發掘自己的潛能，始終未必位位學生都合適於傳統教學模式，較少機會動手做。第二STEM教育較貼近生活。這種能力不像傳統知識，一定能運用於日常生活之中。甚至可以說是給予學生機會將本科知識運用出來。

訪問者：任教的教師需要什麼條件？
受訪者：我認為最重要的是有勇於嘗試新事物的心和具備創意思維。STEM教育與日常生活息息相關，當中的科技貼近現實發展，需要老師定期更新自己新的事物。其次，推行STEM教育不同以往傳統的科目有一定的框架，過程中需要學生發揮創意去進行解難，答案不只一個，老師的思維很影響學生。

訪問者：常識中的STEM?
受訪者：通常較為重視科學知識和解難能力。始終常識科中能運用STEM的元素主要為科學題材，假如學生沒有基礎的科學知識，即使我給予相對應的STEM活動，學生因不理解當中原理亦不能完成。另外STEM教育無論在什麼科目中推行，最重要的是培養學生的解難能力，期望學生能於日常生活中找出問題，並利用自己的方法去解決和改良。而這亦是生活中需有的能力之一。

訪問者：理想與現實？
受訪者：現在的趨勢往往將STEM教育變成學習科技工具，例如microbit、mBot、scratch。學生學習後並不知道當中的意義，感興趣的學生會覺得好玩，不感興趣的學生只是跟着老師的指示去做。失去了STEM教育當中與日常生活的關連及解難的部分。最理想應是讓學生發現生活中的問題，然後去利用科技去解決問題。例如我之前參加的環保智能家居日營，先讓學生思考現時家居不環保的地方，再去用microbit去作改良，如測光測溫從而調整家中光度。

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訪問者：信心？
受訪者：我算是有信心。我認為STEM教育最重視的創意和解難能力我都能應付，而且我過往亦有經驗。但是當去到要牽涉到深入的科學知識或科技，例如python或engineering的部份，我較少接觸，亦不是理科背景，自然信心大減。

訪問者：困難和挑戰？
受訪者：我曾經嘗試過教AI的工具，但當中的接駁已經令我覺得很混亂，所以當學生問我的時候，我都需要跟他一起嘗試，才能夠知道答案。在過程中會害怕學生認為老師都不懂，教學時間亦拖長。我認為這是有關我科技知識不足的問題。

訪問者：大學課程培訓足夠嗎？
受訪者：不足夠。常識科課程只有一至兩個course是說明STEM教育。而且當中大多數都是STEM教育理論的說明，以及部份科技工具的使用，例如創意思維、scratch的基本用法。當中實踐機會較少，而我們亦不需要做相關的功課。而我哋第二主修的數學科反而比常識科更多STEM教學，需要我們利用不同的科技，去寫STEM融入數學科的教案，並要拍攝微格教學。如運用Fusion360製作數學教具去教授指定課題。因此，我需自行報讀大學其他課程去學習更多軟件的運用，但是還是欠缺將STEM教學融入常識科的知識。

訪問者：學校應如何推行？
受訪者：我認為最理想的做法是以project的形式，給予一個月時間學生去完成。開始時老師可以定立範圍，如環保家居，先讓學生觀察日常和蒐集資料，找出問題後與組員一起運用課堂已學到的科學知識、數學技巧和電腦科學到的科技運用去創作成品。過程中老師不應給予建立成品的步驟。而整個過程即使要評分，應根據學生的解難能力、創意、協作能力等作評分，而只不是觀察成果表現。

訪問者：普遍學校推行方式？
受訪者：我知道大多學校以跨學科形式進行，於學期中的數節課舉行STEM活動。例如學生於常識科學會作用力和反作用力後，學生需要進行量度和製作不同長度或物料的紙蜻蜓，然後觀察結果和作紀錄。我認為此方式好的地方是能夠運用學科中的知識，讓學生理解到知識的重要性。過程中亦需要學生判斷如何是最好的結果，需要學生運用解難能力去作改良，但是活動忽略了與日常生活的連結。除此之外，我曾觀察過有學校的STEM課只是電腦課，他們會學習如何使用microbit和scratch。甚至有些老師只會播放網上教學影片，因為他們自己都不懂又要去教。

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訪問者：香港配套和培訓足夠嗎？

受訪者：我認為配套足夠。大部份學校都有購入所謂STEM教育的器材，如microbit電子板。但是培訓不足，有些老師根本不知道怎樣使用。又或是說，他們根本不願意去學習，即使你給予培訓，他們亦無能力將其融入教育之中。

訪問者：香港STEM教學的好與壞？

受訪者：我認為現時香港STEM教育過份偏向科技發展。我認為簡單的STEM教育，即是不用牽涉任何科技工具亦可以進行，例如讓學生思考如何只使用膠紙和A4紙建立出最高的一座塔。當中已經能令學生發揮創意和去作解難。但現時推行STEM教育時，大多學校只注重帶出的成果，和跟隨其他學校節奏，變成每間學校都只在上科技課。

訪問者：如何改善？

受訪者：我認為在一至三年級，應習慣讓學生找出生活中的問題，然後給予指定工具，要他們製作能幫助他們的作品。到高年班時，才給予科技，讓學生運用科技再作生活解難。我認為當中的重點是推行 STEM 教育必須與生活連繫一起，學生才能於將來運用出來。

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Appendix 8: Transcript of Participant H (Pre-service Teacher)

受訪者 H 的背景資料
修讀科目：主修常識，副修視藝、STEM
教學經驗：3 年 STEM 經驗

訪問者：推行STEM教育經驗?
受訪者：手工、m5、高卡車、電腦編程。

訪問者：STEM教育有什麼意義？
受訪者：STEM教育是一個平台讓學生去訓練創造力，和展示他們的創意。對學生有很大的意義，例如他們需要合作，突破傳統的框框，不再局限於傳統的教科書上去獲取知識。他們很多時都需要trial and error，即是錯誤對於他們來說，到時一個學習的機會。STEM會不斷鼓勵他們重新去嘗試，重新學習，沒有一個正確的標準。

訪問者：STEM老師需要什麼條件？
受訪者：有耐性，要有專業的知識，本身都需要具備創意力，才能啟發到學生，給予適當的方向讓學生思考。

訪問者：常識科STEM重視哪個範疇？
受訪者：我最重視學生的解難能力，相反本科知識未必佔太多部份。在解能力方面，我會讓學生不斷嘗試用不同的方法，他們亦可以看到其他同學所用的方法，從而去刺激他們的想法，原來有不同方法解決同一問題。

訪問者：理想與現實？
受訪者：當然希望STEM日後會變成一個主要科目之一。現時很多時候是用興趣班、課外活動的形式去帶入STEM，這些方式都主要視乎學生本身自己的興趣，因為興趣班不會讓全校學生都參與。但是STEM這一個學科對於所有學生而言都是很適用的，當中的理念和學到的技巧技能，學生都能應用於其他科目。最理想當然是再全面和更普及去推行STEM教育。

訪問者：信心？
受訪者：中度。因為STEM教育日新月異，不斷在轉變，作為一位教師要經常裝備好自己，除了現有的知識外，亦需要不斷去學習新的技能和知識，例如當有新的編程軟件，你都需要自己去學習。學習後，亦都需要快速理解，才能告訴學生。

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訪問者：困難？
受訪者：大部份時間都遇到一些學生沒有反應或比較靜的學生，很難讓他們說話。例如做小組討論活動，他們都會比較靜，或是沒有發揮的機會。這個時候我都會鼓勵他們用圖畫的方式，用文字去表達他們想說的內容，亦能讓其他同學都能理解他們的思想和意見。

訪問者：大學的培訓足夠嗎？
受訪者：我認為大學的培訓主要是給予我們多點機會去嘗試不同的硬件，但在實踐方面就比較少。很多時候都是靠同學自己另外去獲取教班經驗去彌補不足的地方。而大學中副修的STEM課程主要是學習思維方面，一些STEM新興科技試玩，例如如何組裝。但是這些都很難去實踐教授小朋友，因為大學不是教你如何利用這些硬件去教授STEM。所以我最想要的支援是實踐的經驗，讓教師知道利用m5如何教導學生。又或者一些手工班，如何能教識學生。

訪問者：根據你的教學經驗，學校會如何推行STEM？
受訪者：通常學校會用興趣班和課外活動班的形式去推行STEM教育，大多是用課餘時間進行。資源足不足夠就視乎學校方面是否願意撥出資金，一般來說STEM教育都是一個熱門的議題，大部份學校都願意，但是至於啱唔啱用就要視乎學校如何選擇硬件上的購入。

訪問者：應該如何推行？
受訪者：在常識科都有慢慢滲入於課程之中，我有見過一些學校會於常識科去用STEM的形式做專題研習，擺脫傳統教科書的教學。我認為長遠而言，可以由常識科先行做起，課程改革方面有一半可以使用STEM的專題研習方式、小組活動、或是STEM的模型、機械人的組裝去代替本科的課程。

訪問者：跨學科推行STEM重要？
受訪者：因為STEM不單止可以在常識科中推行，其實不同科目都能做到，例如視藝科、數學科。因為STEM的核心價值不單止訓練學生的思維能力，亦能普遍運用於其他科目。

訪問者：進步？
受訪者：政府可以給予更多資源學校，讓學校順利運行 STEM 教學計劃。很多時候有些學校已經踏出一大步，因為他們的資源比較多，願意投放。有些學校相對傳統，較為執着於教科書的教學。STEM 很難用成績去評核學生叻唔叻，整個教學風氣不應注重成績，而是可以檢視學生的創意、解難能力、思維。STEM 這門學科可能不要計分，而是去評估他們整個計劃的表現，這樣能令學生更有興趣，明白原來這一課不是為分數的，而是為自己的興趣去進行的，這樣就不會有太大的壓力。

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Appendix 9: Transcript of Participant I (Pre-service Teacher)

受訪者 I 的背景資料
修讀科目：主修常識，副修 STEM、中文
教學經驗：一年 STEM 經驗，實習、課外活動班

訪問者：STEM教育是什麼？
受訪者：我認為STEM是跨學科的學科。透過多科合作，從而提升學生的創意力、解難能力和協作精神。

訪問者：老師需要什麼條件？
受訪者：首先是知識，需要了解STEM教育的課程需要發展，coding方面的知識。

訪問者：常識中的STEM?
受訪者：我會重視本科知識。STEM在常識科中重視科學議題，例如光、水，老師先要幫助學生建構基礎知識，才能進行分組活動，因而透過動手做去帶出課題中的知識。其次是解難能力，學生在常識科中的STEM教育可能需要解決日常生活中的問題，而且其他傳統科目較不注重和較難實現解難能力上的培訓，例如中英較多背誦。

訪問者：現實與理想？
受訪者：我認為時間方面，課程緊湊，推行STEM教育時需要學生和老師課堂以外的時間去完成，令到教授內容不深入。例如我曾帶領低小學生動手做活動，課堂只有一小時，結果未必每位學生都能完成成品，最後令到老師需要額外的時間協助他們，而他們亦未能親自完成作品。

訪問者：信心？
受訪者：低。雖然我有修讀STEM教育，但很多時候都是理論層面，而我認為推行STEM教育需要更多實踐，我自己較少STEM教學經驗。而且STEM教育注重科學知識，我中學不是讀Science，認為自己科學知識比較弱。

訪問者：常識科和STEM有教授如何將STEM元素融入教學的方法嗎？
受訪者：我認為常識科比較少。常識科課題太多、太廣，未能重點教授STEM教育如何推廣至學生層面。已副修的科目令我反而更加多機會了解STEM教育，更多實踐，例如3D printing、microbit，亦有講解教學法的運用，例如SCAMPER。但實際上不足夠因為主要是理論的部份。

訪問者：教授中的開心與困難？

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受訪者：因為不是理科背景，所以在解釋科學理論時，如機械中的力、動能，我都未能清楚解釋。不過在推行STEM教育時，能容易感受到學生的成功感，他們亦因為STEM愛上了科學，是很感動的地方。

訪問者：你的教學主要focus科學嗎？
受訪者：對。我主要運用動手做的方法教導科學原理。

訪問者：大學應給予更多培訓嗎？
受訪者：需要。現時學校都注重STEM教育，而且課程變化速度快，我希望大學能夠給予更多培訓，實際情況多於理論，例如實踐機會，讓我們知道如何融入教學之中。

訪問者：應如何在學校推行？
受訪者：我認為由數學科、常識科、電腦科三科去跨學科定期完成專題研習，例如一個學期做兩次。除此之外，亦可以舉辦講座或活動日，讓學生能夠享受學習STEM過程，過程中亦能深透三科中的知識。我認為不能只在常識科中推行STEM教育，會很單薄。跨學科學習能令到學習變得雙向和多元化，有機會去應用知識。

訪問者：根據教學經驗，香港普遍學校是如何推行STEM教育？
受訪者：以我的實習學校為例，學校推行度不足，STEM教育的文化不濃厚，每個學期會完成一個project，但不是以跨學科形式，只是在常識科去做關於STEM的課題，甚至科學活動就等於STEM教育。該學校的常識科panel年資較大，不清楚現時STEM教育的趨勢，亦沒有該方面的人才，所以學校中的STEM活動不太多元化。而學校比較重視成績，課程較為注重教科書內容，大於一些校本STEM活動。學校有設立STEM room，但因風氣和老師不懂得使用而令使用率較低。

訪問者：香港配套和培訓足夠嗎？
受訪者：我認為配套是足夠的。每間學校都設有STEM room，甚至有3D printer。但是我認為教師培訓不足，因為甚至常識科major的同學，例如我自己都不熟悉STEM教育，更何況不是主修常識科的同學或老師，他們會更加少這方面的專業知識。

訪問者：香港推行STEM教育時出現什麼問題？
受訪者：STEM教育需要資金，有些學校較少資助或資源，即是老師想推行，亦有心無力。

訪問者：風氣如何？方向正確？

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受訪者：我認為算是濃厚。坊間有不少STEM的比賽，例如microbit方面。我認為在跨學科去推行STEM教育這方面的方向是正確的，在活動進行當中能夠重溫不同科目的知識。但是我認為需要有更明確的STEM教育的課程，讓老師有更多指引去跟從。

訪問者：怎樣的指引？
受訪者：於不同年級的活動建議，但不需太過規範，因為STEM教育講求創意。我認為提供指引令到學校和老師對推行STEM教育是不會造成混亂。

訪問者：如何令學生成效更大？
受訪者：第一是給予現職教師更多培訓，提升老師的自信心和有更多經驗。第二時撥出更多資源給學校推行，沒有適合的設備，教學根本不能實行。

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Appendix 10: Transcript of Participant J (Pre-service Teacher)

受訪者 J 的背景資料
修讀科目：主修常識，副修數學、STEM
教學經驗：4 年 STEM 經驗，實習、課外活動班

訪問者：推行STEM教育經驗?
受訪者：Coding(swift, app inventor, scratch)、機械人、mircobit

訪問者：STEM教育的意義？
受訪者：對我而言，STEM教育是融入於不同學科，讓學生發揮創意，同時增強思維邏輯能力，去創作。對學生的創造力而言非常重要，當學生有創造力他們亦會有不同的新想法。對社會而言能創造不同的可能性。

訪問者：老師的條件？
受訪者：我認為老師要推行STEM的話，需要願意學習，STEM包含很多範疇，而且時代科技不斷進步，有好多update的資訊，需要與時並進。其次老師需要創新，多創意，因為教授學生是需要創意的思維，當中老師亦需要有創意的思維才能教授他們的思考方法。亦要有很強的解難能力，因為當中學生學習的是解難能力，老師都要先具備。

訪問者：GS重視的範疇？
受訪者：我認為在常識科中教STEM最着重的是解難方面，因為要讓小朋友學習日常生活的不同知識，應用於生活當中。當中應用的部份是讓他們解決日常生活的問題我困難。所以我認為解難能力正正讓學生能夠實踐，而且較為貼地可以運用於平日當中，這才是學習有需要的位置，有目的讓學生學完後有機會運用到，解決日常生活中的問題。

訪問者：STEM至想與現實？
受訪者：我覺得STEM可以用最簡單和普通的顏料和物料，甚至是環保物料，去做小實驗和小活動，又或者去解難。但是我看到現在的STEM教育發展很多時候用到先進的科技，很貴的儀器，再讓學生去學習操作，例如機械人。我覺得未必需要去到這個位置，因為對於我來說STEM是讓學生學習解難能力，亦都學習到科學上的知識，未必需要令到門檻那麼高，這麼難去讓學生接觸得到。我覺得應該要門檻降低，讓很多不同的學生都能夠親身接觸。

訪問者：教STEM信心？
受訪者：高。因為過去有教授STEM的經驗，自己本身亦是理科背景，而且我們對於常識科比

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較熟悉。如果在小學裏教授STEM的話，無論教授編程，還是邏輯上或科學上的課題我覺得都有信心。

訪問者：困難？
受訪者：有時候即是我們是老師比起小朋友有更多的知識，小朋友總會有一些意想不到的問題，很特別創新的想法，甚至乎老師都未必解答得到。在這方面我們無法即時回應學生問題。

訪問者：大學培訓足夠嗎？需要什麼支援？
受訪者：我認為大學給予我們的培訓未足夠。因為很多時候只教授理論的知識，但我們很少時候真的去學習教STEM。主要學習操作上的理論知識，當需要落手教學生STEM，這是就需要靠自己做兼職、去機構試教才能練習得到。

訪問者：根據你的教學經驗，學校通常是如何推行？
受訪者：根據我的學校經驗，有時會有STEM的體驗課會放在常識科作為一個試點。例如首先會在拔尖班裏測試一下學生體驗STEM教育時有什麼效果，有什麼學習情況，之後覺得可行就會在推展到普通班。當中會用到Lego積木、機械人mBot等資源設備去教學生去學習STEM。有時亦會與該級別的常識課題相關，例如當課堂學習到「電」時，會砌一個關於閉合電路的STEM實驗或活動，讓學生去體驗。

訪問者：STEM應如何推行？
受訪者：我覺得STEM教育可以配合課程安排，例如該級別的學生學習到「磨擦力」這類科學課題時，那個月份或禮拜可以舉辦相關的STEM活動，不要安排其他課題的活動。這樣才能互相配合。甚至乎STEM不應只在常識科時推行，而且能夠跨學科進行。例如在某個月份舉辦project，可以涉及不同學科，如視藝科、電腦科、數學科等combine一起去教授課題。不同科目分工做不同的部份，最後才整成一個作品。這也是一個很好的推行方式。

訪問者：跨學科重要嗎？
受訪者：重要。因為透過跨學科的形式教授的時候，小朋友才明白原來什麼時候都能接觸到STEM，很多時候都能應用到相關的知識於不同的範疇上。這才能讓學生感到貼地、實際的、容易操作的，容易應用於生活之中。

訪問者：你認為怎樣再能進步？
受訪者：我認為STEM這門學科未必一定要與成績掛鉤，我認為可以是一個興趣班，比較free的，任學生真正發揮他們的創意，讓STEM教育的風氣更加進步。如果很多事項都與學科一樣與成績掛鉤，學生就未必有足夠的膽子去發揮他們的潛能，他們可能只求穩陣，因為需要合格或中

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上的分數，而不夠膽冒險去嘗試。但STEM教育正正是讓他們去發揮科學家或小小發明家的精神，去讓他們不斷創作和創新。總結而言，我認為STEM風氣再需進步，不應該從成績掛鉤的方式去推行STEM。

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Appendix 11: Transcript of Participant K (In-service Teacher)

受訪者 K 的背景資料
任教科目：電腦、常識、數學
職位：老師

訪問者：教授STEM的經驗？
受訪者：我們學校教授STEM主要在電腦科，小四至小六以前上電腦堂會學習PowerPoint、剪片、打字等課題，這些課題現時會咁少，而增加了有關STEM的元素，主要讓他們接觸不同的科技，例如我們會使用Tinkercad去學習3D printing，又會利用Microbit和Scratch去學習編程。亦有教授mBot，或利用Microbit去接駁不同的感應器去製作一些發明或機械人等。

訪問者：STEM是什麼？有何意義？
受訪者：STEM一路以來由美國主導，主要希望普及科技的應用，以及激發學生於解難能力和創意思維的想法，讓學生有更大的能力和點子去製作一些發明品，從而去貢獻社會和作創科方面的發展。我認為這是STEM教育最想達到的目的，就是令我們的下一代有更多創科、解難的能力。現在香港都有個趨勢叫21st Centry Skills，有不同的範疇和能力包括在內，而STEM教育所注重的範疇與21st Centry Skills亦有很多重疊之處。

訪問者：老師具備的條件？
受訪者：我認為第一是老師要有一定的知識水平，例如數學老師只會計算，但不會任何科技，這樣就不行。相反作為常識科老師亦不能對科技和數學有太少的理解。老師未必需要勝任所有範疇，但是少要具備基本知識。第二是老師需要有懂得去培養學生的能力，推行STEM的目的並不是去教授書本上的知識，例如培養解難能力並不是靠做練習就能培訓到的能力，而是需要一個環境去塑造。因此老師應有相關的教學設計和安排。而我認為STEM四個範疇之中Technology相較為緊要，因為於小學階段Science所涉及的原理不至於過於複雜，於STEM注重的不是科學知識本身，意思如何將其能應用。而Engineering都需要很多科技上的協助。因為推行STEM很注重去完成一件物品，所以我認為T和E是教師較需要有的能力。第三是老師自身都需要有解難和創意能力，才能親身示範或啟發學生。

訪問者：本科知識比較不重要嗎？
受訪者：我認為常識課時已經學習了本科知識的部分，因此推行STEM教學時本科知識就不會是最重視的部份，因為其他科目已經支持了學生的本科知識。而且我認為推行STEM教育的主要目的並不是學會一些本科知識，而是將四方面的知識融合一起作為應用，重視的是利用這些

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能力轉化成為一件產品或發明。總括而言，應先從其他科目學會知識，舉辦STEM活動時，透過創意和解難能力去發揮已有知識。

訪問者：你在學校有信心推行STEM教育嗎？
受訪者：在自身能力而言，我亦很有信心。我曾任教兩間學校，前者任教四年，後者任教六年。上一間學校起初時未推行STEM教育，後來亦只有一個初步的狀態。但在現時這間學校，我曾經歷STEM推行的轉變，因此我亦由對STEM了解不多到現在進修了不少，因此認為自己都有能力。另一方面，學校與教育政策的支援亦很重要。例如即使我很有信心和能力推行STEM教育，學校卻未能安排課時，就會成為限制，令我的主意因時間而未能推行，這亦會成為打擊我的信心的原因。

訪問者：課時倉猝的意思嗎？
受訪者：又不是。學校沒有將STEM成為一個獨立的科目，而是將其參集於不同的科目。亦知道有些同工的學校可能會主要放在常識科，較少聽到有學校會獨立成科。甚至有些學校只是興趣班。由於未能有系統地長期推行，這會成為一個推行STEM的難處之一。另外以前的資源比較少，例如教材、資金，而且教師之間亦未必了解STEM教育的意思，這亦對STEM教育造成影響。

訪問者：同工對STEM教育的知識有改善嗎？
受訪者：很多老師，特別是沒有理科背景的教師，都對推行STEM沒有深入的了解。又或是有同工認為運用科技就是推行STEM，可能在他們眼中玩Scratch和3D printing就是STEM。亦有些老師認為推行STEM需要做些project。未必每位同工都明推行STEM的意義。因為始終不像傳統科目會有明確的課程和知識，所以老師自己亦難以明白。現在有更多的機會給予老師接觸和坊間有更多的討論，學校推行STEM方面已有些改善。

訪問者：學校如何推行STEM教育？
受訪者：現時小一至小六電腦課有撥出一定課時於STEM教育，而常識科亦有進行不同的實驗。例如在「電」的課題中，以前會提供電池、電線和燈膽給學生去理解電路的原理，現在會配合電腦科的microbit，運用Microbit作簡介，讓學生理解原來Microbit亦有利用電路原理運作。而硬件方面，教育局都有撥款讓學校發展STEM教育，因此學校有資源去購入教材，例如Microbit、mBot讓初小學習。以往學校有兩間電腦室，現在其中一間已轉化成STEM Room。STEM Room會有較多的設備用具，讓教師需要時到此課室上課並運用當中的工具。學校亦有增設3D printing的軟件供教學使用。

訪問者：資源足夠嗎？有什麼困難？

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受訪者：資金足夠讓我們完成想做的project，但比較不足的是課程上的支援。現在大多都是校本課程，有時候會上網參考其他學校的例子，再自行作修改。其中一個最大的困難是其他科目例如中英數常都有一個明確的課程，老師可以跟隨課程的指引而得知學生需要學習什麼，可以使用什麼教科書。但推行STEM時就未能有以上方向。但每間學校推行STEM的情況都不一，使用的工具亦不同，亦不會有統一的教材讓教師使用。不過這也因為STEM教育的本質，因為STEM課程會隨着科技進步而改變得很快，例如現在3D printing都未夠接近現況，現在新興的是AI，再過兩三年可能主流風氣又再轉變。因此很考驗老師的技巧和創意，去研發和設計新的課程。

訪問者：教育局提供更多指引，還是校本課程更好？
受訪者：我認為推行STEM時教育局提供一套規定的課程，甚至要規定學校某個時數要推行STEM的課程，這樣又未必好。因為如果全港學生根據教育局指引都學同一樣知識和工具，學校和老師跟足指引，就未必跟上時代的轉變，亦不flexible。但如果什麼支援都沒有，老師又會壓力較大，因此我認為較好的狀態是教育局不會規限學校的課程，而是提供更多資源和資訊，例如新並好用的工具和平台，而這些資源適合很多學校使用。教育局亦能提供更多培訓或分享資訊給老師，這樣更有幫助。這樣教師能考慮如何利用這些資源於教學上，和融合於課程之中。

訪問者：如何令STEM教育推行得更好？
受訪者：香港教育制度很考驗學生的成績，很講求結果。但推行STEM教育所着重的能力很難去評核，例如創意能力、解難能力，甚至可以說是沒有評核的必要。奈何香港的學校比較注重這一點，亦有聽聞其他學校STEM是需要考試。例如在課堂上有利用Scratch去完成一個task，然後於考試需要學生再次呈現。這樣事情根本沒有意義，即使學生能夠滿分完成，但當你要求他自行再創作新的project時，他根本就不懂，他只是背誦了課堂上的project。相反，有能力的學生加入了很多新的元素在project內，反而未必符合評核標準，這樣就有點本末倒置。因此在香港推行STEM的最大障礙就是制度本身有很多局限。

訪問者：理想中的STEM應如何推行？
受訪者：首先評核是不必要的。應給予學生更多機會去嘗試和創造，鼓勵學生創新。因為現時推行STEM教育有個不足的地方是，有時老師已設想一個project，然後需要學生跟着做，但最後學生其實未必明白，亦未能將其轉化成為自己的知識。推行STEM時應讓學生嘗試自己去製作一件產品。我們不應定立一個成品給他們完成。最理想的是學生先學習基本知識，明白一些工具的運用，再自行根據解難題目，去創作自己的成品。當中的過程已經能展現他們的創意和解難。

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Appendix 12: Transcript of Participant L (In-service Teacher)

受訪者 L 的背景資料
任教科目：17 年、7 年常識、數學、中文、沒有修常識（主修中文副修數學）
職位：常識科科主席

訪問者：推行STEM的模式？
受訪者：在我們的小學，一至六年級必須舉辦一次STEM的活動。我們有設立STEM的自學冊，每一年都會有一套。因為常識科一定牽涉科學元素，所以我們會根據該年級的常識課程而去設計該年級的STEM自學冊。其次，書商亦有提供豐富的STEM材料包、教材，因此一至六年級都有玩STEM。另外我們小學在七月亦有舉辦STEM Day，展示學生在STEM中的成果。我們亦會利用書商提供的材料去製作攤位，例如科學小知識。亦有舉辦STEM的興趣班，選擇一些較叻的學生去參加外面的比賽，例如坊間舉辦的STEM比賽。

訪問者：低年班高年班的分別？
受訪者：低年班注重解難的元素，科學元素較少。而高年班則兩方面都注重，因為學生已認識更多科學知識。

訪問者：STEM教育是什麼？
受訪者：STEM不一定是科學，對我而言他是將四個範疇集合於一身，然後去作解難。香港推行STEM教育十分單一，通常只會將STEM教育投放於常識科，但其實STEM教育應由多科一起推行。因為涉及數學、閱讀不同的資料，所以我認為STEM教育應變成一個獨立的課程，而不應只放重於常識科。

訪問者：跨學科？獨立成科？如何推行更好？
受訪者：一定需要跨學科。因為推行STEM教育時，所涉及的範圍太廣，現在的STEM教育需要懂得電腦，例如mBot，涉及太多科目在內。最理想而較現實能做到的推行STEM教育的方法是，已跨學科的形式進行，然後需要一位負責統整STEM的同工，去協調每一科可以貢獻和學習的地方，最終一起完成才能成功。現時學校就沒有如此職位，現況是課程主任需要完成該工作。有些學校做得比較好，就會整週去做STEM，但是我們學校是讓常識科去推行。

訪問者：Project-based?
受訪者：我認為應是Project-based才有用，因為推行STEM教育應是先有一個前設，即是有一個難題，然後讓學生解決這個問題。過程中應先讓學生先觀察社會或他人或自己，才能有動力去解決問題，定去設計STEM產品。

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訪問者：任教教師所具備的條件？
受訪者：最基本要有科學知識，因為涉及得較多科學、電腦及機械元素。如果教師不會，學生更無可能學得懂，亦未能設計一個好的STEM課程給學生。

訪問者：常識科中的STEM?
受訪者：會根據教科書的科學元素，在設計有關的STEM課程。例如在五年級學習「電」的課題，即閉合電路，我們需要學生利用閉合電路的原理去設計一個STEM元素的產品，例如吸塵機。六年班學習槓桿原理，我們要學生利用槓桿原理的物品去幫助學校解決執拾垃圾的問題，例如清潔姨姨於疫情期間不方便用手去執拾垃圾，如何設計一個夾子去幫助他們收拾窗台上的垃圾，避免危險。

訪問者：理想與現實？
受訪者：完全不符合我的理想中推行STEM教育的方法。STEM教育必須情景化才有用。現時推行STEM時太各自為政，各科自行將STEM元素放進課程中，就會浪費大家的資源。

訪問者：硬件和軟件？
受訪者：政府有撥款到學校推行STEM教育，硬件是足夠的。但問題在於軟件，即是人，不是每一位同事都識，這樣就很容易浪費資源。例如學校有mBot、microbit，但同事根本就不認識這兩個工具，又怎能運用到STEM課程之中呢？

訪問者：學校如何幫助以上同事？
受訪者：靠同工自學，自己先試一次。或是用出版社提供的材料包，又出版社告訴我們怎樣利用這些工具。

訪問者：還遇到其餘挑戰嗎？
受訪者：時間。推行STEM教育很花費時間，但同時課程十分緊張，我們學校常識科已經少時間，一個禮拜只有四節。低年班會較好，高年班就很趕急，常識科已有很多冊教科書需要教授。

訪問者：如何平衡常規課程與STEM?
受訪者：沒有。STEM又要Presentation又需要合作和砌一樣物品。只能剪裁一些現有課程，有些較為不重要的課題不教，然後變成STEM的時間。例如最後一個禮拜的四節常識科就變成STEM的課堂。

訪問者：指引清晰嗎？

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受訪者：是有的。但實行是很靠資源和該學校發展STEM教育的意願。執行上未必能做到與指引一樣那麼理想。

訪問者：現在理想嗎？
受訪者：不理想。因為我們學校修過常識科的同事不多，沒有相關背景，到執行時就自然有困難。亦要視乎學校風氣，例如有些學校較厲害，他們會擺很多資源於STEM教育上。亦要很視乎領導層，如校長，是否重視。

訪問者：需要什麼支援？
受訪者：學校需要聘請有修讀過常識科的老師，他們會有更多知識背景。另外需要放更多彈性於剪裁課程時間和要有課程主任去整合現有STEM的元素，讓各科合作，而並不是只有常識科的老師去做。只有一科的老師去做資源和時間都會有限。如果有整個星期所有科的老師一起合作只做STEM，效果、範圍、闊度亦會差很多。

訪問者：從決策者的角度，香港整體推行STEM時如何才能有進步？
受訪者：香港最大的問題是我們的教學不是project-based。各間學校都在追課程和考試。所以很多學校都像我們一樣，有STEM教育，但規模做得小。香港政府可以的話要撥更多資源，不只是給予資金，而是要去深化老師的培訓，亦要給予更多彈性去栽培，而不是一時三刻就能做到。

訪問者：老師只會認識硬件運作，而不懂得運用於教學之中嗎？
受訪者：對，其實STEM的其中一個最重要的元素是解難。很多人的想法都是錯的，認為STEM教育等於科學發明。我們需要給予學生一個前提，希望學生學會解決問題。但問題是現在很多老師都只是將一件成品呈現出來就認為是STEM。

訪問者：學校會外判給予其他機構教嗎？
受訪者：有。因為現在STEM的元素偏向mBot、microbit等科技，而我們老師真的不懂，所以真的需要外判。有些同事擅長這方面亦會自行學習。例如四年班需利用microbit去測濕，然後去解決家中濕度高的問題。幸好該級的常識科同事亦有教授電腦科，因此他熟悉這類科技就能順利完成活動。

訪問者：學校推行STEM教育時也有涉及工程元素嗎？
受訪者：我的學校主要放重於Science和Technology，而Engineering方面根本沒有老師認識。我本身要帶隊去參加機械人的比賽，我都外判了給別人教授。學校和教育局根本沒有培訓給老師，又沒有這批人才，又要推行STEM教育，根本不切實際。

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訪問者：很靠老師自學？
受訪者：對。有些學校推行得好，是因為本身校內已有不少老師已認識STEM的元素，例如Technology方面，或有做「種子計劃」。

訪問者：什麼是「種子計劃」？
受訪者：教育局培訓了一班人才，然後再放進其他學校去推STEM教育。但是有個問題是傳都第二第三代的時候，很容易會失真，大家都只是copy他們的外型，忽略當中的核心，根本不明白當中的意義。

訪問者：你有信心教嗎？
受訪者：沒有，但是都要做。所以要不停自學。

訪問者：有什麼困難？
受訪者：我最近與學生做吸塵機，有很多吸塵機的基本概念，例如吸塵機的氣壓問題，我需要自習，但讀得太深入的時候自己都不明白，我唯有與學生一起上網搜尋資料。我會很坦白與學生說，老師真的不懂，我不是讀這科出身，想要知道答案就要一起學習。科學的世界很大，不會知道所有事。

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Appendix 13: Transcript of Participant M (In-service Teacher)

受訪者 M 的背景資料
任教科目： 5 年常識、中文
職位：常識科科主任

訪問者：STEM是什麼？
受訪者：我認為STEM是彌補常識科的不足，因為STEM的原意是希望引起學生解難的能力，培養他們逆境的思維，批判性思考。

訪問者：需要具備什麼條件？
受訪者：最重要老師不應該害怕錯誤，不要害怕接受挑戰。因為STEM日新月異，作為現職教師，未必在training時有接觸到那麼多STEM的課程。當syllabus變得快時，老師應時刻裝備自己。例如我亦會參加教育局舉辦的training course。

訪問者：常識科中最重視？
受訪者：我最重視解難能力。我認為現時小學課程和常識科亦較少機會讓學生體驗解難，較少題目讓學生發掘自己的方法，訓練學生面對難題時應如何解決，較多的是簡短的問答。

訪問者：理想與現實？
受訪者：難以達到。我認為政府給予的資源不足，特別是現職教師，一來我們沒有受過正統的STEM教育培訓，二來是syllabus轉得很快，以往只教授block coding，現時會思考中學銜接的課程如python，而去調整小學課程程度，例如開始教授AI或python入門，這些較為高階的課程。我認為過於偏重本科知識，而非注重解難能力。甚至學習STEM是為了參加比賽。

訪問者：你有多大信心？
受訪者：中。我本身大學師訓時沒有學習STEM，亦沒有ICT底子，推行STEM教育就會遇上困難。特別是現時STEM教育趨勢偏向Technology，例如編程。學校又沒有支援，就會更沒信心。

訪問者：常識科STEM遇到的挑戰？
受訪者：學生遇到問題，我亦未能好好解答，特別是coding方面，有不同方法亦能完成任務，我就認為自己沒有足夠的知識去勝任。

訪問者：學校如何支援你這些問題？

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受訪者：我們學校利用跨學科形式推行STEM教育。常識、數學、電腦科互相合作。例如小二需要學生利用環保物料去製作磁力推動船，需要運用量度、磁力等科學原理。小一亦嘗試製作橡筋動力車，運用勢能轉為動能。電腦會在過程中會加入coding，低年級會教授SketchUp去編寫動畫，高年班會利用microbit和做blocky的coding。另外學校設立了STEM Room，有不同的Product在內，例如Microbit、mBot、3D printer。希望透過新設的STEM Room去促使學生有更多的機會接觸STEM的活動。

訪問者：低小推行STEM教育會有困難嗎？
受訪者：會。當低小學生要學習microbit，他們連基本電腦都未必懂得操作，只會用tablet，因此連結到Microbit的網站、輸入、插線、用mouse click都比較困難。而動手方面，他們的能力亦較弱，例如讓他們使用橡筋、加膠紙去製作成品都會太複雜。只有我自己一個人教授都會變得手忙腳亂，需要身旁有額外的TA去幫忙才能順利完成。

訪問者：於學校推行STEM的困難？支援？
受訪者：我與其他同工都較少STEM知識，去備課時都相對吃力。教育局有撥出資金，我們學校利用資金與其他機構合作，邀請入校教teacher training。但這些都是one-off training，時間約兩小時，老師學得不多，需要回家再自學，並再tailor-made我們的課程。雖然有支援但比較片面。

訪問者：支援？
受訪者：長期的training和清晰的指引。我認為可以給予更多指引，例如小學STEM的課程達到哪個程度或成果。現在有點惡性循環，不同學校都在爭奪STEM的榮譽，但未必是學生自己能力範圍以內做得到，甚至出現到的情況是成品是由老師完成。

訪問者：學生動機大嗎？
受訪者：大。對學生而言比較新穎和特別，能夠有機會去動手，因此投入。

訪問者：決策者角度改善香港現況？
受訪者：最主要需要加上指引，以免學校不停競爭，課程程度越來越難。例如小學只學到哪個位置，老師教的時候壓力亦較少。另外，我認為小學亦可以一個禮拜加一節STEM的課堂，去聘請對於STEM教育較熟悉和有經驗的老師去教授。

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Appendix 14: Transcript of Participant N (In-service Teacher)

受訪者 N 的背景資料
任教科目： 3 年常識、中文
職位：老師

訪問者：STEM教育是什麼？對學生有什麼意義？
受訪者：一定會有知識的層面。我認為STEM教育主要教授思維，學生如何去思考和解決問題，無論是數學、科學或機械性的問題。所以重視思維大於知識。不要認為學生產出高科技的產品才是STEM，製作手作已經可以是STEM。

訪問者：教師應具備什麼條件？
受訪者：首先老師自己要open-minded，要願意接受新的事物，STEM每日都在變更，幾年前在玩mBot，現在是AI。第二基本要懂得編程，否則難以帶學生出外比賽。不過我身邊很多老師都不認識以上東西，但都要推行STEM。

訪問者：你學校會需要在常識科中推行STEM嗎？
受訪者：會。學校推行方法分兩類：第一個是跨學科的STEM。常識科、數學科、電腦科三科要合作。我們一年有一本STEM小冊子，小冊子會根據該年級所學的課題然後組合一起。當教授到該課題時，就會開始STEM的部份，一科老師教授後就會pass到第二科。例如五年級數學需要學習速率，常識科會教mBot車因為與閉合電路原理相關，電腦科會教編程。編程後車就會懂得行「8」字，然後需要學生計算速率。另一方面是拔尖，老師會挑選學生，再聘請外面機構於一星期一次的活動堂去教授教高階的STEM活動，例如Lego、編程。所以我認為我學校STEM教育在常識科不是主導。

訪問者：最後會有成品？
受訪者：沒有。常識科會做個總結，例如當中遇到什麼難題，如何處理。但就不會有最後成果展示。完成小冊子就已經代表完成STEM課程。我亦觀察不到推行STEM教育的成效。

訪問者：常識科中STEM最重視範疇？
受訪者：解難能力和創意。現時學校推行STEM教育大多是老師做多於學生去做，可能已經Default一個解決方法，沒有時間和機會給學生去自己思考解決辦法，和創新的部份。我認為本科知識是重要，但是學生懂得如何運用本科知識去解決問題更加重要。例如編程時，你的coding可以是長或是短，但究竟學生懂得如何弄成短的code嗎？

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訪問者：現實達到意義嗎？
受訪者：無論在我的學校還是香港整體現況都絕對沒有。香港學校都不會將STEM真正融入課程之中，大多是以參加比賽和獲獎為目標。我自己有帶隊參加STEM的比賽，這些比賽根本就是老師在參與而不是學生，老師完成作品，然後學生將其present。不是一個好的走向。學生只是聽過老師講解製作原因，但成品根本不是學生完成。現在學校都在比賽方面競爭，而不是去訓練解難能力和創意。課程變得越來越難，例如六年級要完成太陽能板，運用Arduino去製作雪櫃，老師都不懂。我認為現在的Focus是完全錯誤的。

訪問者：STEM與常規課程的結合？
受訪者：會有科學元素。每一級都有科學探究週，會選擇教科書內的課題，然後去做實驗。但這是Science不是STEM。

訪問者：低小與高小推行STEM有何分別？
受訪者：我認為低年級較容易。在我們學校，低年級沒有規限特定用具，例如mBot、App inventor。只需要設計一個任務給學生，而任務當中包含STEM範疇和解難元素，就已經完成STEM活動，例如玩手作和小實驗。所以我認為低年級推行時效果更加好。高年級就像走進了倔頭路，只是不停在玩mBot，又死板又不夠updated，亦沒有位置讓學生思考。各科老師只是完成小冊子，有一個佳作，就當完成任務。

訪問者：有多大信心推行STEM?
受訪者：中和低層次的STEM都有信心，但是高階的STEM就沒有信心。只有基本的編程技巧。如果要像坊間設計雪櫃、太陽能板，就一定不懂得。在小一至小四推行是沒有問題，但小五小六就要靠校外機構。

訪問者：多聘請校外機構嗎？
受訪者：一星期會有一節活動課，抽選優秀學生參加編程課程。或試後活動會有一節。

訪問者：困難？
受訪者：同事不願意推行。每日都日新月異，一個人去推行是很困難的事，將STEM教育融入課程之中涉及太多人，例如所有常識科老師、課程發展主任。我認為不只是我學校遇上這樣的情況，其他學校也一樣。一位老師願意推行，其他老師可能只在背後罵你。因為他們沒有STEM知識，有需要去推行。因此最困難的地方是無法起步。

訪問者：學校是想推行STEM?

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受訪者：表面是的，但實際上都沒有成效。學校即使給予培訓老師，老師本身知識不足，效果亦不大。我身邊曾有老師不懂編程，亦要去教。硬件上，當未有funding學校未能換電腦，連mBot網上版都未能使用，完成編程後未能將coding放進機械車中，甚至方向錯亂。硬件和軟件都有問題。教育局有來重點視學常識科，要我們推行更多STEM，但根本又沒有提供相關培訓給予老師。

訪問者：教育局的指引有用嗎?
受訪者：教育局有教材套，例如用mBot廿玩AI。但是作用不大，只是令老師的知識增長，知道現時趨勢，最終都是需要老師自行花費課餘時間去研究和自學。教育局提供的課後培訓，一個月只有幾場，又不是硬性規定。教育局硬推STEM教育，但支援又不足。

訪問者：改善？
受訪者：我認為應在師訓時，特別是常識科主修的同學，就已經需要培訓，教如何編程等。準教師雖然為了增值自己也會報讀外間的課程，但我認為都是不足。一間學校只有一位同工懂得STEM，而其他同工又不懂、又不願付出，而老師之間亦未必會互相教授，是無法推行的。

訪問者：怎樣的培訓？編程？
受訪者：我認為要認識最基本的編程。現在的科技兩三年轉換一次，我認為至少新入職的老師要認識，才可以帶領學校的活動發展。

訪問者：學校要怎樣推行？
受訪者：首先要更新所有硬件，電腦、工具不要求是最新，但是起碼要work。第二，要給予老師自由度，不要故步自封。學校推行時沒有Final product，需要定立明確的最終目標，即使是拿去比賽或作展示都好。

訪問者：最理想推動STEM教育的方法？
受訪者：由低年級開始，讓他們體驗STEM教育的背景，而且習慣去參加STEM活動。學生的思考模式不是只靠老師給予的解決方法，而是學生合作去思考解決辦法。我最近在校內曾舉辦STEM活動，亦有外聘機構教授，外聘導師反映觀察到我學校與其他學校的不一。其他學校的學生習慣分組討論，並分工合作的模式，一起解決難題的思維，但是我學校的學生坐在一起時完全沒有概念應怎麼辦。

訪問者：獨立一科更好？
受訪者：對。找一批有背景、專業的人去推行會更好。

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訪問者：帶隊經驗？

受訪者：築橋比賽。一半老師做，一半學生做。在比賽前先完成一半成品，到比賽時即場再由學生完成餘下作品。這樣起碼學生真的認識有關知識，例如穩固的方法，才能動手完成。有些比賽只是完成成品後拍攝短片作講解，那些活動學生實際參與的成份更少。

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Appendix 15: Transcript of Participant O (In-service Teacher)

受訪者 O 的背景資料
任教科目： 3 年常識、中文
職位：老師

訪問者：什麼是STEM?
受訪者：我認為STEM教育是牽涉多個範疇的知識，然後運用相關知識和技能去解決生活中的難題。對學生而言，當中的共通能力，例如創意力和解難能力，都能幫助他們於現在或將來於日常生活之中面對逆境。

訪問者：教師應具備什麼條件？
受訪者：我認為老師首先要有基本的知識水平，雖然STEM教育牽涉的範圍較廣，但是老師作為推行者對於每方面至少要有大概的理解，不能說自己不擅長與科技就不去學習。因為即使以跨學科形式去推行STEM教育，亦不能數學科老師只負責數學部分，電腦科老師只負責科技部份，這樣最終活動成效不大，而活動亦變得分散。其次老師應願意接受新挑戰，STEM教育變化較快，而且有些學校還是推行初段。

訪問者：常識科中的STEM?
受訪者：主要於常識書的科學議題做STEM活動。我們學校在學期開始之前，已定立好在哪個課題舉行STEM活動。然後於該個月進行研習，每課常識科都會抽取少部份時間去作講解，然後要學生回家完成材料，最後在常識連堂讓學生進行實驗。當中希望學生能夠發揮創意，自己準備實驗材料，並嘗試量度結果，學會比較和推斷，有時間的話會讓學生嘗試改良作品，嘗試解難。

訪問者：理想和現實？
受訪者：現實中學生的材料或成品很多時都是靠家長完成，小二學生在準備材料時已經不停出錯，而他們的家長或補習老師就會幫他們改正，甚至作準備。結果很多時都不是學生完成。我認為主要是課堂時間問題，因為我們學校抽出於舉辦STEM活動的時間不多，導致部份工作需要家中完成，即使最後測試過程需要在學校進行，學生亦未必了解當初選擇製作材料的原因。這是其中一個問題。

訪問者：STEM與常識科常規課程的結合？
受訪者：只有剛才所說的科學研習月。當中主要牽涉該級所教授的科學理論。

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訪問者：小一至小三與小四至小六的分別？
受訪者：在我們學校低年級的學生主要利用簡單的工具去進行實驗或解決一些情景。而到高年班的時候會再加入更多電腦科所學的科技元素，例如MBOT，需要學生利用編程車去走特定路線。我認為低年級的學習雖然簡單但是同樣達到STEM教育的意義。

訪問者：跨學科？
受訪者：學校有舉行STEM Fun Day。需要數學、電腦、常識科老師抽取各自的一個課題去合併成為一個活動，例如環保電動船，需要學生於過程中計時和量度，利用反作用力的原理去行駛，當中亦需要一些電路接駁。不過通常這類活動都會聘請校外機構去作協助，或由他們舉辦。始終我們老師欠缺推行STEM教育的經驗，聘請他們較方便。

訪問者：你有多大信心？
受訪者：視乎該活動的模式。假如該活動涉及的主要是科學理論，因為我本來是常識科主修出身，都能應付。但一旦牽涉科技，例如Scratch，編程軟件我完全不認識，只能靠自己去學習。

訪問者：困難？
受訪者：如上述所說，有時STEM活動牽涉編程，我只能將任務放在電腦科老師上，跟學生說老師不擅長電腦，讓他們明白每個人都有弱的地方。

訪問者：學校如何推行STEM?
受訪者：有購入相關設備，例如3D printer和microbit，亦有增添手提電腦。但是使用的老師較少，原因有二：課程時間已經不足，所以更不會帶學生到STEM Room。試想想，學生走到STEM Room都需要10分鐘時間，一定要等到連堂才會有機會運用該室的器材，而常識科根本很少連堂。第二，有些老師根本不懂得使用，例如我假如要教授時，必須先在家自學，但又未必每位老師都願意這樣付出。

訪問者：學校有給予老師支援嗎？
受訪者：有興趣的同事會自行學習，而不感興趣的同事自然不會參加外面的課後培訓。學校有時都會舉辦Talk，但主要在教師發展日。

訪問者：學校應如何改善？
受訪者：起碼在聘請新老師時，需要請有STEM教育經驗的老師，讓他們帶來新的知識和科技，始終現職教師已習慣一向的教學模式，較年輕和有經驗的新老師能協助帶領部份新活動發展。假如學校沒有相關人才，根本難以推行。

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訪問者：從決策者的角度，如何改善香港推行問題？

受訪者：現時香港學校盲推STEM教育，當然有些學校做得很好。但是像我的學校，只是循例舉辦STEM的活動，其他時間是在追課程。我看不到STEM教育的效果。假如真的想推行，首先要讓學校有人才，例如讓指定老師進行深化課程，或與其他學校交流。其次STEM活動的舉行方式不應以單次計算，活動應該長久進行。讓學生和老師都有充足的時間去培養STEM教育中重視的觀察能力、思考能力和解難能力，才能與日常生活有所聯繫。

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Appendix 16: Transcript of Participant P (In-service Teacher)

受訪者 P 的背景資料
任教科目：常識、數學、電腦
職位：數學科主任、協助學校部分工程 （22 年教學經驗，4 年 STEM）

訪問者：推行STEM教育經驗?
受訪者：曾於數學課製作掌心陀螺，當中需要學生運用數學原理，然後動手以不同物料去製作成品。亦都有參加機關王。常識課有舉辦水火箭和降落傘比賽等。

訪問者：STEM的意思和意義?
受訪者：我曾聽過其他教授都說過，其實數學科本來已經很STEM，數學本身就需要邏輯思維，亦要有能力去解難，數學就是用來學習怎樣解決問題。而STEM教育的出現，我認為是將四個學科整合，不要各列，因為解決生活問題的時候不能單一使用一個工具，需要學生利用不同的知識去解難。另外interdisciplinary亦令到課堂變得有趣，更大的學習動機。不過我亦有看文獻，沒有白紙黑字寫明一定要有齊四個元素，不需要co-exist，只抽取其中兩個元素都可以，視乎老師的implement。

訪問者：老師具備什麼條件？
受訪者：很多，包括學科知識。假如將來有一堂叫STEM，課堂很嚴謹，對老師的要求都很大。我相對不熟悉Science，我又如何去project，只能去講解熟悉的部份。如要成為一個成功的STEM老師，需要什麼都認識，不能不願意去學習其他範疇的知識。第二是要觸角敏銳，很有創意，有靈感，其實很demanding，不易做。

訪問者：現實與理想的符合？
受訪者：不太符合。我的學校和大部份其他學校都在發展中，主要模式是比賽。比賽的resources有很多，因為機構會提供免費training給學生，例如會教授Audrino、mircobit電子版電路設計、sensor，比賽時就需要學生自行設計一個device解決生活問題，不過過程中就能發揮學生創意。

訪問者：EDB文件足夠？
受訪者：EDB有給予框架，但是不太多參考給予我們去改良，例如外國的例子。

訪問者：學校如何推行？
受訪者：沒有STEM課堂，主要以比賽形式。學校有STEM coordinator負責物色比賽，然後請其他老師分工去帶比賽。我們亦有些課堂都有涉及STEM元素，例如電腦科亦有教授如何接駁電

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路板，不過主要視乎課程發展。我們亦有在每個年級進行跨學科協作project，例如製作降落傘，需要測量、控制sensor計時、科學知識、進行測試和比較。每個學科都會教授project需要的元素，整合後學生就能解決該問題。亦有活動日試行當中，邀請外聘機構教授教科書以外的知識，需時四個禮拜，每日最後兩節課都是活動課，然後去到最後一日會以活動日的形式發佈成果。而其餘時間大多是買service，只要報名，肯俾錢，學生就能學習。

訪問者：其他學校如何推行？
受訪者：課堂時間表的規劃有花功夫，例如會舉行不同的project，例如一個星期其中一日的最後兩節課為活動堂，讓學生去體驗，如智能家居。

訪問者：以比賽主導好嗎？
受訪者：好與壞建基於比賽本身的形式和課程設計。我認為大多都是好的。不過我不認為STEM教育只是不停帶學生參加比賽。

訪問者：學校的資源？
受訪者：學校有購入3D printer、software、雷射切割機這類基本設備。現時未有課室擺放這些設備和舉辦STEM課程，不過正在建立STEM Room。成本貴，需時很久，要等學校批，結果等了兩年才成功批出款項。但仍需一年才能成功建立。而一個constructor需要serve多過一間學校，所以工程經常有delay，需要等候多時才能有得使用。

訪問者：會否提供課程教授老師STEM?
受訪者：暫時沒有，亦未必會做，因為budget問題，即是有budget都會用來買硬件。所以主要靠老師自學，或是STEM coordinator會有些資訊由外間得到，就會與老師分享。EDB course是免費的，老師有興趣就可以報。亦有些感興趣的老師會自行take course或報seminar。

訪問者：信心大嗎？
受訪者：中度。因為我不會認識所有範疇，Science相對不強，我很難去推行一些project可以盡用這四個範疇。我比較擅長以technology或mathematics主導。如果是我自行設計的活動，我當然會有信心。但是如果學校改變方針，活動當中需要四個範疇都很平均，以解決生活問題為主，我就沒有很大信心。

訪問者：重視什麼範疇？
受訪者：將學科知識應用於生活之上，和發揮創意，較為生活化。

訪問者：鼓舞和挑戰的地方？

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受訪者：開心的地方主要是因為看得到學生的學習動機大了，有實作令學生不感到沉悶。挑戰的地方主要是未必有那麼多靈感去恆常設計STEM Lesson，one-off lesson絕對沒有問題，但假如要變成課程，有curriculum 有指引就已經難很多。

訪問者：支援？
受訪者：老師最需要的支援是要更多課堂實例，特別是外國的例子，他們已經完成了很多成功的product。這樣我們就能去用、去改良，就會壓力較少和有更多靈感。我自己的教學設計都很多是來自其他人的分享，再作改良。不要只在文件上告訴我STEM需要這些元素，有什麼模式。我們需要的是實際教學是要的content，現時主要都是靠老師自己去設計。

訪問者：香港推行時有什麼問題出現？
受訪者：有些學校會有Funding問題，假如有更多support在funding方面，我們就能購入更多較優秀的設備，例如VR眼鏡。需要equipment就需要錢，沒有錢什麼都做不到。即做參加比賽都需要使用很多金錢。以及有些學校會讓本身不是STEM背景的老師去教授STEM，這樣對這些老師而言就很困難，只能自動自覺去上堂，甚至讀多個STEM degree。時間表亦難做恆常課堂，根本常規課程都不夠時間，又何以設立多一堂。

訪問者：如何推行最好？
受訪者：Project-based learning，能令學生主動學習和自主學習，是老師之間亦能互相合作，相對上學科知識的壓力較少。第二Share文化都很重要，校內校外都很重要，校內較熟悉的老師可以向其他老師分享resources和聽聞的STEM課堂活動實例。如果各間學校會互相分享資源和例子，就會更好。課程設計上，需要有更有系統的模式去推行，能在某個月份或特定日期中選取其中幾節課專門進行STEM活動，因為我認為課程緊捽的關係，沒有可能全年都進行恆常課程。

訪問者：風氣再進步？

受訪者：我學校都醞釀於太注重比賽的問題，只是未完全發生。長遠計，學校應該設立 STEM 課程，課程上每星期一定要有一至兩堂。而且每間學校的做法不同，有些學校做多有些學校做少，成果就參差。要有課程指引，讓老師知道怎樣去教，知道當中的教學法是什麼，內容是什麼。當然要事情成立的話，就需要提供更多培訓給老師，我們沒有 STEM 知識是無法教書的。EDB 沒有提供，就校本外聘一些 Trainer 去教我們。

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Appendix 17: Transcript of Participant Q (In-service Teacher)

受訪者 Q 的背景資料
任教科目： 7 年常識、數學、體育，4 年 STEM （沒有修讀 STEM 課程)
職位：常識科科主任

訪問者：你在學校曾如何推行STEM教育?
受訪者：在常識的課程中加入STEM的元素，亦會考慮學校外的機構所舉辦的比賽，帶隊參加比賽讓學生對STEM有所認識。

訪問者：STEM有何意義？
受訪者：加強解難能力。我們學校着重解難方面，給予學生一個生活上的問題，透過STEM活動時，去思考一個方法解決問題，就不會是設計一個產品出來。利用STEM的方法解決問題。

訪問者：常識科STEM重視的範疇？如何滲入？
受訪者：解難能力。我們會先給予同學一個情景，簡單說明現時已有的解決方法，但是有什麼問題存在。然後教授學生一些STEM思考方法，例如加一加、減一減、擴一擴等方法去想到其他解決方法。而解決方法我們都有六種方法，亦會去再教他們。例如之前曾問過一個問題是關於戴口罩時眼鏡起霧的問題，教了加一加後，有些同學會想到在眼鏡上加上風扇葉，就能吹走霧氣。

訪問者：STEM教育老師的條件？
受訪者：我認為是需要有修讀理科的背景，如果沒有修讀理科的背景，就需要再大學時修讀相關的課程，始終STEM包含數學、電腦、Engineering等等的知識。我們學校就不會安排文科背景的老師去推行STEM教育。假如有文科老師對於某一個課題不熟悉，我們在教的時候，都會提供足夠的資料，就像剛才提及到的解難方法，這些方法都是搜尋過後給予老師的，然後老師就可以跟隨教材去教授，不用憑空想像。資料會有負責老師準備好，他們會負責主力去思考教授方法。如果該課題關於解難，就會由解難組的教師去負責。如果是常識相關的課題，就會由我們常識科主任去準備一個教學方法出來。

訪問者：現實與理想？
受訪者：其他學校的話，他們的定義放在解難上，但是他們像是想學生去設計一件產品出來，例如小小機械人。但是這樣的話其實是學生的能力以外，學生根本做不到，這些產品或者成品通常都是老師或家長去整出來。這樣就沒有意義了。這些學校舉辦STEM展覽都是不同學生所設計出來的產品展示,但是這些產品真的是學生去做的嗎？就一定不是了。家長的參與性較多。

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但是我們的學校注重的不是產品設計上，而是真的在課程上滲入了，去刺激學生的思維。等學生在之後遇到新的問題時，他們都能夠使用這些已學到的方法去解決。即使是去比賽，我們都會挑選一些學生參與得較多的，他們能自己去做得更多的，就不是全是老師去做。

訪問者：信心？
受訪者：中度。因為始終我不是修讀這個範疇的課程，當學校說要推行時，只給了我們一些簡單的講座或基本的知識給我們，我們才知道什麼是STEM。但其實在推行的初期，其實不知道自己在推行什麼。因為檢視到外國的STEM和香港的STEM是很不同。而外面的機構很多都是去設計一些機械人的課程，就叫做推行STEM。所以我自己都摸索了兩三年，才見到方向，可能在課堂內加入coding元素。例如學習大腦時，reaction time，一個刺激然後大腦如何作出反應，我們就會利用coding，將其放在這課題之中，寫程式的時候就像我們的大腦一樣，去接受外界的刺激，就像輸入了一個指令給電腦，然後程式再運作該做的事，就像大腦需要我們縮手一樣。這樣去教授就能知道我們正在學習的課題原來都與電腦科有一定的關連。這亦是在課程中加入STEM元素的其中一個例子。

訪問者：成功提升解難和創意力嗎？
受訪者：就我這兩年的觀察，我認為是成功的。學生去思考解難方法時都很有創意的，能否實踐就另一回事，不過創意就很高的。

訪問者：大多是學生自己思考到解決方法嗎？
受訪者：我們解難的元素是額外的一節課來的。在解難堂內，我們會先教授解難的方法，低年級先學三個方法，然後高年級再加新的方法。再讓學生去思考在不同情景和議題應如何應用這些方法去解決問題。最後就會開放給學生在思考到解決方法後，在網上eclass內去描述或畫出他們自己的解決方法出來。然後老師就會選出當中的解決方法去作全校分享和講解，從而刺激其他學生的思維。

訪問者：困難？
受訪者：思考情景的時候。這些情景可能是我們日常生活中都不常去留意到的，就像剛才說到的眼鏡起霧的問題，因此在思考這些情景的時候就要花費更多的時間。老師要思考這個情景學生是否真的能思考到解決方法，不可以想一個很複雜的情景或學生根本做不到的情景。

訪問者：學校有給予培訓？
受訪者：有但是不多。可能是坊間所提供的一些講座，只有少數的老師可以去到，不是全體老師都能參加的，例如科主任聽完後將知識帶回學校與其他老師分享。我曾去過別人的小學去觀察發展STEM教育的過程，去其他學校取經。又或是一些教授出的講座，例如應如何發展STEM。

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這些講座有少許作用，但是別的學校和自己的學校處境不同，他們做到的發展方法，我們未必做得到。

訪問者：學校如何推行STEM？
受訪者：我們學校將STEM元素結合於常識科常規課程之中，而電腦科亦有協助我們常識科去發展STEM。而跨學科形式方面，我們都有做到的。例如四五六年級我們會做一個跨學科的專題，這個專題會有STEM的元素在內。六年級我們會整一個智能家居去解決問題，這個會讓六年級的學生自由去思考家居有什麼問題，例如老人家很容易跌親，學生需要思考一些解決方法去解決這個問題。我以往見過學生會製作警報器，老人跌親的時候，當地下感受到一定的重量時，就會響起警報器，直接接駁到警署，讓人知道他跌親了，可以提供救援給他。而四年級就製作濾水器，他們要計算究竟用什麼物料才能製作一個真的能濾水的工具。同時，學生亦要計算水滴下來的時間和速度，會否太快或太慢，其實都會牽涉到數學。而常識科都會給予關於濾水的知識。而學生亦需要測試水質是否真的過濾得乾淨，我們會使用到Microbit，這就是電腦科去教授的。這就是一個跨學科的專題。以往我們會於堂與堂之間去進行這個專題活動，現在我們改為有一個星期的時間，前三天會在上學期，後兩天會在下學期進行，暫時仍是試行階段，未知分開後的效果如何。以前深入於課堂時，會是電腦負責一部份，常識負責一部份，會有點無法關聯。可能常識科未教授到濾水的物料，但是電腦科已經教授了如何使用Microbit去寫coding去測光，知道水質是否真的清澈，這樣就會無法協調。但現在有了一星期時間，暫時看到有更好的協調。頭三日已經會做很多的實驗，例如四年級會做實驗數次去得知該使用哪種物料。到最後兩日就會將成品砌好，再在自己班別中做presentation。

訪問者：還有舉辦興趣班或給予家長聆聽的講座嗎？
受訪者：有兩個興趣班，是資優的課程，是讓STEM教精英的同學去參與的，會外聘出面的教練來教授。家長方面就沒有。

訪問者：怎樣推行最好？
受訪者：我認為真正的STEM教育應給予更多的空間學生，不能有太多局限。例如剛才提及到的濾水器，其實我們學校進行的時候都給予了學生很多限制，以免學生想得太多，這樣我們做評核時就會有困難，但這樣就會違背了STEM的原意。但是我們為了評分就會局限了他們，例如只能使用這30種的物料的其中兩三種。但其實真正要做一個濾水器，你去Test 1000種都可以。但是評分上就會有困難存在。我認為要發展STEM是不用評分，而是讓學生啟發興趣，再去思考一個解決方法，然後運用數學、科學等知識去思考一些方法去解決問題。

訪問者：你會覺得STEM需要獨立成科嗎？
受訪者：我認為小學生做不到獨立成科。因為STEM教育始終牽涉了Engineering，其實不是小

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學生會識的知識。所以我認為小學的課程，例如常識、電腦教某一個課題就已經足夠。然後再加上專題研習，例如一個禮拜去做一個專題，就已經足夠了，以小學的程度而言。

訪問者：低年級會推行嗎？
受訪者：我認為低年級未需要推行STEM，高年級才進行。因為低年級所學到的知識不是太足夠去做STEM。所以我認為高年級推行才較為適合，我們學校小一至小三的跨學科專題都與STEM無關。

訪問者：學校有足夠的資源嗎？
受訪者：我認為政府都已經給予很多資源，例如之前安裝wifi98。而我們亦有利用資金去聘請導師教授一些精英STEM的知識。常識科有5萬元一年，我們就將這筆資金放在兩個STEM課外活動身上，不需要申請就會批。但是有資金的情況下，老師的師資不太足夠，因為以以前的老師為例，就像我，我也沒有修讀過STEM。我只是教了七年，但一些再舊些的老師，他們更加不熟悉STEM。所以需要更多的培訓，例如在出面聽講座，但是需要是一些真正有用的講座。

訪問者：怎樣的講座才真正有用？
受訪者：需要教授老師怎樣去將STEM應用於教學生身上，而不是關於一些理論。例如我過去聽過幾次講座，都是理論，就較少實踐方面。

訪問者：教育局的指引有用嗎？
受訪者：我沒有看過那份指引。我會希望有更多的實例，去教老師怎樣去教STEM。

訪問者：有風氣上面的問題出現嗎？

受訪者：很多學校純粹是以比賽或是設計機械人或機械車等的產品出來，就認為是做了 STEM。普遍老師對 STEM 的理解都是不太足夠。政策方面，政府最開初推行的時候沒有給予很多支援老師，因此一些年紀較大的老師他們根本不知道什麼是 STEM，但又要去推行。這樣就會讓老師感到迷惘。我認為政策配合上，應先教授好老師如何推行 STEM，才給予資金。

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Appendix 18: Transcript of Participant R (In-service Teacher)

受訪者 R 的背景資料
任教科目： 5 年常識、數學、視藝
職位：老師

訪問者：什麼是STEM?對學生有什麼意義？
受訪者：我認為STEM教育是將多個學科的知識綜合並應用於解決生活問題。當中強調學生的協作能力、創意思維和解難能力，讓學生透過自己動手做，建構知識。

訪問者：任教STEM的教師需要具備什麼條件？
受訪者：我覺得老師需要具啟發學生思考的能力。STEM教育重視學生自主學習，而非靠老師單方面的教學，很多時候需要學生互相啟發，探索相關知識。因此老師能給予引導的問題，但不可以直接提供答案。第二老師需要貼近現今STEM教育的發展。雖然STEM教育重視解難過程，但是我認為亦要適時加入新興科技工具，讓學生更貼未來趨勢。

訪問者：常識科中的STEM教學？
受訪者：我最重視學生的解難和創意。我們學校的常識科會利用設計循環，去訓練學生在設計產品時的步驟，例如改良。當中需要學生運用創意思維思考產品如何才能成本效益較高、方便性、多功能。而我們亦要求學生在指定題目下找出現今問題所在，這類型的解難才能令學生於將來懂得運用出來。

訪問者：現今與現實？
受訪者：在我的學校算是推行得不錯。學校注重STEM教育的發展，因此撥出不少資源於設備和培訓方面，老師亦為每級準備校本教材，切合學生和學校所需。例如低年班會玩家務助理機械人，運用已有知識和日常觀察到的問題所在，利用摩打造成的震動去令清潔工具移動。不過學校偏重比賽成績，所以都有一點本末倒置，有點偏向忽視學生真實成效。

訪問者：你有多大信心推行STEM教育？
受訪者：中度，但需要不時於課餘時間自學，才能理解STEM內容。

訪問者：困難？
受訪者：Coding方面，我自己打code沒有問題，但是當學生有自己的方向時，我未必每次都能幫助他打到他想完成的code。只能將他的想法簡單化，從而合理他的程度，亦能解決他的問題。

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訪問者：學校如何將STEM教育融入常規課程之中？如何推行？
受訪者：首先會舉辦科學探究週。提供特定主題給學生，然後把STEM元素融入。活動為期兩星期，只會抽出常識科時間去完成。另外學校亦有舉辦STEM體驗日讓學生和家長參加，因為很多時候家長不明白為何要學習STEM，計算的成績亦不多，對於將來看似不重要。所以該類型的活動主要希望讓學生和家長合作完成任務，亦都能加強家校合作，令到學校推行STEM教育是更得心應手。在疫情之前，我們學校亦會帶領學生到科學園參觀。亦會挑選較為優秀的學生參加比賽。

訪問者：跨學科只包括常識科、數學科、和電腦科嗎？有涉及視藝嗎？
受訪者：對。我們學校在視藝方面沒有涉及STEM元素。

訪問者：在推動時遇到什麼困難？
受訪者：每位老師能力不一，沒有這方面經驗的同工會感到有壓力，有壓力的時候亦自然沒有太大的動力去推動發展。其次為了減低對現有的常規課程影響，推行STEM教育時需要利用更多的課餘時間，亦造成更多工作負擔。在趕課程的同事又要舉辦STEM活動令不少老師都覺得很累。

訪問者：硬件和軟件？
受訪者：學校設備齊全，有基本的機械人硬件和電子板，我們學校甚至有設立機械人的比賽場地，讓課外活動的學生去進行機械人編程解難障礙賽。而學校亦有定期舉辦STEM工作坊給予老師參加，例如在教師發展日，外聘校外機構去舉辦STEM體驗活動，讓同工亦能有相關技能發展，亦能做到全校老師一同推行的效果。

訪問者：在香港小學推行STEM的困難？
受訪者：我認為主要是學習風氣偏重成績。結果很多重點推行STEM教育的學校都會不停參加比賽，可以獲得家長關注之餘，亦是一個方法證明學校的能力。但是我認為這種風氣並不好，很容易會忘記STEM教育中的原意，重點培訓優秀的學生，令到低年級和能力中等的學生欠缺發揮創意和解難的機會。

訪問者：如何改善此問題？
受訪者：我認為風氣問題好難去改。不過學校可以多留意學生是否有平等的機會去學習STEM的知識，亦需定期去作評估，檢視學校的重心和不同活動的分佈，不可以只偏重比賽方面。而老師亦不應時常出手幫忙學生的作品，應該由學生自主創作和發揮潛能，這樣才能有效培養學生的創意思維亦能提升他們的興趣。

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