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Honours Project Report

The Effectiveness of Different Policies on Promoting STEM Education: A case study of a secondary school in Hong Kong

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Declaration

I, Mak Yick Tim declare that the study is own work with the supervision of Dr. Choi Tae Hee,, and this work has not been submitted previously for examination to any tertiary institution.

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Abstract

This study would like to find out the effectiveness of different policies that the Hong Kong government has posted for promoting STEM education in secondary schools. With McGinn (1999), successful education reform should include three main elements: financial support, trainings, and suit to the local culture. Semi-structured interviews were conducted with four experienced teachers and the findings showed that teachers are satisfied with the financial support from the government. However, teachers also reveal their dissatisfaction in some fields: guidelines and teaching materials, workshops, curriculums, the content of the curriculum, and the atmosphere in the society.

This paper contributed to help to point out the missing areas of policies in implementing STEM education in secondary schools, and the government then can publish more focus policies to promote STEM education in secondary schools more efficiently. Beyond the discussion of the findings, six suggestions that about different problems that teachers have complained about were made. The study would like to make an insight on the topic, hoping to let STEM education implement more smoothly in future Hong Kong.

Key Words: STEM education, effectiveness of policies, secondary school, Hong Kong

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1. Introduction

1.1 Background

In the new century, “STEM” is a hot term in the education field worldwide, and so as in Hong Kong. The Education Bureau (EDB) has encouraged primary and secondary schools in Hong Kong to promote STEM education in schools since 2015. Seminars, workshops, and guidelines are held and made for educators since then, helping teachers be more familiar with this new learning style. Besides, education resources are invested every fiscal year for encouraging schools to imply STEM education. For example, according to the Policy Address in 2017, HKSAR (the government) allocated HK$200,000 to each secondary school to imply STEM education, hoping students could learn better with this new teaching model style. More and more schools required teachers have the abilities on holding and teaching STEM activities. Nevertheless, there was a survey posted in 2019 conducted by the Hong Kong Federation of Education Workers. The result showed over 70% of the interviewees think it is hard to run STEM education in schools, both in-class and after-class. Few years passed, these sound have not disappeared, which means there are difficulties promoting STEM education in Hong Kong schools.

STEM is a term that acronym for science, technology, engineering and mathematics, but not just about these four subjects. STEM will be treated as the new century education trend as it moves beyond simple test performance and focuses on developing students' higher level

of thinking skills. By connecting classroom learning to a real-world problem, students can also train to have critical-thinking skills and with broader horizon about the world. In recent years, the new reform effort like the "Next Generation Science Standards" faces more emphasis on the connection between and among the STEM disciplines. (Strimel & Grubbs, 2016) It brings out the concept of STEM education, not just the individual subjects that make up the acronym, but the relationship between them, as in the real world, science relies on technology, mathematics and engineering; and engineering depends on the findings on sciences, the application of mathematics and the use of technological tools. In Hong Kong, the Education Bureau has published a report called 'Promoting of STEM Education – Unleashing Potential in Innovation' in 2015, formally proposed that bringing STEM education to Hong Kong. It aims to strengthen students' ability in those four subjects and the skills required, nurture more diversified talents in those fields. (P.4)

Many secondary schools in Hong Kong are promoting STEM nowadays, after the report posted by EDB in 2015. Some treat it as a selling point when promoting their school, showing students can accept the most talk-about education in their schools. However, there are some current problems with STEM in Hong Kong. Visiting the websites of different secondary schools in Hong Kong, we can find out that most of the school promotes STEM in after-school experiences, such as holding extra-curricular activities or post-examination period activities that about STEM or joining robotics competitions. It means that not every student can have the

chance to have STEM education as we cannot force students to join after school activities, and most of them have to join quotas. Also, most of the STEM teaching and learning in the classroom focuses on science and mathematics, which are the subjects included in the public examination (DSE). Comparatively, little attention has paid to technology, the products and systems that meet human needs, and the engineering, the creative process used to design these things. Besides, the four subjects in secondary schools' classrooms have taught in isolation.

Some voices claimed that the STEM education promotion in Hong Kong did not reach the purpose of STEM. Mitts (2016) mentioned that STEM education should highlight the connection between the four subjects, so that students can learn more and more deeply. They might see STEM disciplines as more relevant to their lives. It could lead more of them to pursue STEM courses and careers. Research also suggested that the implementation of STEM education has to balance the learning of individual STEM subjects like textbooks and classes and the hands-on activities, which means there should be a linkage between STEM knowledge taught in classrooms and the problem-based learning activities.

1.2 Research Purpose and Research Questions

The study would like to conduct a case study on a selected secondary school, focus on the effectiveness of different policies posted by the government on promoting STEM education in secondary school. Also, discussing which policies provide positive affection on promoting STEM education, are those policies enough and which policy support areas are missing with teachers. Government policies have an important role in promoting a new education trend. (Shrestha et al., 2018) They also pointed out that if the policies posted are not suitable with the current local situation, or the frontline staff do not think the policies help, and things will never be promoted successfully.

This study is needed for promoting STEM education. If the current situation in Hong Kong continued, the purpose of STEM education would not reach, students may not get benefits from learning, and the resources from EDB may be wasted. The competitiveness of Hong Kong students in the world will be decreased. To avoid the above consequences, the effectiveness of different Hong Kong government policies for secondary schools on promoting STEM education needed to be found, so more target-oriented policies in different areas can be posted, and secondary schools in Hong Kong can promote STEM education more easily.

Research Questions:

1) Which area(s) of the policy posted by the HK government is/are providing positive affection on promoting STEM education in secondary school?

2) Which area(s) of policy is/are missing that support secondary schools to promote STEM education?

2. Literature Review

This is a study that focuses on STEM education, policies that the government has posted for promoting STEM education in Hong Kong secondary school, and the policy's effectiveness. In order to have a better understanding about the topic and can have an accurate analysis for the study, three main directions of literature are found.

2.1 Definition of STEM Education

This study is based on a critical concept: STEM education. There is a definition made by an article named "A conceptual framework for integrated STEM education", which published in 2016. Kelley and Knowles, the authors, illustrated that after the concept of 'STEM' is said, most of the STEM education is more focused on 'S' and 'M', but not paying attention to the other two in the last decades. (Kelley & Knowles, 2016) This way of 'STEM' would lead to a bad result that students cannot learn the higher-thinking skills that supposed to emphasis in STEM education, for example, the skills of collaboration, communication, research, creativity, problem-solving and critical thinking. Then the project of STEM would become as same as the traditional teaching and learning model. Actually, it is not a new talk, Sander

(2009) had also suggested that the concept of STEM education should not treat S, T, E, M as four isolated subjects, but described it as “approaches that explore teaching and learning between/among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other school subjects” (p. 21). STEM education stressed the relationship between the four subjects, Moore et al. (2014) treat STEM education as “an effort to combine some or all of the four disciplines of science, technology, engineering, and mathematics into one class, unit, or lesson that is based on connections between the subjects and real-world problems” (p. 38)

2.2 Education Policies in Hong Kong on promoting STEM

The Education Bureau has provided many resources for schools on promoting STEM education in Hong Kong. By the same report that EDB posted in 2015, there are six suggestions proposed, which are (1) renewing the curricula of STEM-related subjects; (2) enrich learning activities for students; (3) provide learning and teaching resources; (4) enhance the professional development of schools and teachers; (5) strengthen partnerships with community key stakeholders; and (6) conduct review and disseminate good practices. (P.8) In the following years, the Hong Kong government has suggested a series of implements in these directions, most of them are financial support. JobsDB (2020) has published an article listing the government’s financial support for promoting STEM education-related projects. For example,

the one-time subsidies of HK$200,000 for each secondary schools in 2017 as initial capital on developing STEM education in school. Moreover, the budget plan of 2019 has mentioned that the government announced that the government would allocate HK$500 million in the next three academic year, promoting a project called "IT Innovation Lab in Secondary Schools" to purchase IT equipment and organize innovative STEM activities for students.

Yang, the head of EDB, also presented the governments' policies about STEM education in an interview with Openschool(2018). Besides financial resources, EDB also held many workshops and seminars for school and teachers, sharing different experiences they gained while promoting STEM education in schools. EDB also posted some STEM class materials on the internet, giving schools references on holding STEM activities and adding STEM elements in the classroom. In the interview, Yang emphasised that there are no straight guideline and timetable for school to follow. There is also no requirement for schools to finish. Schools can freely design their plan that suitable their situation on promoting STEM education. Yang presented the approach of the government on promoting STEM education as school-based autonomous. "The autonomy of a school refers to its degree of self-government in relation to the degree of state intervention."(Neeleman, 2019) In this case, schools are free to promote STEM education in their school, schools can use those funding freely, and different schools use those funds to promote STEM education. The government will not inspect the schools everything that about STEM, but mainly observed the use of the funding by urging

schools to hand proposal when applying for funding. The purpose of this approach is not to put too much pressure on school.

2.3 Elements of Policies for a Successful Education Reform

In this project, the effectiveness of different government policies on promoting STEM education in secondary schools will be discussed, whether positively or negatively, to promote STEM education in Hong Kong. To analyze a policy's impacts, Schlicht, Stadelmann-Steffen and Freitag (2010) suggested that a policy's importance is its effectiveness. The most direct way to ask the implementation agency, as they are the one who faces the problem, so they are the one who knows the most whether the government's policies are effective or not. For education policies, teachers are the central implement unit, and their opinions are the most convincing.

STEM education is an education reform for the new century. McGinn (1999) published an article that discussed the requirements of successful education reform. He pointed out that if the government would like to promote a new teaching approach, there are many things to do. Financial support is so important but not the only one. McGinn stated out some of the essential areas that policymakers should care about when new concepts approach. The most well-known area is financial. Anything needs money to promote new things in society.

Providing enough guidelines or regulations for different stick-holders in different

situations is also important for promoting new concepts smoothly. People will feel confused when new subjects appear but without any instruction to follow. In most reforms, if the following three conditions are met, the reform will be easier to succeed, which are:

1) Understand the goals of the new program;

2) Knowing what is expected of them, in terms of new practices; and

3) Having the skills, and the materials, to carry out those practices (O'Day, Goertz, & Floden, 1995).

If the goals are unclear, the reforms will usually fail. As McGinn pointed out

> *"The reforms are not implemented because those responsible for implementation do not know what they are supposed to do. Moreover, they are not tried out because the requisite skills and materials have never been provided."* (McGinn, 1999, p.5)

At the end of the paper that McGinn (1999) posted had listed 12 points that policymakers should keep in mind. Besides the directions discussed, McGinn also suggested that the government create a suitable environment for the new concept to promote and develop. The reform will promote more smoothly if it fits regional and local cultures. The reform will be a success only if the reform concepts are agreed upon by the schools, students, parents, and the communities. So the government should also pay efforts to let society understand the benefits

of reforms and let the reform consistent with the cultural values.

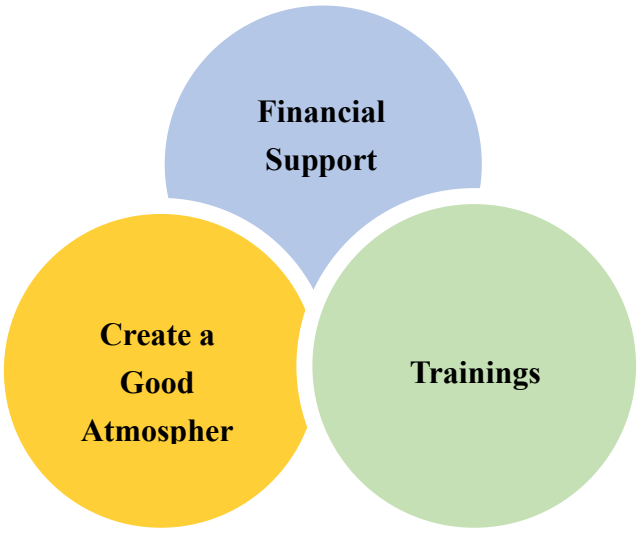

Fig. 1 Elements of a successful reform

3. Methodology

3.1. Research Method

This study uses the qualitative research method as the research type. Jamshed (2014) claimed that qualitative research type could get an in-depth study on different stockholders' view, and further discussion on what causes or why those views occur. The study is set to be a case study. Starman (2013) suggested that a case study can be applied to the field of education, which focuses on some main objectives, for example, understanding a phenomenon based on a group of participants' perspectives and experiences relayed to the phenomenon. Small sample sizes are usually set as the data collection method of case studies and mainly depend on the in-depth interviews with the participants. (Sandelowski, 1995)

3.2. Participants

The study participants are four experienced teachers in charge of teaching STEM education related subjects, which are Mathematics, Science and Information and Communication Technology (ICT). One of them is the headteacher of the 'STEM unit', which is in charge of the stuff related to STEM education in the school. Asking the teacher in charge of STEM education for an interview can also collect the data that what difficulties running STEM education in school at the practical level, both in class and outside the classroom. Besides, interviewing subject teachers that teaching STEM-related subjects can help researcher get information about how STEM education is running in a secondary school classroom and their feelings about the policies posted for promoting STEM education.

Table 1. Background of the 4 teachers that are interviewed

Participants (Pseudonym)	**Sex**	**Teaching experience (Years)**	**Subject teaching/ post in school**
Mr. L	**M**	**13**	**Science/ Head of the 'STEM Unit'**
Mr. A	**M**	**21**	**Subject panel of Mathematics**
Mr. C	**M**	**31**	**ICT**
Miss. W	**F**	**>10**	**Science**

The selected school is the first secondary school in Tuen Mun District, but they are a step behind other colleges for STEM development. The selected school has committed to finding a way to promote STEM education in school, so a group called 'STEM unit' is in charge of holding different STEM activities for students. Inviting subject head teachers as the interviewees as they know about the situation of promoting STEM education on their subject, what policies can help or what are missing, the most.

3.3. Data Collection

Semi-structured interviews were conducted for the data collection. Semi-structured interviews, which are widely used in qualitative research, will encourage interviewees to express more about the issue. (Wethington & McDarby, 2015) All the participants are asked the same set of 'stem' question. Usually, there are some predetermined response answers, and the researchers can get basic information about the participants. The researchers can then ask follow-up questions according to the answer to these 'stem' questions. Anderson et al. (2010), however, pointed out a limitation of a semi-structured interview that the researchers must have rich knowledge about the study topic in order to obtain more helpful information for the study.

As the heavy workload and business of teachers, the data-collection process is chopped into two parts. Four teachers were first invited to finish a questionnaire in November 2020. The questionnaire will replace the 'stem' questions that are supposed to be asked in the semi-

structured interview. It is about the general thought about the policies that the government has posted. After collecting the data from the questionnaire, more focused, open-ended questions will be set for different teachers, and four teachers were separately interviewed. As the preparation time was longer, researchers had more time designing questions that can help get more related information for the study, avoiding the disadvantage that Anderson et al. that have mentioned in the paper. The average time for a face-to-face interview was around 15 minutes. Chinese and Cantonese is used for the questioners, and the interviews, respectively, as both interviewees and researcher can express their meaning more accurately and smoothly. The structured part of the semi-structured interviews (questionnaires) provides comparable data for the study about teachers' thought about the government policies in three dimensions. For the unstructured part (interviews), teachers can feel free to share their experiences or opinions towards STEM education in secondary school.

Related to the topic and the pieces of literature found, questions were designed according to three big sections, which is financial support, training and creating a good atmosphere for STEM education. The sample of the questionnaires (both Chinese and translated English version) is included in the Appendix 1.

3.4. Data Analysis

After collecting the data from teachers, the conceptual content analysis method was

used in the study. Krippendoeff (2018, P. 29) pointed out that interviewees may be really willing to share their experiences, but some of them are off-topic, and valuable messages always occur in particulars situations. Content analysis can help to find information that related and useful for the study in interviews. With the recording of the four interviews, the data analysis work was started by organizing the data by typing the transcript of all four participants' interviews. Then examine the data for patterns by finding common words, phrases and ideas. Develop a set of codes that can categorize the data collected after that and tag the responses of different participants with the codes. The codes were assigned to the data, and spreadsheets are created for organizing the data. Finally, themes can be made by linking the codes together. (Ruona, 2005, P.240-263)

4. Findings

During the interviews, four teachers have introduced to the activities related to STEM education that have held in these years and shared their thoughts towards promoting STEM education in secondary school. In the selected schools, the STEM activities are mainly focused on four fields: group projects, cross-curricular activities, off-campus competitions, and help to organize STEM activities for primary school students. Some of the examples are included in Fig 2 that shown below.

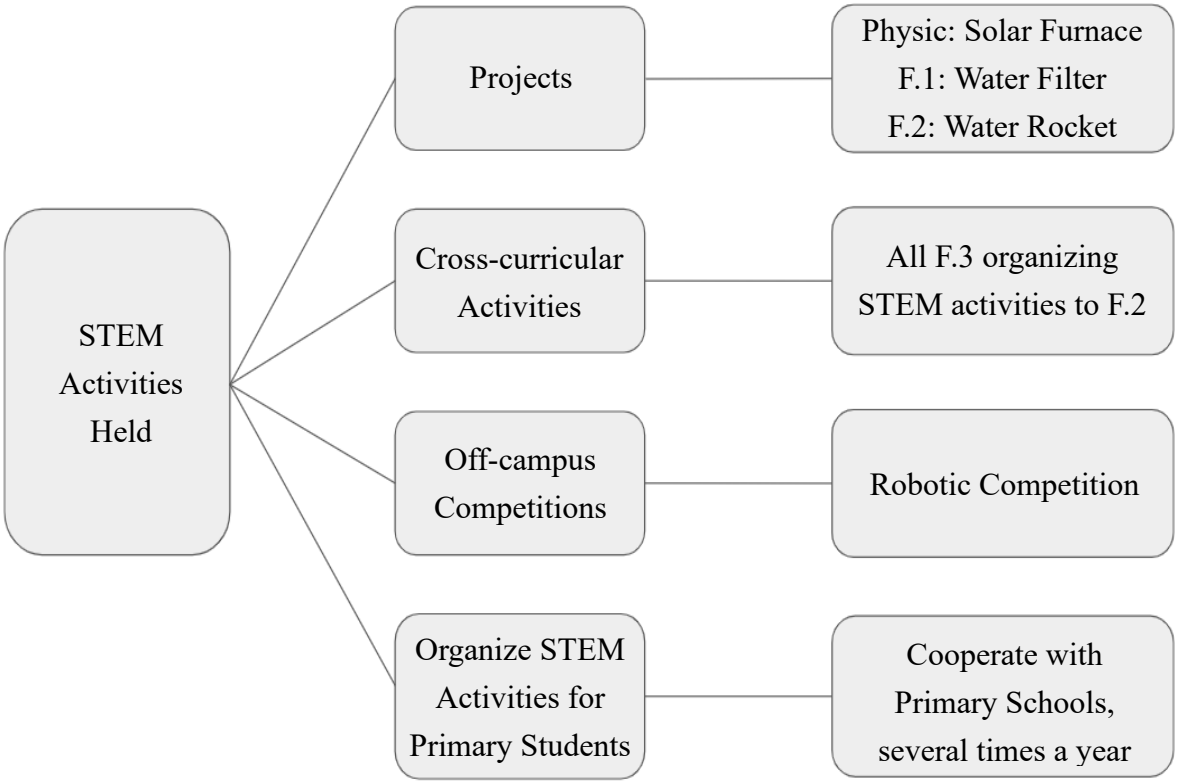

Fig. 2 Four main fields of STEM activities that the selected schools has held

From the above figure, it is noticed that the STEM education promotes in the selected school is mainly focus on after-school activities and also extra-curricular activities, like most of the schools in Hong Kong (Kutnick et al., 2020). For the in-class STEM activities, project-based learning is used. However, Mr. L, the STEM head in the selected school, as well as an experienced science teacher, explained that teachers seldom emphasized the integrated knowledge during the lessons but focused on the knowledge that related to their own subject. For example, the solar furnace project did in the physics lessons, and teachers would focus on explaining the knowledge on heat but not treat it as a STEM activity. It also does not emphasize the engineering part, which is the process of making the solar furnace.

After having a brief understanding of the situation on promoting STEM education in the selected school, more questions are asked about teachers' views towards different policies that the government has posted. In the interview, four teachers have expressed some similar ideas in different education policies that the government has posted. After coding the transcripts of four interviews, it was discovered that the ideas could be generalized into the following five directions.

4.1. **Financial Support**

All four teachers are satisfied with the financial support given by the government. It is because they think there is quite an amount of funding that teachers and schools can apply for organizing and preparing STEM activities, for example, Quality Education Funding (QE Fund). For the one-off grant for schools to promoting STEM education, the selected school has built an iLab, which contains a demonstration of Aquaponics, and bought some STEM-related tools, for example, a 3D printer, laser cutter, Et cetera. They have applied the QE Fund for building some solar panels. However, teachers also think there are some places that the government can be better. Miss W mentioned that:

"*The procedures on applying the funding are quite inflexible. I agree that if the school needs to build laboratories like our iLab, writing a proposal is a must that seeing whether the school has good planning on that much money. However, schools seldom build*

something big. Buying teaching materials or hiring tutors to hold small STEM activities are our daily school life. These activities are hardly writing a proposal for them."

Mr. L also expressed his slight disappointment on the funding from the government for promoting STEM education is a one-off appropriation but not continuous, supporting funding. Nevertheless, four teachers generally think the financial support from the government is enough.

4.2. Guidelines and Materials

Four teachers have a similar feeling towards the guideline that the government posted, and they think the guideline is too vague. They pointed out that STEM education is new for Hong Kong educators. It is no doubt that teachers should learn more by themselves, but if the government would like to promote STEM in all Hong Kong schools, detailed guidelines are needed. Mr. L said with a resigned sigh:

"The guidelines that the government has posted provided a good framework about STEM. The guidelines have a detailed discerption of learning objectives, learning attitudes, and skills students expected to learn during STEM education. However, there are not many examples of how to reach these outcomes. There is too much space that requires teachers to explore by themselves. The polite name for this is space to explore, and the impolite name is nothing practical in the guideline."

Mr. C, who has the same feeling as Mr. L, also pointed out that most of the teachers only noticed that EDB wanted to promote STEM education in schools, but there are no instructions on what actual learning activities or requirements that schools should be done. There is also lack of STEM-related teaching materials provided for schools and teacher as well. The products from the outside companies are uneven that they need to spend more time on choosing companies. Therefore, most of the teachers, concluded by the interviewed teachers, felt quite confused and helpless in promoting STEM education in their secondary school.

4.3. Workshops

Most of them think the workshops are helpful and can help teachers generate new ideas in STEM education. They think the workshops provide the things that the guideline is losing. Mr. L pointed out that the EDB has held more and more experience-sharing sessions in recent years. He claimed that:

> *"These sharing sessions are very beneficial for me, I think, also for other teachers. As these are the actual examples that are missing in the guideline. I can take the examples that have shared in the workshops as references, seeing whether I can use them in our school or not. Also, we can listen to other schools how they run STEM in secondary schools, thinking our school can follow or not. "*

Miss W thinks the workshops are pretty audience-friendly for teachers who are new in STEM education, also for experienced teachers in STEM, they can generate new ideas in STEM through the workshops. However, Mr. A also pointed out a problem that some examples made in the workshops do not suit to hold in schools because of the cost, time limit, the expensive facilities, Et cetera. Although there are some places that can be improved, four teachers think the workshops are suitable for promoting STEM education in secondary school and hoping there will be more workshops on more topics related to STEM education.

4.4. Curriculum

Some teachers complained that the curriculum now is so full that STEM education can hardly be conducted in class. Most of the STEM education activities can only hold as after-school activities. Mr. A has pointed out that the current learning contents are quite full that teachers usually need to make up lessons after school or even during holidays to complete the required curriculum. It is hard for teachers spending extra time on having STEM education activities during classes. Miss W felt the same as Mr. A, and she took SBA as an example. Miss W shared her experience frankly that:

> *"The learning objectives of SBA are to train students' science abilities and creativity in experiment designing. However, because of the tight syllabus, honestly, these objectives cannot be reached. Most of the schools in Hong Kong, I think, will only*

let students remember the steps of the experiments that have set by the schools and do the experiments in a limited time. There is no time for SBA, so why EDB thinks schools can add STEM education to the current curriculum? It is a mission impossible."

In reality, just looking at the curriculum of each subject, many contents need to be taught in a limited time. Most of the teachers are undertaking tremendous pressure about it, so they think it is impossible that spending more extra time on STEM education, a subject that is not required and will not be examined.

4.5. Atmosphere

During the interview, two teachers, Mr. L and Mr. C, pointed out that the atmosphere of the society in Hong Kong is not really supporting promoting STEM education. They also thought the government did not have enough promotion about STEM education to the public. Mr. L expressed that the majority in the society still thinks there is no way out in studying STEM, but only studying financial, children can make big money and be successful. Mr. C thinks the attitude of the government is also not clear enough, he mentioned that:

"The government only presented the idea of promoting STEM education in Hong Kong, but not many following instructions or policies. It seems like a merchant has sold a good, only meeting the sales target, but did not have any after-sale service for

the customers."

Without a big promotion from the government, both of them think the stereotype towards the technological field and the thoughts towards STEM education of the society will not be changed, and the effectiveness of promoting STEM education in secondary school will not have great success.

5. Discussion and Suggestions

The findings suggested teachers' thought towards different government policies that promote STEM education in secondary schools. For the following discussion, findings and literature found were linked up and drew several conclusions. Suggestions are also made, hoping to increase the effectiveness of the related policies on promoting STEM education in Hong Kong secondary schools.

5.1. Financial Support: Continuous Funding

The importance of the financial support for promoting new policy is well-known that McGinn (1999) had also mentioned in his article. The government has spent quite a lot since the term 'STEM' is said in 2015. (JobDB, 2020) From the EDB report mentioned, most of the policies are instalments, subsidizing schools to promote STEM education in schools Et cetera. So, the teachers also feel pretty successful in this area as they can have enough capital on

running STEM education in schools. However, for a deeper look, most of the funding for STEM is one-off funding, which means the schools can only apply for the funding once, and the main purpose of the funding is to build facilities in the secondary schools. From our findings, teachers also feel like the money that the government provided is not flexible enough. STEM education is not just holding extra-curricular activities or visiting laboratories, but the ideas of self-motivated learning and exploration of the world. McGinn pointed out that successful reforms should have financial support to the places that really need money. Financial support from the government should not only focus on some 'big items', for example, building laboratories or adding solar panels in schools but also the teaching materials, teaching contents of STEM education. In this case, if the government provides continuous funding for STEM education only, providing an appropriation for schools purchasing teaching materials or hiring tutors that experienced on holding STEM education activities, then the cost that implementing STEM education in secondary schools will mitigate, and the financial pressure for schools on promoting STEM will reduce. Schools will be more willing to promote STEM education.

5.2. More Practical Example for Teachers

McGinn (1999) suggested that there are three conditions that should be met for a successful reform, and which is understand the aims of the reform, what is expected of them and have the skills and materials to run the reform. However, from the findings, the second and

the third conditions cannot be met. Teachers do not know what they are expected to do as there is no guideline from the government, telling them what outcomes or activities that they should do. Workshops are held for teachers to train themselves to have the technique of teaching STEM, but teachers mostly think they are not enough. The government should give more particle examples for schools and teachers on how to promote STEM in schools. The guidelines' content should include the learning objectives and the teaching content for teachers' references. The workshops' content should also be about the STEM education lessons that teachers can take them as samples, back to school and teach students, but not only talking about new technologies that cannot apply in schools (for example, the workshop about AI). Besides, the guidelines and workshops should not only focus on after-school activities, but also telling teachers and secondary schools how to add the element of STEM into the classroom, into daily life lessons. More particle examples for teachers can let them feel more confident in teaching STEM as they have some instruction to follow. If the government provides guidelines that include particle examples, teachers will have targets, knowing what they should do or teach, but not exploring only by themselves.

5.3. Cut Down some of the Curriculum

There is a complaint that repeated in the four interviews, which is "The curriculum is too full". The survey conducted by the Hong Kong Federation of Education Workers (2019)

also mentioned that teachers are exhausted from finishing the required curriculum, and there is no time for having STEM education. The lesson time for the original curriculum has stuffed full the lesson time, or even the after-school time with make-up classes. Both teachers and students are feeling stressed on finishing the curriculum, they would not have that vigour and passion on holding and joining STEM activities after school, the tight schedule of the teaching plan also not allow teachers adding STEM elements in class. If the government wants to promote STEM education in secondary schools, some of the curricula should be cut down, let students and teachers have time for STEM education, no matter for in-class or after-class.

5.4. Promote STEM to the Public

From the literature that McGinn (1999) suggested, the reform will usually fail if the reform does not match the local culture. In the current situation in Hong Kong, most of the public do not understand the term of STEM. They also think that studying engineering and technology is not the best choice as there are little prospects after graduation. Not only the public, but some students also think in this way, think STEM will not help them get into the university, so they have no interest in joining STEM education activities. One of the reasons that cause this norm is because there is no successful example in Hong Kong. Even the government always mentions STEM education in the Policy Address since 2015, saying STEM education helps cultivate talents in the new century, it is hard to convince the public. When the

students and the publics do not motivate to join the reform, STEM education is hard to be promoted. Government can try to change the publics' thought starting by promoting a long-term career path if students have chosen to learn STEM education and focus on studying technology and engineering. Tell both students and society how high the students can get if they get success in this field. Having a clear career path can help to change students' and parents' minds on thinking learning engineering and technology cannot have a higher living standard, increasing their confidence in learning STEM in the college.

5.5. Linking Companies and Schools

Teachers should have enough materials for the new education style in order to let the reform succeed. (McGinn, 1999) For the current situation in Hong Kong, there are actually quite a lot of companies having STEM teaching material sets or STEM activities sets for schools, and they will fax the advertisements to schools, promoting their products and services. Alternatively, teachers will search for suitable STEM-related material on the internet. That is a problem that those companies' reputation is not affirmed as everyone can send advertisements to the schools or post on the internet. The government can take a role in this situation, be the bridge that linking companies and schools. aFor example, the government can take the online shopping mall in HKedcity as references, choose some STEM teaching materials or activities services that have good quality and put them on the website, and let teachers directly search

for trustworthy products.

5.6. Having a Subject call STEM

Yang (2018), the head of EDB, has described the approach of promoting STEM education as school-based autonomous. As schools independently develop STEM education, it caused some schools are so successful in STEM education, but some are far behind. For example, some schools in Hong Kong will take the time after lunch every day or a day in a week as 'STEM time', students will do some projects on STEM-related topics. However, only a few secondary schools have this kind of arrangement. Most of the secondary schools in Hong Kong suffer similar problems as the selected school I have interviewed. To unify the process of promoting STEM education, the government can create a brand new subject called STEM, having a complete instruction, guidelines, curriculum, Et cetera; like we have for Mathematics, Sciences or other different subjects. When STEM is treated as a subject, although the preparation of EDB will be extensive, every school will run STEM education with a standard, then every student in Hong Kong can have the chance on having this new century education style, training their higher thinking skills, increase their competitiveness around the world. Besides, most of the problems that the teachers have mentioned, for example, the lack of particle guideline, full of curriculum, will be ease when the EDB has treated STEM as a separate subject. If the government would like to promote STEM as a long-term education style

in Hong Kong, having a separate subject will be a good suggestion.

6. Limitations

There is a limitation of the sample size of the study. There are only four experienced teachers from the same school were interviewed in the study. They are all teachers that have experiences in teaching for over ten years. New teachers' sound was not included in the study, so that the data may be cannot reflect all the thoughts that teachers think about towards the policies for promoting STEM education. However, they are all experienced teachers. They have much communication with different teachers, including new teachers, so the four experienced teachers will also share the thought of teachers of different ages and teaching years during the interviews. Also, only one school was selected in the study, which means that data collected may not reflect all secondary school. Nevertheless, with visiting websites of different secondary schools in Hong Kong, most of the schools promote STEM education usually by after-school activities, which is same as the selected school. In the interview, teachers also share other teachers' feeling from different schools, and most of them are having similar feeling with the participants, so the information can reflect on the thought of majority Hong Kong secondary school teachers.

7. Conclusion

To conclude, the study has focused on the effectiveness of policies that promote STEM education in Hong Kong secondary schools, finding out which areas of policies are having positive effects on the issue and which areas are missing. Through the study, teachers expressed their satisfaction with the financial support provided by the government, but also expressed their concern about the lack of particle guidelines and teaching materials, full of curriculum that no time for STEM education, and the worse atmosphere for developing STEM education from the public. In order to let all secondary schools' students in Hong Kong having the chance to experience this new century education style, training their higher thinking skills that required in current society, the study is important. Besides pointing out the merit and deficit areas of the policies, the study also gives suggestions on easing or solving the insufficient places on promoting STEM education in Hong Kong secondary schools.

Promoting STEM education is a kind of education reform, and it is a long process. I believe the government would overcome the difficulties and have an improvement on promoting STEM education in all secondary schools in Hong Kong. Hoping students in Hong Kong can enjoy STEM education with a complete system in the near future.

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Appendixes

Appendix 1 Questionnaires (Chinese + English version)

有關推行 STEM 教育政策之問卷調查

Questionnaire on the Policies Promoting STEM Education

您好！感謝閣下抽空回答本問卷。此學術問卷希望能夠收集中學老師對政府在推行 STEM 教育時各種政策的意見。煩請閱讀後，針對各問題作答。所填寫內容亦完全保密。本問卷僅供學術研究參考，閣下意見對本研究非常重要，謹致由衷的感謝。

Hello! Thank you for taking time to answer this questionnaire. This academic questionnaire hopes to collect the opinions of secondary school teachers on different policies in the implementation of STEM education. Please answer each question after reading it. The content filled in is completely confidential and for the academic research only. Your opinion is very important and I would like to express my sincere thanks.

香港教育大學數學與科技學系中學數學教育

The Education University of Hong Kong Mathematics Education (Secondary)

指導教授：崔太僖 博士

Supervisor: Dr. Choi, Tae Hee (Department of EPL)

學生：麥亦甜 敬上

Student: Mak Yick Tim

第一部分/Part 1：個人背景/ Background

1. 姓名／Name：	
2. 教學年資/Years of Teaching：	
3. 任教科目/Subject teach：	
4. 行政職務/administrative duties：	

第二部分/Part 2：

1. 每年您主要任教科目用於 STEM 教育發展的預算大約為多少港元？

   How much (HKD) your subject taught spent on STEM education (each year)?

   ☐ 10 萬以下 10 million or less ☐ 10 萬到 20 萬 10 - 20 million

   ☐ 20 萬到 30 萬 20-30 million ☐ 30 萬到 40 萬 30-40 million

   ☐ 40 萬以上 40 million or more

2. 請問學校有申請優質教育基金（QE Fund）嗎？

   Have the school applied the QE fund?

   ☐ 有 Yes ☐ 沒有 No

3. 學校有申請其他機構（如賽馬會慈善基金）有關 STEM 教育的資助？

   Have the school apply funding from other organization (e.g. JC Charity Fund)

   ☐ 有 Yes ☐ 沒有 No

4. 您認為政府於推行 STEM 教育時給學校有足夠的財政上的幫助嗎？

   Do you think the financial support from the government is sufficient?

   ☐ 非常不足 Very Insufficient ☐ 不足 insufficient ☐ 一般 General

   ☐ 足夠 Sufficient ☐ 非常足夠 Very Sufficient

5. 您認為政府給老師於在中學推行 STEM 教育的指引是否足夠？

   Do you think the guidelines provided by the government is sufficient?

   ☐ 非常不足 Very Insufficient ☐ 不足 insufficient ☐ 一般 General

   ☐ 足夠 Sufficient ☐ 非常足夠 Very Sufficient

6. 您認為政府給老師於中學推行 STEM 教育的指引內容抽象嗎？

   Do you think the content of the guidelines provided by the government is abstract?

   ☐ 非常抽象 Very Abstract ☐ 抽象 Abstract ☐ 一般 General

   ☐ 具體 Specific ☐ 非常具體 Very Specific

7. 您認為教育局電子化服務入門網站(e-service)提供的工作坊是否足夠？

   Do you think the number of workshops held by EDB is sufficient?

   ☐ 非常不足 Very Insufficient ☐ 不足 insufficient ☐ 一般 General

   ☐ 足夠 Sufficient ☐ 非常足夠 Very Sufficient

8. 您認為教育局電子化服務入門網站(e-service)提供的工作坊對新接觸 STEM 的老師有否幫助？ Do you think the workshops are helpful for teachers that are new in STEM?

   ☐ 很有幫助 Very Helpful ☐ 有幫助 Helpful ☐ 一般 General

   ☐ 較無幫助 Not Really Help ☐毫無幫助 No Help

9. 請問您有沒有參考過教育局發佈有關 STEM 的教材？

   Have you took the STEM teaching materials that posted by EDB as references?

   ☐ 有 Yes ☐ 沒有 No

10. 如有，您認為教育局發佈有關 STEM 的教材有多大幫助？

    If yes, do the materials helps?

    ☐ 很有幫助 Very Helpful ☐ 有幫助 Helpful ☐ 一般 General

☐ 較無幫助 Not Really Help ☐毫無幫助 No Help

11. 您認為教育局發佈有關 STEM 的教材有否經常更新？

Do you think the teaching materials renew frequently?

☐ 經常更新 Always update ☐ 有時更新 Updated Sometimes ☐ 甚少更新 Seldom update ☐ 較為過時 Quite outdated ☐十分過時 Very Outdated

12. 您認為推行 STEM 教育有多大程度影響閣下所任教科目的正常課程要求？

How the implementation of STEM education affect the normal curriculum requirements?

（1 為毫無影響/ 1 means no impact，5 為非常影響/ 5 means very affecting）

1	2	3	4	5

13. 您認為政府推行 STEM 教育的進程如何？

What do you think is the progress of the government promoting STEM education?

（1 為過於急進/ 1 means too fast，5 為過於緩慢/ 5 means too slow）

1	2	3	4	5

14. 現時中學文憑試（HKDSE）對各科的考核標準均以理論為主，您認為有多大程度影響學校對 STEM 教育的推行力度？

HKDSE are mainly based on theoretic examination, what do you think it affects the promotion on STEM education in secondary schools?

（1 為毫無影響/ 1 means no impact，5 為非常影/響 5 means very affecting）

1	2	3	4	5

15. 您認為學生有多積極參與 STEM 的教學活動？

Do you think students join STEM activities positively?

☐ 非常積極 Very positive ☐ 積極 Positive ☐ 一般 Normal ☐ 不積極 Negative

☐ 非常不積極 Very Negative

16. 您認為政府在營造有利 STEM 教育環境的工作是否足夠？

Do you think government has create a good atmosphere on promoting STEM education?

☐ 非常不足 Very Insufficient ☐ 不足 insufficient ☐ 一般 General

☐ 足夠 Sufficient ☐ 非常足夠 Very Sufficient

17. 請問學校有否與商界或其他機構合作舉行 STEM 活動或向其購買相關教材？

Have schools have purchased STEM-related product from the outside companies?

☐ 有 Yes ☐ 沒有 No

18. 您認為若政府於學校與商界間建立平台作交流 STEM 活動或教材，會對中學推行 STEM 教育有多大幫助？

If the government take a role, linking the companies and schools, do you think it is helpful for promoting STEM education in secondary schools?

☐ 很有幫助 Very Helpful ☐ 有幫助 Helpful ☐ 一般 General

☐ 較無幫助 Not Really Help ☐毫無幫助 No Help

再次感謝您完成本問卷。為得到更具體的意見，現誠邀您進行十至十五分鐘的訪問希望您可抽空接受訪問。訪問內容主要是了解中學老師對政府推行 STEM 教育於財政、教師指引及培訓及營造有利 STEM 教育推行的環境上的政策之意見。如閣下能撥冗接受我的訪問，煩請通知時間，以便安排。謝謝關注！

Thank you again for completing this questionnaire. In order to get deeper understanding of the comments, I sincerely invite you to conduct a 10-15 minutes interview. I hope you can take time to accept the interview. The content of the interview is mainly focuses on the opinion of secondary teachers' feeling towards the implementation of STEM education I terms of financial support, trainings for teachers and the environment promoting STEM education. If you can take time to accept my interview, please contact me. Thank you for your attention!

Appendix 2 Excerpt from Mr. L Transcript (Translated)

1. Q: What STEM activities the school has held before?

   A: In-class projects, some off-campus competitions and organized some STEM activities for primary students. Some of the activities in the cross-curricular day also about STEM.

   Q: For the in-class project, are there any product? Or just text report is done?

   A: There would be a product. But actually, we will not emphasize that is a STEM project, but focus on the knowledge of the subject. For example we will make a solar furnace in physics lessons, but we seldom focus on how they make the product but the theory applied.

2. Q: What do you think about the financial support from the government on promoting STEM?

   A: I think it is enough, but it is not continuous. I think it is not too good.

3. Q: What do you think about the guideline provided by the government?

   A: The guidelines that the government has posted provided a good framework about STEM. The guidelines have a detailed discerption of learning objectives, learning attitudes, and skills students expected to learn during STEM education. However, there are not many examples of how to reach these outcomes. There is too much space that requires teachers to explore by themselves. The polite name for this is space to

explore, and the impolite name is nothing practical in the guideline.

4. Q: What do you think about the workshops then?

   A: It's good! There are more experience sharing sessions recently which I think I can take them as my references. These sharing sessions are very beneficial for me, I think, also for other teachers. As these are the actual examples that are missing in the guideline. I can take the examples that have shared in the workshops as references, seeing whether I can use them in our school or not. Also, we can listen to other schools how they run STEM in secondary schools, thinking our school can follow or not.

5. Q: You said the promotion of STEM education affect the normal curriculum requirement? How is it affect?

   A: The curriculum is too full that no time for STEM. Also STEM is an integrated subject, as you say, so it is hard to teach other subject knowledge just for the STEM project.

6. Q: Do you think the government have enough promotion to the society on STEM?

   A: Actually I think the social norm is still thinking technology and engineering is not the fields that can be so success. The government has done something, and always emphasized the important of technology….but…no something particle has done.

Appendix 3 Excerpt from Mr. A Transcript (Translated)

1. Q: What do you think the financial support from the government is enough?

   A: Actually I am not sure do the funding I use is from the school or the government, but I think it is enough.

2. Q: What do you think about the guidelines about STEM education?

   A: I think most of the teachers only know EDB want to push STEM education in schools, but there are not enough actual plans and instructions for us. And the teaching materials also, there are only a few activities, I think is not enough.

3. Q: What do you think about the workshop?

   A: I think they are ok, better than not having them. But some of them cannot apply in schools because of the time, cost etc. I think the EDB should hold more workshops that teachers can hold in schools but not introducing new technology to us.

4. Q: Do you think the curriculum affect the implement of STEM education?

   A: Of course! The curriculum is quite full that teachers usually need to make up lessons after school, or during holidays. So, we will not spend extra time on having STEM education activities during classes, as the reality not allow us.

Appendix 4 Excerpt from Mr. C Transcript (Translated)

1. Q: What do you think about the guidelines about STEM education?

   A: I think most of the teachers only know EDB want to push STEM education in schools, but there are not enough actual plans and instructions for us. And the teaching materials also, there are only a few activities, I think is not enough.

2. Q: Do you think the government has created an environment that suitable for STEM education development?

   A: Well……actually I do not think the government has promoted STEM hardly to the society.

   Q: Do you think government should give some confident to the public that studying STEM can be success, or…

   A: Yes, I think promoting a big picture of STEM to the publics will help. Send a message that studying STEM also can help students get into the universities, or even have a better level of growth. But I think, in my feeling, the government only presented the idea of promoting STEM education in Hong Kong, but not many following instructions or policies. It seems like a merchant has sold a good, only meeting the sales target, but did not have any after-sale service for the customers.

Appendix 5 Excerpt from Miss. W Transcript (Translated)

1. W: What do you think about the financial support from the government?

   A: It is enough. However, the procedures on applying the funding are quite inflexible. I agree that if the school needs to build laboratories like our iLab, writing a proposal is a must that seeing whether the school has good planning on that much money. However, schools seldom build something big. Buying teaching materials or hiring tutors to hold small STEM activities are our daily school life. These activities are hardly writing a proposal for them.

2. Q: What is your feeling towards the guidelines provided?

   A: Well, just so-so. As there are only a complete framework, but little content in it. I think more particle examples, like how we can add STEM education in project learning etc. I think it will be better.

3. Q: How about the workshops? Do you think someone who do not understand STEM can learn from them?

   A: I think they are audience-friendly for them. Not only new teachers, also for experienced teachers in STEM, they can generate new ideas in STEM through the workshops.

4. Q: You think STEM activities should hold after school. So, do you think STEM education cannot add into the classroom?

A: I know STEM education should be both in-class and after-class. But I think we need to face to the true situation in Hong Kong. There are no time other things but to finish the required curriculum. You know I am a science teacher, let's take SBA as an example. You know what is SBA of science subject right? (Researcher: Yes.)The learning objectives of SBA are to train students' science abilities and creativity in experiment designing. However, because of the tight syllabus, honestly, these objectives cannot be reached. Most of the schools in Hong Kong, I think, will only let students remember the steps of the experiments that have set by the schools and do the experiments in a limited time. There is no time for SBA, so why EDB thinks schools can add STEM education to the current curriculum? It is a mission impossible.

5. Q: Do you think the government should be the linkage between the companies that provided STEM-related products and the schools?

   A: I hope government will. As I have an experience that I contacted a companies for a STEM activities, but in the middle of the communication, the companies has disappear. Fortunately that I haven't paid for any. I think if the government can take the role, I can be purchase the service more at ease as I think the reputation of the companies are guaranteed.