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Challenges and Opportunities with Hong Kong students' Science, Technology, Engineering and Mathematics aspirations

香港學生對科學、科技、工程及數學的抱負的挑戰與機遇

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Executive Summary

Abstract

STEM (Science, technology, engineering and mathematics) has recently become one of the global educational initiatives. This development has given rise to numerous discussions on the forms and effectiveness of STEM education around the world. Hong Kong is no exception. STEM education has been promoted as a key emphasis of the school curriculum in primary and secondary schools in recent policy addresses, encouraging students to develop solid knowledge and interest in STEM and to pursue the study of STEM-related subjects.

The aim of this research is to better understand students' STEM aspirations and underlying factors related to family, school and society, and to provide the government and the public with references in STEM education and curriculum policy. A set of three quantitative surveys that targeted students at key stages 2, 3 and 4 (senior primary, junior secondary and senior secondary) was designed. Data samples were collected through an online survey. Descriptive statistics, one-way ANOVA, *t* tests, logistic and multiple regression, as well as path analysis were adopted in the data analysis.

Findings show that students who are more likely to choose to study STEM subjects tend to have higher self-efficacy in science and mathematics, and have more positive images of STEM professionals. Primary and junior secondary school boys are more likely to choose STEM subjects than girls. Image of STEM professionals and informal STEM activities are significant predictors of STEM career aspirations for all students, while school STEM opportunities significantly predict senior secondary students' STEM career aspirations. Parental expectations and social identity directly and positively influence STEM career aspirations for students, but senior secondary school students have relatively lower social identity than students of other key stages. Boys of all three key stages are more confident in science-related subjects and mathematics, as well as having higher STEM career aspirations than girls.

Based on the above findings, eight major recommendations in four aspects of individual, family, school and society for policy makers are made: (1) make STEM opportunities available for all students; (2) narrow the gender gap in STEM aspirations; (3) enhance parent education on students' study and career choices; (4) build STEM capital to bridge the social economic status gap; (5) articulate STEM learning progression across the key stages; (6) integrate STEM career understanding into school education; (7) highlight STEM contributions to society and country; and (8) improve the quality of STEM education.

近年 STEM（科學、技術、工程和數學）成為全球關注的其中一項教育倡議， 並引起世界各地廣泛討論有關 STEM 教育的模式和其有效性。香港也在最近多次的施政報告中推廣 STEM 教育為中小學學校課程重點，以促進學生對 STEM 知識的學習，並鼓勵學生繼續學習 STEM 相關學科。

是次研究目的是為了更好地了解學生的 STEM 抱負以及與家庭、學校和社會相關的潛在因素，並為政府和公眾提供 STEM 教育和課程政策方面的參考。數據樣本為香港三個學習階段的高小，初中和高中學生。數據收集採用在線問卷調查的形式。數據分析採用描述性統計、單向方差分析、t 檢驗、邏輯和多元回歸以及路徑分析。

研究結果表明，學生在科學和數學上具有較高的自我效能感，亦對 STEM 專業人士的印象更為正面，更有可能在未來選擇學習 STEM 學科。小學和初中階段男生比女生更有可能選擇 STEM 科目。學校的 STEM 機會則可有效地預測高中生的 STEM 職業抱負。對所有學生來說，STEM 專業人士的形象和課外 STEM 活動是他們對 STEM 職業抱負的重要預測指標。父母的期望和社會認同亦直接而積極地影響他們對 STEM 的追求，但高中生的社會認同相對低於其他學習階段的學生。各學習階段的男生對科學和數學的信心，和 STEM 職業抱負皆女生為高。

基於上述結果，對政策制定者在四個範疇的八項建議是：（1）為所有學生提供 STEM 學習機會；（2）縮小 STEM 職業抱負性別差距；（3）加強家長對學生學習和職業選擇的教育；（4）建立「STEM 本錢」以減低社會經濟地位差異；（5）在各學習階段闡明「STEM 學習進程架構」；（6）將 STEM 專業元素納入學校課程；（7）強調 STEM 在社會和國家中的貢獻；（8）提高 STEM 教育的質素。

Layman Summary of Policy Implications and Recommendations

Recommendations for policy makers to address students' STEM subject choice and career aspirations are to: (1) make STEM opportunities available for all students by infusing STEM learning elements into various subjects; (2) narrow the gender gap in STEM aspirations by developing more gender-based STEM opportunities in cooperation with NGOs and greater representation of female professionals in the media; (3) enhance parent education on students' study and career choices by raising parents' awareness of the changing society; (4) build STEM capital to bridge the social economic status gap by promoting informal STEM learning and public STEM literacy; (5) articulate STEM learning progression across key stages by developing a research-based progression framework from a special task group; (6) integrate STEM career understanding into school education by bringing STEM career elements into the curriculum; (7) highlight STEM contributions to the society and country by way of public education programmes, mass media and greater emphasis on STEM-related issues in the Liberal Studies curriculum; and (8) improve the quality of STEM education by continuous teacher education programmes and education research.

為政策制定者對促進學生的 STEM 學科選擇和職業理想的建議是：（1）將 STEM 學習要素融入各個學科，為所有學生提供 STEM 學習機會；（2）與非政府組織合作開發更多縮少性別差距的 STEM 機會，並在媒體中增加女性專業人士的代表性；（3）提高家長對瞬息萬變社會的認識，加強家長對學生學習和職業選擇的教育；（4）促進非正式 STEM 學習和公眾 STEM 素養來建立「STEM 本錢」，以減低社會經濟地位差異。（5）建基於教育研究的理論框架，在各學習階段闡明「STEM 學習進程架構」；（6）將 STEM 專業元素納入學校課程，整合 STEM 專業內容的認識；（7）通過公眾教育計劃，大眾媒體以及通識教育課程，強調 STEM 在社會和國家中的貢獻 ；（8）開展持續的教師培訓和教育研究，提高 STEM 教育的質素。

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Chapter 1 Background of Research

1.1 Innovation and Technology Development in Hong Kong

Currently, financial services, trading and logistics, tourism and professional services and other producer services are the key industries with good prospects in Hong Kong (Labour Department, 2019). Yet, innovation and technology has become one of the main driving forces of current economic growth. However, in 2013, the number of jobs available in the IT industry accounted for only 0.9% of total employment (Our Hong Kong Foundation, 2015). According to the data in the 2015-2016 Global Competitiveness Report by the World Economic Forum, it was reported that Hong Kong ranks relatively low in ‘innovative capacity’ (29th), and ‘availability of scientists and engineers’ (41st) (Our Hong Kong Foundation, 2015).

With the aim of turning Hong Kong into an international innovation and technology hub, a series of policies have been implemented to encourage entrepreneurship through research and development, fostering economic development and providing employment for young people. For example, the Innovation and Technology Bureau (ITB) was established in 2015, a huge amount of money was invested in research and development, and support was provided for start-ups. In 2017, innovation and technology was highlighted by the Chief Executive as one of the main policy directions for the economic development of Hong Kong during her maiden policy address. The Innovation & Technology Bureau also provided plans to launch a $500 million Technology Talent Scheme. The scheme aims to encourage young people to engage in research and product development. It is part of the Government's plan to boost innovation and technology in eight key areas to help Hong Kong become an international I&T hub. The key areas are resources for research and development, nurturing a talent pool, venture capital, scientific research infrastructure, legislation review, opening up of data, government procurement, and popular science education.

These policies and commitments reflect the urgent need to nurture and supply a STEM workforce for economic ends. This development is interpreted as a response to the weak situation of the STEM industries and the narrow industrial structure in Hong Kong (Hong Kong Policy Research Institute, 2017). Thus, there will be high demand for STEM experts with deep understanding of STEM skills for developing STEM and innovation and the technology industry, to foster economic development and create employment.

The benefit of national development and economic prosperity, as well as the nation’s productivity from I&T development requires a critical mass of university graduates in the related areas (Marginson, Tytler, Freeman & Roberts, 2013). In order to have more students pursue the study of

I&T and STEM subjects at university level, in the long run, there is a need for concrete strategies to enhance the development of STEM education at the primary and secondary school levels so as to encourage and equip school students with the necessary STEM interest and abilities.

1.2 Promotion of STEM Education in Hong Kong

The putting forward of STEM education in Hong Kong started with the 2015 Policy Address, which stated that the Education Bureau would:

> *renew and enrich the curricula and learning activities of Science, Technology and Mathematics, and enhance the training of teachers, thereby allowing primary and secondary students to fully unleash their potential in innovation. (Item 152)*

In the 2016 Policy Address, it was emphasized that the Government would:

> *step up efforts to promote STEM (Science, Technology, Engineering and Mathematics) education and encourage students to pursue the study of these subjects. (Item 89).*

In the 2017 Policy Address, it was further suggested that the Education Bureau would:

> *strive to promote Science, Technology, Engineering and Mathematics (STEM) education. Following the provision of additional resources for primary schools at the beginning of last year, the EDB is prepared to provide each public sector secondary school with an additional one-off subsidy of $200,000 to facilitate the implementation of school-based programmes related to STEM education. (Item 212).*

In the 'Promotion of STEM Education – Unleashing Potential in Innovation' prepared by the Education Bureau in 2015, the following five guiding principles for promoting STEM Education were reported: learner-centred approaches; essential learning experiences; a balance among different purposes, views and interests; building on strengths; and a continuous development process.

However, in the current STEM education framework and policies, no concrete directions or guidelines for schools and teachers were found (Youth I.D.E.A.S., 2018). The 'Task Force on Review of School Curriculum' by the Education Bureau (2019) also reviewed that 'the four core subjects were considered as taking up too much learning space of students …, some even attributed the slow progress in Hong Kong's development in STEM to the over-emphasis on the core subjects, which has allegedly inhibited students from taking more science elective subjects and weakened their exposure to and interest in STEM exploration'. It was also observed that the 'pace and implementation strategy of STEM education varies a lot among schools' and the 'level of understanding and practice of STEM education in schools are very diverse'.

1.3 Studies on STEM Education in Hong Kong

In response to the government call for the promotion of STEM education in Hong Kong, there have been various studies and reports done by different associations to evaluate the current situation and implementation of STEM education.

The 2017 report '*Science, Technology and Mathematics Education in the Development of the Innovation and Technology Ecosystem of Hong Kong*' by The Academy of Sciences of Hong Kong pointed out that 'STEM education [is] not being extended to all students ... almost half of the new senior secondary students in Hong Kong do not take any Science or Technology subject' (ASHK, 2017). The report also discussed the over-emphasis on examination results and core subjects, current university admission policies, and the poor prospects of studying science and engineering, all of which may shape and narrow students' studies.

The survey, '*STEM Education in Primary Schools*' conducted by the Hong Kong Federation of Youth Groups in 2017, revealed that only a small number of student respondents regularly engage in STEM learning activities in school, and they have limited exposure to such activities. Science experiments, scientific inventions, and field trips can arouse students' interest in learning science and technology, but the survey pointed out that teachers are the key people to enlighten students about learning science, technology, and mathematics subjects. However, the lack of support, training and confidence of teachers in teaching STEM may impact on the effectiveness of teaching and learning. The survey also investigated the factors that hinder students' participation in STEM-related extra-curricular activities. Excessive homework, expensive activity fees and unattractive activities are cited as major hindrances.

The Croucher Foundation collected data and conducted the study '*The Out-of-School STEM Ecosystem in Hong Kong*' in 2017. The study identified a total of 1,074 out-of-school STEM activities and 144 STEM organisers from 2015 to 2016. The activities included competitions, exhibitions, talks, workshops, courses, field trips, and camps. STEM education in Hong Kong cannot be easily promoted due to certain limitations. These limitations include the lack of support from schools, parents and students who may prioritise in-school and academic-related activities over STEM activities; students' schedules which are often fully occupied; certain teachers who do not have science backgrounds and do not possess STEM knowledge; and the lack of strategic funding from the HKSAR government.

The 2016 report '*To STEM or Not STEM Factors influencing Adolescent Girls*' *Choice of STEM subjects*' by The Women's Foundation revealed that respondents' choice of whether or not to study STEM-related subjects was mostly affected by their early experience and exposure to STEM, their self-perceived ability, self-interest and aspirations. These experiences are shaped by society, parents, and to a large extent, by schools. However, it is worth noting that the report found that ‘gender stereotypical beliefs on the part of both students and teachers significantly affect girls’ intention to study STEM subjects overall’. Furthermore, the report indicated that ‘parents often lack information on STEM career options, yet they are the main influencers when it comes to advising their daughters on educational subjects and career paths’ (The Women’s Foundation, 2016).

The report ‘*Globalization & Top-level Design of STEM Education*’ released by the Hong Kong Policy Research Institute and Hong Kong Vision in 2017 emphasised the fact that STEM education as well as the innovation and technology industry are linked. To create a positive environment for STEM and career development, the report suggested joint efforts of the governmental, business, and educational sectors in creating a ‘STEM+ Promotion Centre’, promoting different teaching strategies stage-by-stage, establishing a STEM+ literacy framework and a STEM+ business-school platform, improving the university admissions system by nominating talented students to study related courses, etc. These reports and statistics provide a general picture of the current STEM education in Hong Kong including the types of STEM activities students are engaged in, their frequency of participation, barriers to students’ participation, challenges of promoting STEM education, and weaknesses of existing education policies.

1.4 What are STEM Aspirations?

The literal meaning of ‘aspiration’ in the Oxford dictionary is ‘a hope or ambition of achieving something’. Brannen and Nilsen (2007, p. 155), from a sociology perspective, discussed that aspirations can range from vague and uncertain ideas about the future to ‘more concrete and achievable plans’. More specifically, Kao and Tienda (1998) discussed aspiration in education by stating that, ‘aspirations represent the hopes and desires of students as they realize their own ambition toward educational attainment. These aspirations are the product of many elements including personal goals, life experiences, and personal beliefs about educational attainment in general’. Similarly, students’ conceptions of STEM and the interaction of factors at the family, school, and societal levels would be the main sources for establishing students’ STEM aspirations. Thus, in this proposal, ‘STEM aspirations’ refer to hopes or ambitions of pursuing education attainment and/or careers in STEM fields.

1.5 STEM Learning Ecosystem

Multiple factors may contribute to students’ aspirations for STEM studies and careers. With reference to Archer and Dewitt’s (2017) research on young people’s science aspirations and the UNESCO 2017 study ‘Cracking the code: Girls’ and women’s education in STEM’ which was a cross national study covering more than 120 countries and dependent territories, the following paragraphs described the factors for exploring and understanding students' aspirations comprehensively. Although the U.K. study and the UNESCO focus on 'science aspiration' and girls' STEM education respectively, they are highly relevant to this study on the STEM aspirations of primary and secondary students in Hong Kong.

1.5.1 Individual Factors

- Self-Efficacy in Learning STEM

Self-efficacy refers to peoples' confidence in their ability to do something, whereas academic self-efficacy can be looked at as students' confidence and belief in their capability to achieve academic success (Sander & Sanders, 2015). High levels of self-efficacy are characteristics of higher levels of achievement which may be necessary to persevere in students' academic motivation and future studies (Bernasconi, 2017; Bryant et al., 2013).

Bolstering students' STEM self-efficacy is believed to be effective in terms of strengthening their STEM learning interest (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010), and these two factors together could be the predictors of youth's STEM career aspirations (Robnett & Leaper, 2013). It was also supported by the study of Brown, Concannon, Marx, Donaldson, and Black (2016) that students' self-efficacy in STEM was one of the best predictors of their intention to pursue STEM persistently.

- Gender Difference

The UNESCO report suggested that self-efficacy of students' potential in STEM and their gender are closely linked. It is reported that, compared with male students, female students had lower levels of self-efficacy in STEM subjects, which could possibly undermine their persistence in pursuing STEM studies or careers (Cotner, Ballen, Brooks, & Moore, 2011; Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013; Simon, Aulls, Dedic, Hubbard, & Hall, 2015).

Gender difference in STEM aspiration has been investigated by a number of previous studies, and the findings mostly suggested a similar phenomenon: males show a significantly stronger tendency to aspire to STEM careers than females. The research by Sadler, Sonnert, Hazari, and Tai (2012) on career plans of high schoolers reported that male students showed far more interest in engineering, while the study by Liu (2018) on Chinese middle school students suggested a similar phenomenon that girls were far less likely to show career aspirations as scientists and engineers than boys, with only 2.2% of girls having aspirations to become scientists or engineers, compared to 13% of boys showing the same aspirations.

- Informal STEM Learning

Other than students' everyday school life, informal learning activities outside of regular school settings are also considered fundamental to cultivating students' interest and aspirations. Informal activities allow more autonomy for students to explore knowledge based on their own interest and to learn it at their own pace (Zhang & Tang, 2017), and to provide opportunities for students to solve problems that are related to their environment using STEM (So, Zhan, Chow, & Leung, 2017). As a result, it is believed that informal activities can be an effective and long-lasting means to motivate students (Fenichel & Schweingruber, 2010; Wilson et al., 2014)

The impacts of informal scientific activities on cultivating students' STEM interest have been extensively explored by previous researchers. Hosssain and Robinson (2012) and Vanmter-Adams, Frankenfeld, Bases, Espina, and Liotta (2014) indicated that students who demonstrated a strong interest in and talent for STEM were initially ignited by informal activities such as non-classroom childhood experiences or encounters in nature or science such as astronomy, science fair competitions, summer camps, as well as fiction and nonfiction media about science. The study by Zhang and Tang (2017) supported that participation in informal activities not only enhanced students' learning interest in STEM, but also boosted their academic self-efficacy.

- Images of STEM Professionals

In order to encourage more students to aspire to become one of the future STEM professionals, their perception of 'what STEM professionals are like' is considered one of the fundamental factors in influencing their will to join the field. Yet, a considerable amount of literature has shown evidence of students' misconceptions of STEM professionals. Thompson and Lyons (2008) reported that primary and middle school students generally demonstrated incomplete and inaccurate perceptions of engineers. Later it was even suggested there was 'a lack of conception as to who engineers are rather than a misconception' (Fralick, Kearn, Thompson, & Lyons, 2009).

Having positive perceptions of STEM professionals was linked to having more STEM interest, STEM subject choices and career aspirations by other studies. Images of scientists were positively correlated to students' attitude to learning science as well as to their interest in studying it (DeWitt et al., 2011; Miller, Blessing, & Schwartz, 2006). The inaccurate perception of engineers which was reported by Fralick et al. (2009) was believed to be a factor for students not to include STEM in their academic subject selection and career path. Added to that, Miller, Blessing, and Schwartz (2006) revealed relatively more unappealing images of scientists by girls than boys. Scientists were referred to by some of the female students as 'uncaring', 'passionless' and even 'violent', and there was a connection of these negative images to the tendency to choose non-science majors by these students.

1.5.2 Family Factors

- Perceived Parental Expectation

Nichols, Kotchick, Barry, and Haskins (2010) indicated that the educational expectations of parents and their involvement in their children's education are positively correlated with students' educational aspirations. Perceived parental support is also believed to affect students' beliefs about their ability, decision to study STEM, education achievement and career choices. Banerjee, Harrell, and Johnson (2011) reported that positive parental involvement in the education of their children is related to better academic achievement.

More importantly, parents provide an important context to young people within which they form their occupational aspirations (Archer et al., 2012). Research carried out in Australia by Lloyd, Gore, Holmes, Smith, and Fray (2018) suggested the association of students' interest in STEM occupations with their parents' expectations: 90% of the parents of students who expressed their interests in STEM occupations had aspirations for their children to attend university.

- Family Socioeconomic Status

Family socioeconomic status (SES) in this study refers to parental education and occupation. Although SES does not seem to have as direct an influence on children as other factors, children's interest in STEM learning and their aspiration may be shaped, in both good and bad ways, by the family's extent of science-related advantages including science skills, knowledge, interest and jobs (DeWitt, Archer, & Man, 2016; Godec, King, & Archer, 2017; Sheldrake, 2018). Generally, students with lower SES are less likely to develop and maintain their interest in pursuing a STEM career (Saw, Chang, & Chan, 2018).

Parents' educational background showed a linkage to their children's academic aspiration in STEM. Students with parents who had higher education levels were found to have a stronger intention to pursue the same level of higher education qualification as their parents and undertake STEM courses in college or universities, compared to those students whose parents did not have post-secondary education backgrounds (Gil-Flores, Padilla-Carmona, & Suárez-Ortega, 2011; Siani & Dacin, 2018). Another factor regarding family SES that may facilitate children's STEM career aspirations is whether their parents work in STEM-related fields. It was discussed in various studies that students who expressed more interest in and aspirations for STEM careers had higher proportions of parents working in STEM fields (Holmes, Gore, Smith, & Lloyd, 2017; Sheldrake, 2018).

1.5.3 School Factors

- STEM Learning Experiences in School

Young people's aspirations are influenced by their perceived experiences of school, teachers, specific interests and aptitudes that they develop through their lessons and learning at school, as well as career conventions or websites recommended by their school (Archer & Dewitt, 2017). The UNESCO (2017) report provides detailed descriptions of the school factors including, 'factors within the learning environment,… learning materials and resources … and student-teacher interactions'. Opportunities for real-life experiences with STEM including hands-on practice (e.g. conducting experiments, apprenticeships, or career counselling) are essential to stimulate students' STEM learning.

Positive perceptions of learning experiences in school could be an indicator for motivation in STEM learning. Vennix, den Brok, and Taconis (2017) studied students' perceptions of STEM learning activities implemented in schools. Results indicated that students in general rated the STEM learning activities positively, and adding activities to the regular learning environment in school 'would potentially add value for students' intrinsic motivation for science learning'.

- Quality of STEM Education

Students' views and perceptions of teaching quality can help shed light on how they influence students' STEM learning. Previous research conducted by Magen-Nagar and Azuly (2016) studied the contribution of perceived teaching quality to students' learning achievement. The findings echoed the studies by Darling-Hammond and Pecheone (2010) and Tam (2011) in that there was a positive and significant relationship between quality of teaching and students' education achievement. It was also found that student-perceived teaching quality was positively related to their achievement emotions of enjoyment, which was one of the prerequisites of academic achievement (Lazarides & Buchholz, 2019).

1.5.4 Societal Factors

- Social Identity

There are two kinds of social identity for the general public in Hong Kong: the regional 'Hong Kong people' identity and the national 'Chinese' identity (Ye, 2015). This unique dual identity of the Hong Kong people may imply that people's sense of belonging or acknowledgement of the achievements of the city and China could be fundamentally different.

Studies have been conducted to investigate how social identity could influence students' interest in STEM. Ito and McPherson (2018) found a lower sense of social belonging in girls when compared with male students. Particularly for females, social belonging effectively predicted their intention to persist in STEM.

- Social Reasons for STEM Learning

The reasons to pursue STEM study and careers may vary among students, ranging from individual reasons such as achieving personal goals, to a greater societal vision such as contributing to the world's advancement. The Education Bureau (2015) suggested that the societal, national, and global necessity to promote STEM education in Hong Kong was to maintain Hong Kong's international competitiveness, to enable Hong Kong to contribute to national development such as the 'Belt and Road' initiatives, and to fulfil the needs of technological and scientific advancement, as well as economic developments in the contemporary world.

The study by Lee, Capraro, and Viruru (2018) identified students' social perspectives in regards to why they were interested in STEM and the importance of science in their STEM career choice. The three major reasons provided by students for their pursuit of a STEM career were to help people, to interact with others with 21st century ideas, and to impact the world. The findings showed strong evidence of students' societal and global vision of the importance of having s STEM occupation as they attributed STEM careers to the good of the society and the globe such as 'curing people', 'contributing to society', 'an instrument through which they could communicate with others about important 21st century ideas', 'development of the world' and 'greater convenience and innovation in the world'. It demonstrated that social reasons could be one of the explanations for students' STEM career choices.

1.6 Pursuing a STEM Career

Understanding students' intention to pursue a STEM career is required for strategy formulation to nurture young people with the necessary skills, education and experience to engage as STEM professionals. This provides a valuable reference for the government in preparing curriculum policy to optimise STEM education in schools.

There is no universally agreed-upon definition of STEM careers. Experts generally do agree that STEM workers use their knowledge of science, technology, engineering, or mathematics to try to understand how the world works and to solve problems. Their work often involves the use of computers and other tools (Gottlieb, 2018). The nature, practice and operation of careers related to STEM, which are in construction, education and training, electricity, gas, water and waste service, financial and insurance service, health care and social assistance, information media and telecoms and manufacturing industries described by different researchers (Craig, et al., 2011; Fayer et al., 2017; Prinsley and Baranyai, 2015) and those in the Hong Kong Standard Industrial Classification

Version 2.0 are similar to those of the workforce that possesses STEM skills. However, work in occupations with no specific STEM requirements may nonetheless draw in STEM graduates' skills and knowledge in a more generic sense (Siekann & Korbel, 2016).

The findings of the study by DiBenedetto, Easterly, and Myers (2015) revealed that scientific reasoning scores predict students' likelihood to indicate intention to pursue a STEM career and plan to pursue college. It is supposed to engage students in thinking critically and solving real-world problems, while exposing them to the requisite skills for STEM major/career access.

The study conducted by Blotnicky, Franz-Odendaal, French, and Joy (2018) found that students with higher mathematics self-efficacy were more knowledgeable about STEM career requirements. Their study supported the need to improve access to knowledge to facilitate students' understanding of STEM careers and the nature of STEM work, and exposure of students to STEM careers can enhance their interest in pursuing a STEM career.

1.7 Research Gap

Specific research on STEM career aspirations is limited compared with research on career aspirations as a whole (Mau & Li, 2018). Given the considerable number of previous reports on the engagement of students in STEM learning activities both in and out of school, girls' STEM subject choices and STEM career development, there is still a lack of research with a focus on STEM aspirations from the perspective of Hong Kong primary and secondary school students. It would therefore be useful to explore students' personal views of and attitudes towards STEM, and the interaction of the factors influencing students' opportunities, participation, achievement, and progression in STEM education. Inspired by the U.K. study 'Understanding Young People's Science Aspirations: How students form ideas about "becoming a scientist"' (Archer & Dewitt, 2017), it is believed that emphasising the aspirations can not only help predict the general type of career path young people may take, but may also provide a useful reference for policy makers to adjust education policies to improve young people's STEM education participation and STEM career opportunities, which are considered as STEM aspirations in this study.

1.8 Objectives of This Study

- To examine Hong Kong students' STEM attitudes, understanding and aspirations;
- To study a snapshot of Hong Kong youth's STEM aspirations across the different key stages 2, 3 and 4 (senior primary, junior secondary, and senior secondary) for future analysis of their development over time;

- To investigate the influence of students' conceptions of STEM and factors at the individual, family, school, and societal levels on youth's opportunities, participation, achievement, progression, and aspirations in STEM;
- To foster informed discussion on the future design and implementation of STEM education;
- To provide the government and the public with reference data to support future optimisation in STEM education and curriculum policy.

Chapter 2 Method

To give the government and the public a useful reference for future adjustment of STEM education and curriculum policies in the face of the trends of innovation and technology and the need for STEM professionals, a survey was conducted with local primary and secondary students. The survey aims to understand Hong Kong students' views on STEM learning, factors that affect their participation, opportunities, achievement and progression in STEM, and their aspirations regarding their career and education.

A set of three quantitative questionnaires that target students at key stages 2, 3 and 4 (P5-6 for senior primary, S3 for junior secondary and S4-5 for senior secondary) was designed. Studying the career aspirations of young people in secondary schools is common for the sake of preparing youngsters for their forthcoming career path; understanding the career aspirations of primary students is equally important as childhood aspirations can give a reasonably good approximation of the general type of career path that young people take in the future (Archer & DeWitt, 2017).

2.1 Participants

A stratified sampling method was adopted for the quantitative survey to enhance the representativeness of the sampling and to minimise sampling errors. Data were collected online from students aged 9 to 18 from P5-6 in local primary schools, and S3-5 in secondary schools in Hong Kong. Schools sampled are registered in the Education Bureau, and include government, aided, caput and direct subsidy scheme (DSS) schools. Private schools were not covered this time as some of the private schools operate non-local curriculum courses. The basic principles of selecting students involved all students in a class and kept the same gender ratio balance.

Invitations were sent to targeted schools with a reply slip for the schools to indicate their initial interest in participating in the research. Upon receiving the reply slip, the research team contacted the corresponding teachers provided in the reply slip by email to confirm the arrangement (including date, time and venue for survey) and to distribute a 'No objection letter' to the guardians of the sampled students via the teacher. Teachers would then arrange a suitable venue and equipment for students to complete the survey, excluding those students whose parents had indicated their objection to survey participation. A dedicated link to the questionnaire for each participating school as well as a general guideline were provided to the teacher with a reminder not to show students the questionnaire prior to the implementation.

Totally 3,991 students from the three key stages completed the online survey, as shown in Table 2.1. This number is roughly around 1% of the total student population of the three key stages according to government data. Appendix A is the list of research schools.

Table 2.1

Number of students by key stages who completed the survey

Key stages	Number of students who completed the survey	Number of schools involved
Senior primary 154,343 students from the government data in 2018	2127	21
Junior secondary 154,868 students	1199	19
Senior secondary 146,158 students	665	12
Total	3991	/

2.2 Survey Instrument

The questionnaire was designed largely based on the study of 'Understanding Young People's Science Aspirations' by Archer and Dewitt (2017), and with reference to the international studies of TIMSS and PISA, as well as to UNESCO (2017), with due consideration of the local situation and culture.

All parts of the questionnaire comprised direct and reversed statements. Most questions were designed using a 4-point Likert scale (ranging from 4 to 1 with *strongly agree, agree, disagree* and *strongly disagree*). Yes/no types and multiple-choice questions were also adopted for different types of questions. Appendix B lists the three sets of questionnaires for students from the three key stages. The range of topics includes the following:

Demographic Background

Collection of a range of demographic data including gender, age, household organisation, parents' educational level, parents' jobs, languages used, place of birth for data comparison and analysis of the factors that would affect the STEM aspirations of Hong Kong students.

Choice of STEM Learning

Identification of the factors that affect students' future subject choices and to understand their education plan for STEM studies. Sample question items of factors that might affect subject choices including future study choices and reasons for STEM Learning.

STEM Career Aspirations

Evaluation of students' future job intentions and the factors affecting their career choices. Sample question items of future job intentions including the nature or types of jobs students are interested in, and images of STEM professionals.

Academic Self-efficacy in Science and Mathematics

Evaluation of the effect of individual factors, including students' self-efficacy and perception of the usefulness of studying STEM, learning STEM in school lessons and ability of learning STEM, on students' engagement, interest, achievement and STEM aspirations. Sample question items of self-efficacy in Science and Mathematics include learning efficiency in Science and Mathematics, difficulty of learning in Science and Mathematics and self-perception of the ability to do well in in Science and Mathematics.

Informal STEM Learning Activities

Investigation of students' exposure to STEM areas, and their opportunities for participation in STEM education outside school to assess the relationship between informal activities and STEM aspirations. Sample question items of STEM participation outside school include frequency of participation and types of STEM activities students participate in.

Perceived School Support

Assessment of the association with students' STEM aspirations among STEM resources at school, perceived quality and opportunities in STEM lessons/activities at school to understand the most common method of assessment the school adopted and to examine its influence on their performance.

Sample question items of perceived STEM education in school including students' perceptions of STEM learning opportunities in schools, teachers' knowledge in STEM, teachers' teaching strategies and teachers' enthusiasm in STEM.

Perceptions of Parental Expectations

Assessment of the effect of family factors including students' perceived parental expectations, school involvement and attitudes towards STEM on students' STEM aspirations. Sample question items of perceived parental expectation include students' academic performance, students' future career path and students' educational level.

Social Identity

Evaluation of students' opinions of Chinese culture, scientific achievement and its development affecting their STEM career choices. Sample question items of their opinions include the extent to which they acknowledge Hong Kong's scientific achievement and development, and the extent to which they acknowledge China's scientific achievement and development.

2.3 Piloting of the Survey

Two phases of piloting were undertaken to ensure the suitability and feasibility of the survey with reference to the objectives. An initial piloting in the form of focus group interviews was conducted in a local secondary school with eight secondary school students of varied abilities, genders, and backgrounds. The interview focused on the students' perceptions of STEM learning and teaching quality in school, subject and career choices, and perceptions of STEM industries and professionals. The interview provided a brief understanding of current students' views on STEM education and industries, as well as their educational and occupational aspirations. The second phase of piloting was carried out to pre-test the survey, and assessed the time required for completion. Pilot exercises were implemented for students from the three key stages sampled from one primary school and one secondary school. The sample size for the piloting was 49 senior primary students (24 boys and 25 girls), 22 secondary 3 students (12 boys and 10 girls), and 10 secondary 5 students (5 boys and 5 girls). After the pre-test of the survey by the students, a focus group interview was conducted with students from each key stage to evaluate the wording and options available in the questionnaire to reduce ambiguity and ensure the understanding for students of different levels and abilities. All pilot interviews were conducted by research staff or student research assistants from the Education University of Hong Kong. Training in interview skills was given to the interviewers before piloting.

2.4 Reliability of the Questionnaire

The internal consistency method was used to estimate the reliability of the questionnaire and the consistency of results across items within a test. For example, to measure satisfaction with STEM learning at school, more than one question was asked about various related aspects of STEM learning at school. It was reasonable that if someone was dissatisfied with his or her STEM experiences, then he or she would score low on all items. Reliability is reflected in the alpha coefficient by using Cronbach's alpha. A reliability coefficient of .70 or higher is considered acceptable in this research. An item 'STEM professionals are odd' in 'Students' Image of STEM Professionals' was deleted due to low reliability.

2.5 Data Analysis of the Questionnaire

Data were digitalised and analysed using SPSS in different ways according to the nature of the questions. Descriptive statistics were used to summarise the features of the data in the study. All results and data were illustrated by graphs and/or charts. Besides, ANOVA was used to examine the differences in students' responses on the various variables by gender and key stages, chi-square tests were used to examine students' STEM subject choices by key stages and gender in each key stage. *t* test was used to investigate the differences in students' responses by their parents' education level and occupation. Logistic and multiple regression analysis was used to explore the associations between each dependent variable (e.g. STEM subject choice or STEM career aspirations) and independent variables (e.g. gender, informal STEM activities, Science and Mathematics self-efficacy, perceived parental expectations and social identity) to identify the significant predictors of STEM subject choices and STEM career aspirations. Path analyses were conducted to test the associations between various factors and STEM career aspirations.

2.6 In-depth Interviews with Students, Parents and Teachers

To have a better understanding of views, experiences, and aspirations as well as the relationships of students' STEM aspirations and family and school factors, interviews were conducted with students, parents and teachers from schools selected randomly from sampled schools. Thus, a total of 10 student interviews, 10 parent interviews and four teacher interviews were arranged and conducted.

The in-depth interviews took around 30 to 45 minutes for students and around 1 hour for parents and teachers. All interviewees were treated anonymously. The interview topic areas included students' constructions of self (e.g. self-identity and self-efficacy); experience and view of STEM learning in and out of school; views on STEM education; formation of aspirations with a focus on STEM aspects; future subjects and career choices; and perceptions of STEM professions and usefulness of STEM. Appendix C lists the three sets of interview questions for students, parents and teachers. All interviews were digitally audio-recorded and transcribed. The interview data was used to supplement the analysis of the questionnaire data in formulating the policy implications and recommendations.

Chapter 3 Findings

3.1 Demographic Background

In total, 3,991 responses from the three key learning stages of senior primary, junior secondary and senior secondary were collected from the online survey. The respondents' demographic backgrounds are presented in Table 3.1.

There were 2,127 primary school students who participated in this survey. Of these students, 47.4% were female and 52.6% were male. Their ages ranged from 11-14 years old, with a median of 12 years old. Of these students, 89.10% were born in Hong Kong, while about 9.7% were born in Mainland China; 44.6% of the students' homes were in the New Territories, 31.6% were in Kowloon, 16.2% were in Hong Kong Island and 7.6% were in Mainland China.

There were 1,199 junior secondary school students who participated in this survey. Of these students, 42.5% were female and 57.5% were male. Their average age was 15 years old. Of these respondents, 82.20% were born in Hong Kong, while about 15.9% were born in Mainland China; 37.3% of the students' homes were in the New Territories, 35.2% were in Kowloon, 26.9% were in Hong Kong Island and 0.7% were in Mainland China.

There were 665 senior secondary school students who participated in this survey of whom 53.1% were female and 46.9% were male, and their average age was 17 years old. Of the senior secondary school students, 82.6% were born in Hong Kong, while about 15.8% were born in Mainland China; 35.6% of the students' home were in the New Territories, 39.2% were in Kowloon, 24.5% were in Hong Kong Island and 0.6% were in Mainland China.

About 45% of the senior primary students' fathers and mothers had university degrees. Around 45% of their fathers and 13% of their mothers were working in STEM-related areas. Around 34% and 32% of the fathers and mothers of the junior secondary school students had university degrees, respectively. Approximately 42% of their fathers and 10% of their mothers had STEM-related jobs. About 33% and 28% of the senior secondary school students' fathers and mothers had obtained university degrees, respectively. Around 46% of their fathers and 11% of their mothers had STEM-related jobs.

A total of 23 individual interviews with students, parents, and teachers from the three key stages were conducted. A brief summary with the interview transcription (Appendix D) was used as supplementary materials in the formulation of policy implications and recommendations.

Table 3.1

Demographic characteristics of the three key stages of senior primary, junior secondary and senior secondary school students

		Frequency			Percent (%)		
		Senior primary	Junior secondary	Senior secondary	Senior primary	Junior secondary	Senior secondary
Gender	Female	1008	509	353	47.4	42.5	53.1
	Male	1119	690	312	52.6	57.5	46.9
Birth place	Hong Kong	1895	986	549	89.1	82.2	82.6
	Mainland China	206	191	105	9.7	15.9	15.8
	Others	7	7	1	0.3	0.6	0.2
Home areas	New Territories	948	447	237	44.6	37.3	35.6
	Kowloon	673	422	261	31.6	35.2	39.2
	Hong Kong Island	345	322	163	16.2	26.9	24.5
	Mainland China	161	8	4	7.6	0.7	0.6
Father's education level	University Degree	967	403	217	45.5	33.6	32.6
	Non-University Degree	902	674	398	42.4	56.2	59.8
	Missing	258	122	50	12.1	10.2	7.5
Mother's education level	University Degree	901	382	186	42.4	31.9	28.0
	Non-University Degree	984	710	445	46.3	59.2	66.9
	Missing	242	107	34	11.4	8.9	5.1
Father's occupation	STEM- related	946	506	303	44.5	42.2	45.6
	Non STEM- related	812	439	260	38.2	36.6	39.1
	Missing	369	254	102	17.3	21.2	15.3
Mother's occupation	STEM related	284	124	75	13.4	10.3	11.3
	Non STEM- related	1605	874	534	75.5	72.9	80.3
	Missing	238	201	56	11.2	16.8	8.4

3.2 Choice of STEM Learning

3.2.1 STEM Subject Choice

The percentage of students at each key stage of senior primary, junior secondary and senior secondary choosing STEM-related subjects is shown in Figure 3.1.

Analysis of students' willingness to learn STEM subjects in their future studies revealed that 65.9% of the senior primary school students would like to be engaged in STEM-related subject learning in junior secondary schooling, while 56% of the junior secondary school students expressed willingness to study STEM subjects in their senior secondary school study. For the senior secondary school students, 53.4% would like to choose science-related subjects in their future university studies.

Chi-square tests were performed to examine students' STEM subject choices by gender in each key stage and the impact of key stage on students' STEM subject choices. Significant gender differences were found for students in senior primary schools (χ^2 (1) = 59.103, P = 0.000 < 0.05) and junior secondary schools (χ^2 (1) = 20.912, P = 0.000 < 0.05), while there was no difference due to gender on STEM subject choice for students from senior secondary schools (χ2 (1) = 3.501, P = 0.061 > 0.05). In other words, boys (73.4%) were more likely to choose STEM subjects than girls (57.5%) in senior primary school. The percentage of boys (61.6%) choosing STEM subjects was significantly higher than girls' (48.3%) in junior secondary school. In addition, there was a significant difference by key stages in students' STEM subject choices in their future studies (χ^2 (2) = 48.664, P = 0.000 < 0.05). More senior primary school students were willing to study STEM than secondary school students.

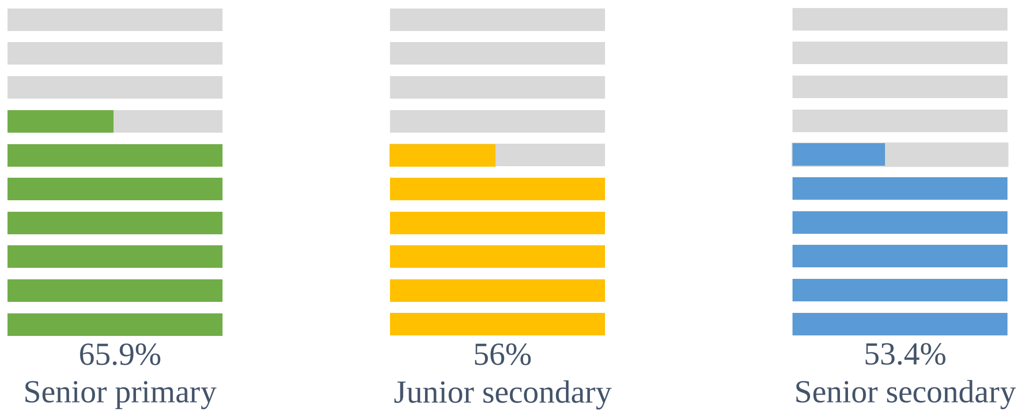

Figure 3.1. Percentage of students choosing STEM-related subjects.

3.2.2 Reasons to Study STEM

Students were asked to rate the possible reasons of their STEM learning based on family and social (HK society, national, global) motives (Table 3.2). The percentages of the students at each key stage agreeing with family reasons are presented in Figure 3.2. About 49.9% and 50.4% of the senior primary students believed that they would study STEM to fulfil their parents' advice for subject choice and to satisfy their parents' future job expectations. The percentages for junior secondary students were 46.4% and 47.1% respectively, and for senior secondary students they were 36.5% and 37.9%. Fewer students reported that their choice of STEM study was to seek recognition from their relatives across the three key stages.

An ANOVA was conducted to examine the impacts of key stage (senior primary, junior secondary and senior secondary) and gender (boys and girls) on students' family reasons to study STEM. There was a significant difference across key stages (F = 23.944, P = 0.000, η^2 = 0.012); that is, as students reported, influences of family motives on senior primary school students (M = 2.47, SD = 0.92) to study STEM was significantly higher than for junior secondary (M = 2.39, SD = 0.81) and senior secondary students (M = 2.20, SD = 0.78). Moreover, although there was a significant difference by gender in students' family reasons to study STEM (F = 10.428, P = 0.001), the effect size was quite small (η^2 = 0.003). This may be as a result of the large sample size in our study, which makes the difference in students' family reasons reach a statistically significant level. Thus, students' family reasons to study STEM were comparable for girls and boys.

Table 3.2

Perceived family, society, national and global reasons for STEM study

Family	Society	National	Global
• To fulfill parents' advice for subject choice • To satisfy parents' future job expectations • To seek the recognition of relatives	• To become a future talent in Hong Kong society • To contribute to Hong Kong's economy • To meet the needs of Hong Kong's innovative technology	• To contribute to the prosperity of the Nation • To contribute to the development of innovation and technology of the Nation • To contribute to the Nation's economy	• To meet the trend of a high-tech world • To improve the living conditions in modern life • To contribute to the world's sustainable development

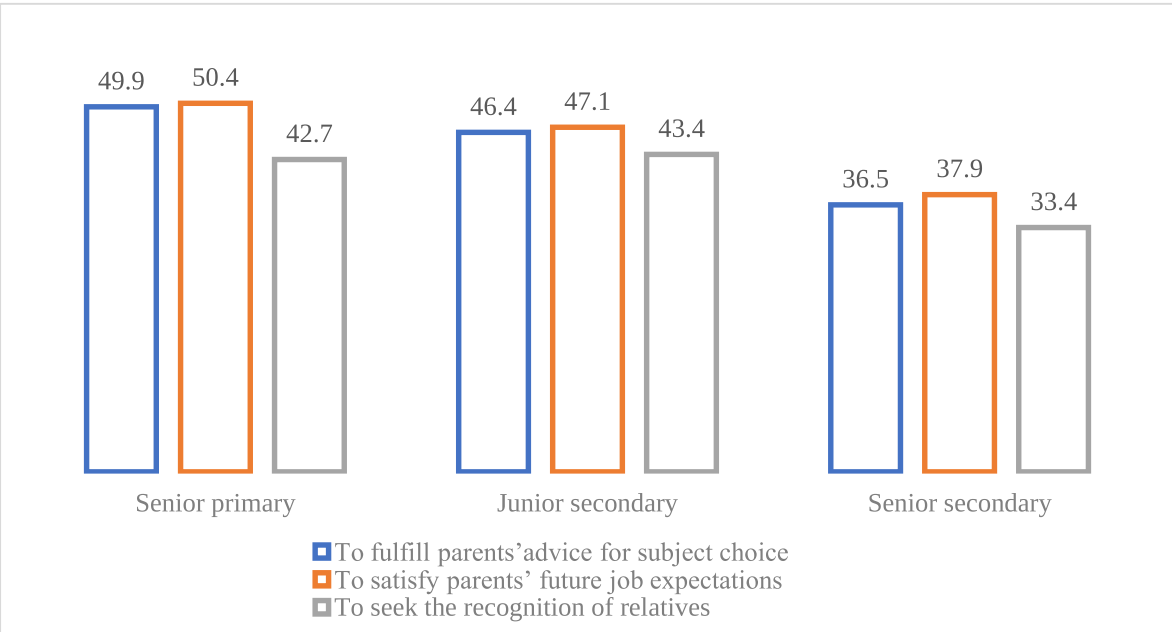

Figure 3.2. Percentage of students agreeing with family reasons to study STEM.

The mean values that students agreed with the reasons of HK society, national and global needs to study STEM based on a 4-point scale are shown in Figure 3.3.

The means of HK society as the reason for STEM learning were 3.16 (*SD* = 0.72), 2.89 *(SD* = 0.69) and 2.81 (*SD* = 0.67) for senior primary, junior secondary and senior secondary school students, respectively. Quite different from the high percentage of senior primary students (80%) agreeing that the national perspective was their reason for STEM learning (*M* = 3.00, *SD* = 0.79), there were fewer (around 64%) junior secondary school students (*M* = 2.66, *SD* = 0.79) and even fewer (around 50%) senior secondary school students (*M* = 2.42, *SD* = 0.78) who intended to study STEM for the reason of contributing to the development of innovation and technology of the nation. The mean scores of students agreeing with global reasons to study STEM were 3.09 (*SD* = 0.68), 2.94 (*SD* = 0.66) and 2.84 (*SD* = 0.61) for students in each key stage, respectively.

ANOVA examining the differences by key stage and gender on social reasons for STEM study, by taking HK society, national, and global reasons as a whole, was conducted. Results revealed significant differences in the students' reported social reasons for studying STEM (*F* = 120.876, *P* = 0.000, η^2 = 0.057). That is, more senior primary school students (*M* = 3.08, *SD* = 0.65) were likely to agree with the social reasons to study STEM than junior (*M* = 2.83, *SD* = 0.64) and senior secondary school students (*M* = 2.69, *SD* = 0.59). In addition, the results showed that there was no significant difference in STEM career aspirations between boys and girls (*F* = 0.846, *P* = 0.358).

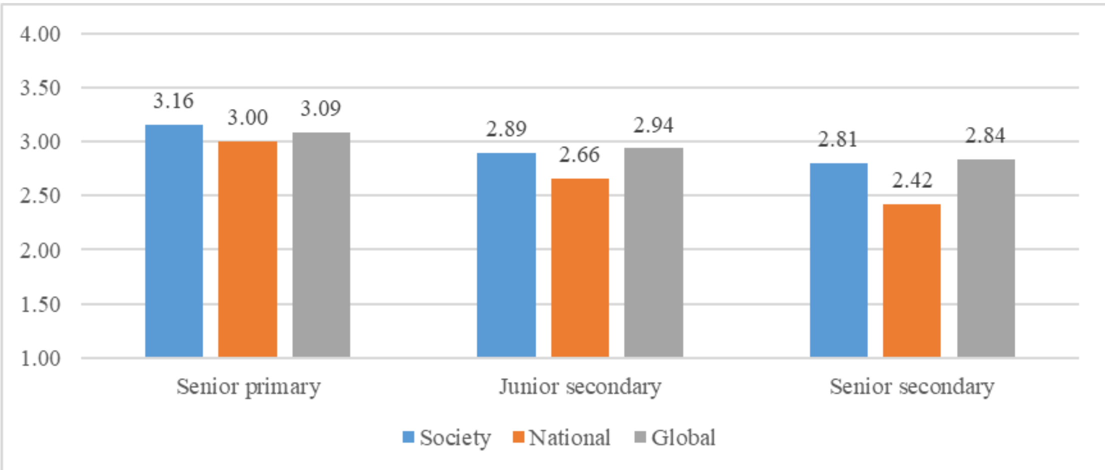

Figure 3.3. Mean values of students agreeing with their global, national and society reasons to study STEM.

3.3 STEM Career Aspirations

3.3.1 STEM Career Aspirations

The percentages of students who were likely to choose to work in each of the following STEM-related fields is shown in Figure 3.4:

- Work in the medical field (such as nursing, treatment, pharmaceutical)
- Work in the science field (such as laboratory tests, nutritional science, and environmental science)
- Work in the engineering field (such as civil engineering, automotive engineering, and architectural design).
- Work in a field using technology (such as software development, multimedia design, computer system management)
- Work in a field using mathematics (such as actuarial, accounting, insurance)
- Work in a STEM-related field (such as product design, measurement, environmental monitoring)
- Be an inventor

Generally, less than half of the students in all three key stages chose to work in the fields related to 'engineering', 'technology-related work', 'mathematics', 'inventor' and 'other STEM-related work' as their future career. For the careers of 'medicine' and 'science', less than 50% of the senior primary school students would like to choose these two fields, around 50% of the junior secondary students would like to pursue a career in these two areas, and about 55% of the senior secondary students claimed that they were interested in working in these two areas.

Among the STEM-related fields, technology-related jobs appeared to be the most popular choice for senior primary students (48.4%), followed by working in science fields (47.8%); 41.1% of the senior primary students would like to work as an inventor in the future. The lowest percentage (31.1%) of senior primary school students agreed to work in the engineering field as their future career.

For the junior and senior secondary school students, technology-related work was not their first career choice. They preferred working in medicine the most (50.3% for junior secondary students and 55.5% for senior secondary students), followed by science as their second preference (48.9% for junior secondary students and 54.1% for senior secondary students). About 40% of the secondary school students claimed that they would like to pursue engineering as their future career, and only one-third of the secondary students would like to become an inventor as their future career.

Results of the ANOVA showed that there was no significant difference in STEM career aspirations among the students from the three key stages (F = 1.407, P = 0.245, η^2 = 0.001). However, the influence of gender on students' STEM career aspirations was significant (F = 134.685, P = 0.000, η^2 = 0.033), which indicated that boys (M = 2.49, SD = 0.71) had significantly higher STEM career aspirations than girls (M = 2.19, SD = 0.60).

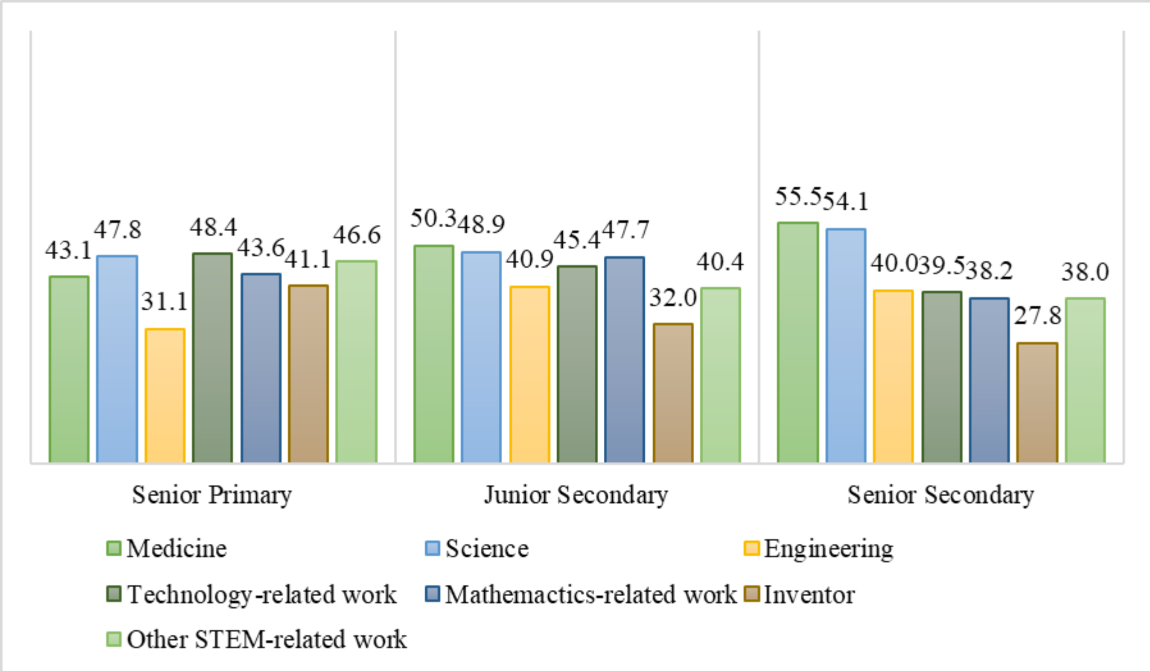

Figure 3.4. Percentages of future STEM career choice among students.

3.3.2 Image of STEM Professionals

The respondents were asked to state to what extent they agreed with the following statements about the image of STEM professionals:

- Can change the world
- Make a lot of money
- Have exciting jobs
- Smart
- Respected by others
- Work alone
- No other interests

Over 80% of the students from all key stages agreed that STEM professionals were smart. Approximately 70% of the students believed that STEM professionals could change the world and were respected by others (Figure 3.5).

Of the senior primary school students, 73.5% considered that the work in STEM fields was exciting, whereas about 71.6% and 68.7% of the junior secondary and senior secondary school students agreed that STEM professionals had exciting jobs. About 65.0% of the secondary school students supported that STEM people could make a lot of money, and around 53.3% of the senior primary students agreed with this.

Respectively, 75% and 60% of all the students agreed that STEM professionals were respected by others and they worked alone. Fewer students (about 35%) agreed that people in STEM fields did not have other interests or hobbies.

An ANOVA was conducted, showing that there was a significant difference by key stage (F = 10.827, P = 0.000) and a significant difference by gender (F = 4.753, P = 0.029) in images of STEM professionals; however, the effect sizes were quite small, at η^2 = 0.005 and η^2 = 0.001 respectively. This is possibly due to the larger sample size which meant that the differences in students' image of STEM professionals reached a statistically significant level. In other words, the students' images of STEM professionals might not actually differ among students across key stages and between boys and girls.

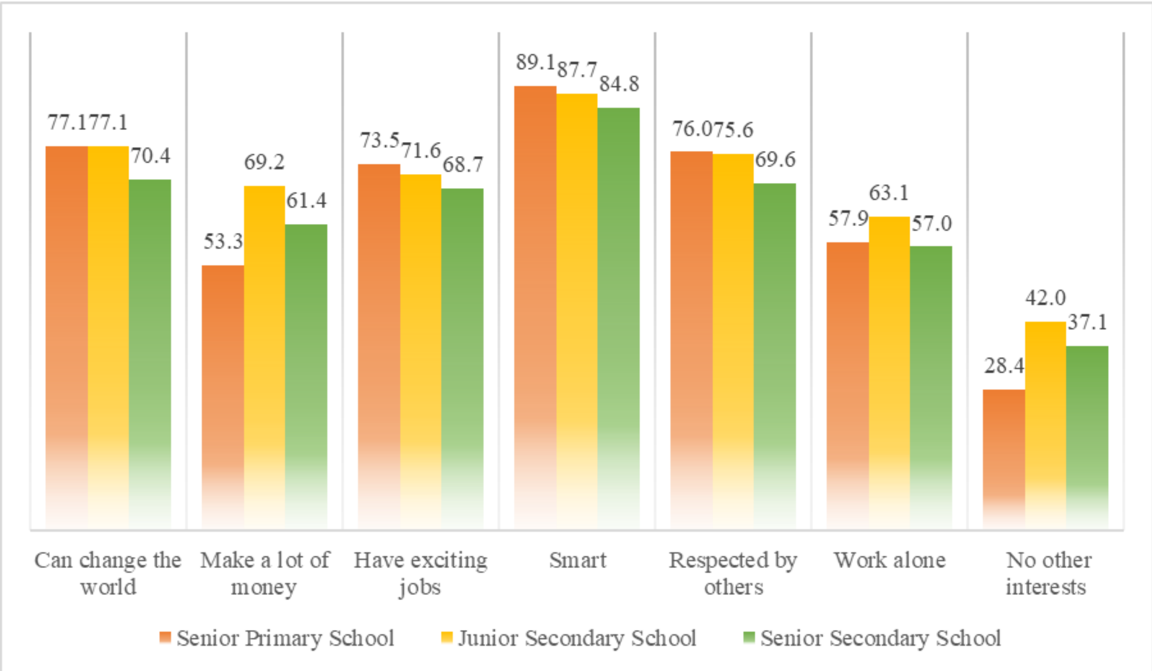

Figure 3.5. Percentage of students' perceptions of STEM professionals.

3.4 Academic Self-efficacy in Science and Mathematics

3.4.1 Self-efficacy in Science-related Subject Learning

Among the four aspects listed below, the percentages of students who agreed that they understand most of the content knowledge in each science-related subject were the highest. The science-related subject for senior primary school is science-related units in the subject of General Studies; junior secondary school is Integrated Science and senior secondary school are Physics, Chemistry and Biology.

- I understand most of the content knowledge of science
- I perform well in science
- I am not good at learning science
- I find it difficult to learn science

Nearly 90% of the senior primary school students agreed that they were able to understand science-related units in the subject of General Studies. Approximately 75% of the junior and senior secondary school students also agreed that they were capable of understanding Integrated Science, Physics, Chemistry or Biology (Figure 3.6).

Over 80% of the senior primary school students agreed that they performed well in studying science-related units in General Studies. However, for the junior secondary school students, those who agreed that they performed well in studying integrated science were 64.2%. Only 50% of the senior secondary school students agreed that their performance in learning Physics, Chemistry or Biology was good.

It was also found that the senior primary school students who reported that they were not good at and lacked confidence in learning science-related units in the subject of General Studies was only 21.7%. However, the percentages for secondary school students were around 40%.

Students in the three key learning stages reported difficulties in learning science. There was 26.3% of students in senior primary schools who agreed that science was not easy to learn, and around 45% of secondary school students reported that it was difficult to learn science.

The results of ANOVA showed that the influence of the three key stages (F = 294.015, P = 0.000, η^2 = 0.129) and gender (F = 54.011, P = 0.000, η^2 =0.013) on students' self-efficacy was significant. This means that senior primary school students (M = 3.07, SD = 0.59) were significantly more confident in learning science-related subjects than the junior secondary students (M = 2.71, SD =

0.66) and senior secondary students (M = 2.56, SD = 0.28). Boys (M = 2.96, SD = 0.62) showed significantly more confidence in science-related subjects than girls (M = 2.78, SD = 0.58).

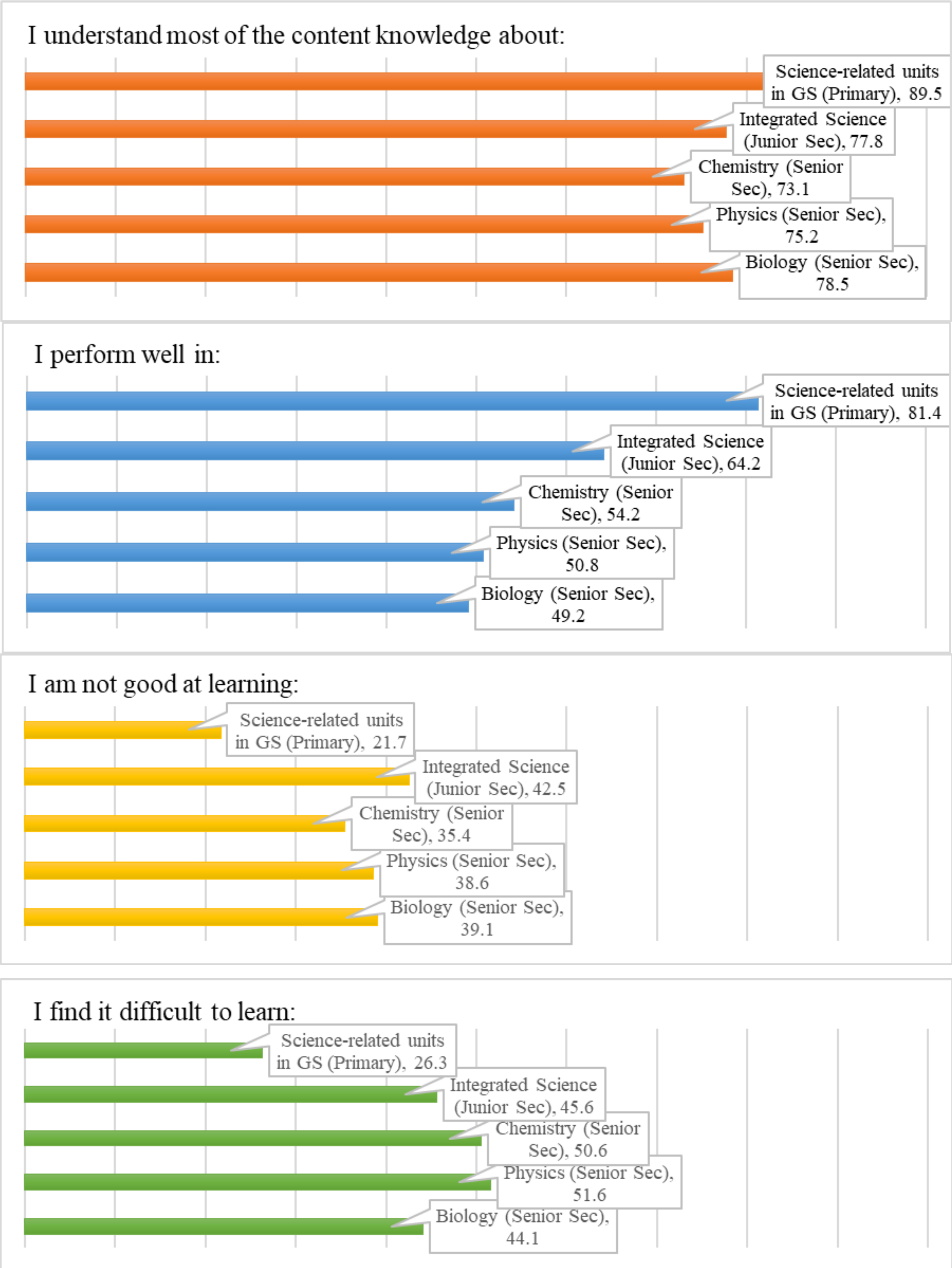

Figure 3.6. Percentages of students' reported self-efficacy in learning science related subjects.

3.4.2 Self-efficacy in Mathematics Learning

Students' rating of their self-efficacy with the following four aspects of mathematics learning was recorded (Figure 3.7).

- I understand most of the content knowledge of mathematics
- I perform well in mathematics
- I am not good at learning mathematics
- I find it difficult to learn mathematics

Of the senior primary school students, 87% agreed that they were able to understand mathematics lesson content. However, there was a slightly lower percentage of junior and senior secondary school students who agreed with this, at 76.3% and 75.9% respectively.

Over half of the students (67.1%, 56.2% and 51.4% of senior primary, junior secondary and senior secondary school students) agreed that they performed well and viewed themselves as capable of learning mathematics. Only 33.3%, 49.8% and 46.9% respectively reported that they were not good at learning mathematics.

Around 33.2% of the senior primary school students found mathematics learning as not easy, while around 50% of the secondary students agreed with this.

The ANOVA was performed to examine the influence of key stage and gender on students' self-efficacy in mathematics. The results indicated that there were significant differences in mathematics self-efficacy by key stage (F = 108.438, P = 0.000, η^2 = 0.052) and by gender (F = 145.232, P = 0.000, η^2 =0.035). That is, senior primary students (M = 2.95, SD = 0.74) were significantly more confident in mathematics learning than junior (M = 2.61, SD = 0.76) and senior secondary school students (M = 2.61, SD = 0.72), and boys (M = 2.95, SD = 0.76) were significantly more confident in mathematics than girls (M = 2.61, SD = 0.73).

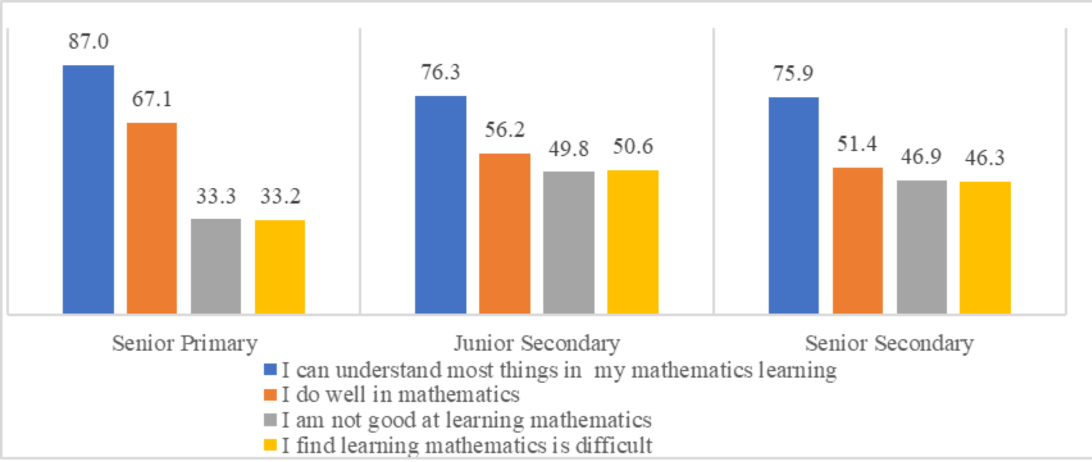

Figure 3.7. Percentages of students reporting confidence in learning mathematics.

3.5 Informal STEM Learning Activities

3.5.1 Frequency of Museum and Exhibition Visits

The percentages of students who reported that their frequency of visiting the following STEM-related museums and exhibitions more often than once per half year (Figure 3.8):

- Go to a science museum/ science park/ space museum/ zoo/ botanic garden/ ocean park/ nature trail, etc.
- Visit exhibitions (such as: animation exhibition, book fair, flower show, computer and communication festival, innovation technology exhibition, in-home expo, etc.)

Overall, around 50% of all the students attended STEM activities in both museums and exhibitions at least once per half year.

Around 70% of the senior primary school students reported that they visited science museums/science park/space museum/zoo/botanic garden/ocean park/nature trail more frequently than once per half a year, while around 51.4% and 49.8% of the junior secondary and senior secondary school students claimed that they visited science-related museums and exhibitions at least once per half a year, respectively.

The percentages of students from the three key stages who visited exhibitions (such as animation exhibition/book fair/flower show/computer and communication festival/ Innovation Technology Exhibition/in-home Expo, etc.) remained at a similar level. Approximately 50% from each key learning stage reported more frequent visits to exhibitions than once per half a year.

The ANOVA examining the significant differences in the frequency of museum and exhibition visits among the students from the three key stages was significant (F = 40.335, P = 0.000, η^2 =

0.020). On the other hand, the results showed that there was no significant gender difference in frequency of museum and exhibition visits (F = 1.290, P = 0.256). This means that senior primary school students (M = 1.89, SD = 0.90) had more significant frequent visits to museums and exhibitions than junior secondary (M = 1.64, SD = 0.92) and senior secondary school students (M = 1.63, SD = 0.82).

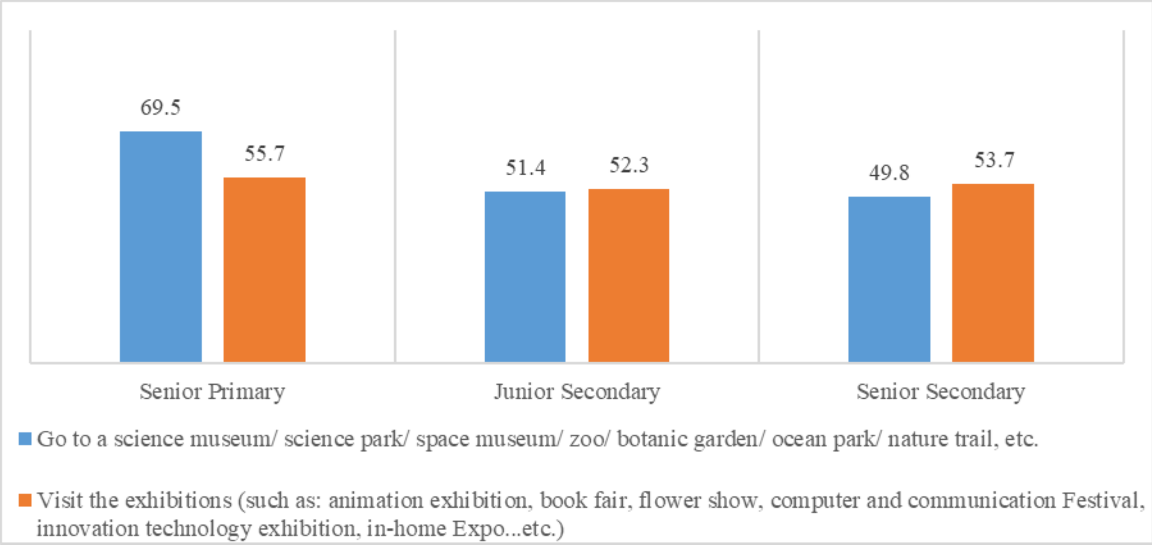

Figure 3.8. Percentage of students visiting museums and exhibitions more frequently than once per half a year in each key stage.

3.5.2 STEM-related Reading

The percentages of students who had the following STEM-related reading activities more frequently than once per month are shown in Figure 3.9:

- Read a book or magazine, or watch a TV programme.
- Visit websites about science/ technology/ engineering/ mathematics

Senior primary school students had more frequent STEM-related reading activities such as reading books, magazines, watching movies, watching STEM-related television programmes and vising STEM-related websites.

Around 92.7% of the senior primary students had consistent reading more frequently than once a month. About 77.6% of them read STEM-related books or watched STEM television programmes at least once a month. There were 86.3% of the junior secondary students and 88.4% of the senior secondary students who read STEM books or magazines at least once a month, and 56.8% of the junior secondary students and 59.2% of the senior secondary students reported that they did online STEM-related reading more than once a month.

Generally, more students had frequent informal STEM-related activities such as reading books and watching STEM television programmes, compared with accessing STEM-related websites. The results showed that around 56.8% of the senior primary students, 45% of the junior secondary students and 49.8% of the senior secondary students had the practice of searching for information from STEM-related websites once a month.

ANOVA results showed that there were significant differences in students' frequency of STEM-related reading among the three key stages (F = 80.182, P = 0.000, η^2 = 0.039). This means that senior primary school students (M = 3.01, SD = 0.87) did more significant STEM-related reading than junior secondary (M = 2.59, SD = 1.03) and senior secondary school students (M = 2.73, SD = 0.88). Moreover, although there was a significant gender difference in students' frequency of STEM-related reading activities (F = 14.145, P = 0.000), the effect size was quite small (η^2 = 0.004). This may be as a result of the larger sample size in our study, making the difference in students' STEM-related reading reach a statistically significant level. Therefore, boys' and girls' STEM-related reading frequencies might not actually differ.

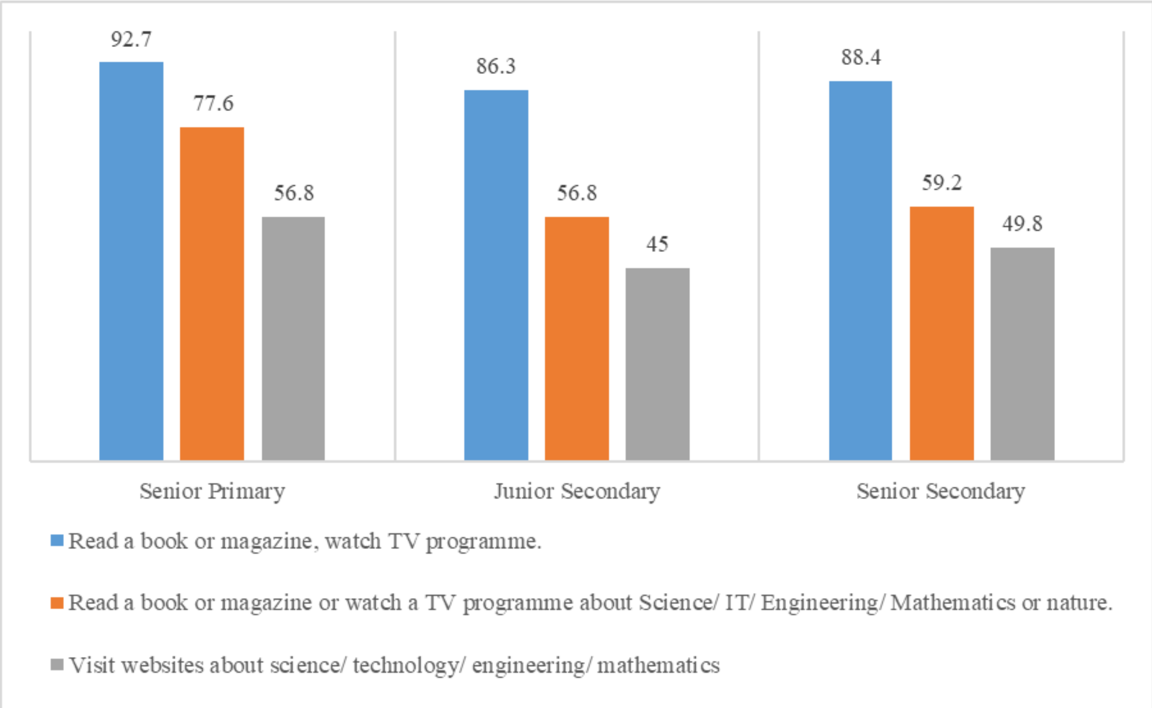

Figure 3.9. Percentage of students who read books, magazines, and watch STEM-related television and STEM websites more frequently than once per month.

3.5.3 Mobile Use

Regarding the amount of time spent on mobiles and computers by students of the three key stages, almost all students spent time on mobiles and computers every day. Higher grade students from senior secondary and junior secondary spent longer on their electronic devices than senior primary students.

Around 74.5% of senior primary students spent more than 30 minutes on their electronic devices every day. Specifically, 30.3%, 24.6% and 19.6% spent about 1 hour, 2 hours and 3 hours every day, respectively (Figure 3.10a). About 94.4% of the junior secondary students spent over 30 minutes per day. Respectively, approximately 55.5% and 26.9% used their mobiles and computers for about 3 hours and 2 hours each day (Figure 3.10b). The majority (96.8%) of the senior secondary students spent more than 30 minutes on screens, with 52.8% and 32.9% spending about 3 hours and 2 hours, respectively, on screens each day (Figure 3.10c).

The ANOVA results revealed that the influence of key stage on students' mobile use was significant (F = 442.763, P = 0.000, η^2 = 0.182). This means that significantly more time was spent by senior secondary (M = 3.35, SD = 0.82) and junior secondary school students (M = 3.30, SD = 0.97) on mobile use than senior primary school students (M = 2.35, SD = 1.12). Senior secondary and junior secondary school students spent about 2-3 hours per day on mobiles, while senior primary students spent around 1-2 hours on mobile use every day. The ANOVA results also showed that there was no significant difference in the mobile use time of boys and girls (F = 1.284, P = 0.257).

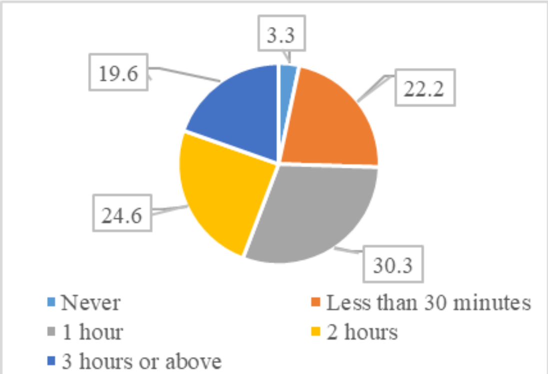

Figure 3.10a. Percentage of time spent on mobiles and computers – Senior primary school students.

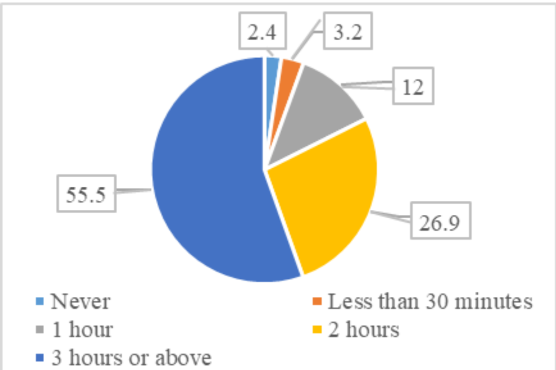

Figure 3.10b. Percentage of time spent on mobiles and computers - Junior secondary school students.

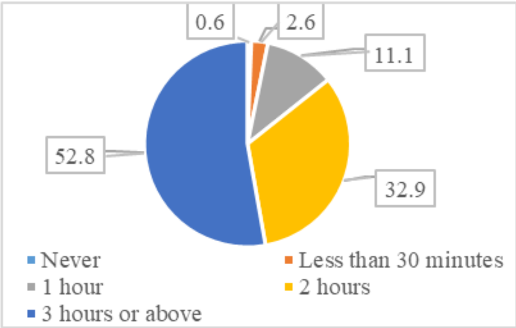

Figure 3.10c. Percentage of time spent on mobiles and computers - Senior secondary school students.

3.6 Perceived School Support

3.6.1 Opportunities for STEM Education in School

The results revealed notable differences in students' perceptions of school STEM opportunities among the following items. The percentages are presented in Figure 3.11.

- My school has provided STEM learning opportunities in Mathematics lessons.
- My school has provided STEM learning opportunities in General Studies/Integrated Science/Science lessons.
- My school has provided STEM learning opportunities in other lessons.
- My school provides STEM learning opportunities outside of class time.
- I think my school does not put much emphasis on STEM learning.
- I do not have enough opportunities to engage in STEM learning.

More than 80% of the senior primary school students agreed that their schools provided enough opportunities in mathematics, while respectively around 71.7% and 63.6% of the junior secondary and senior secondary school students were satisfied with the mathematics learning opportunities provided by their schools.

The majority of the respondents at senior primary (90.2%) and junior secondary (82.6%) stage held positive views on the STEM learning opportunities provided by their schools in General Studies and Integrated Science respectively. Less than half (48.9%) of the senior secondary school students agreed that they had sufficient STEM learning opportunities in their science subject learning.

About 75.0% of the students in all learning stages considered that their schools provide enough STEM opportunities in other lessons. Approximately 84.8%, 76.5% and 66.6% of the senior primary, junior secondary and senior secondary school students reported that their schools provide access to learning STEM opportunities outside of class time.

Only 16.5% of the senior primary school students believed that their schools does not put much emphasis on STEM learning, and around 30.0% of the secondary school students agreed that there was sufficient emphasis on STEM learning.

In general, only 30.0% of the senior primary school students reported that they did not receive sufficient STEM learning opportunities in school. About half of the secondary school students held negative views on their schools' STEM educational supports.

The results of one-way ANOVA by key stage revealed that there were significant differences in students' perceived opportunities for STEM education in school (F = 270.867, P = 0.000, η^2 = 0.120). That is, senior primary school students (M = 3.11, SD = 0.53) agreed that they received more STEM opportunities from school than did the junior (M = 2.82, SD = 0.49) and senior secondary school students (M = 2.63, SD = 0.50).

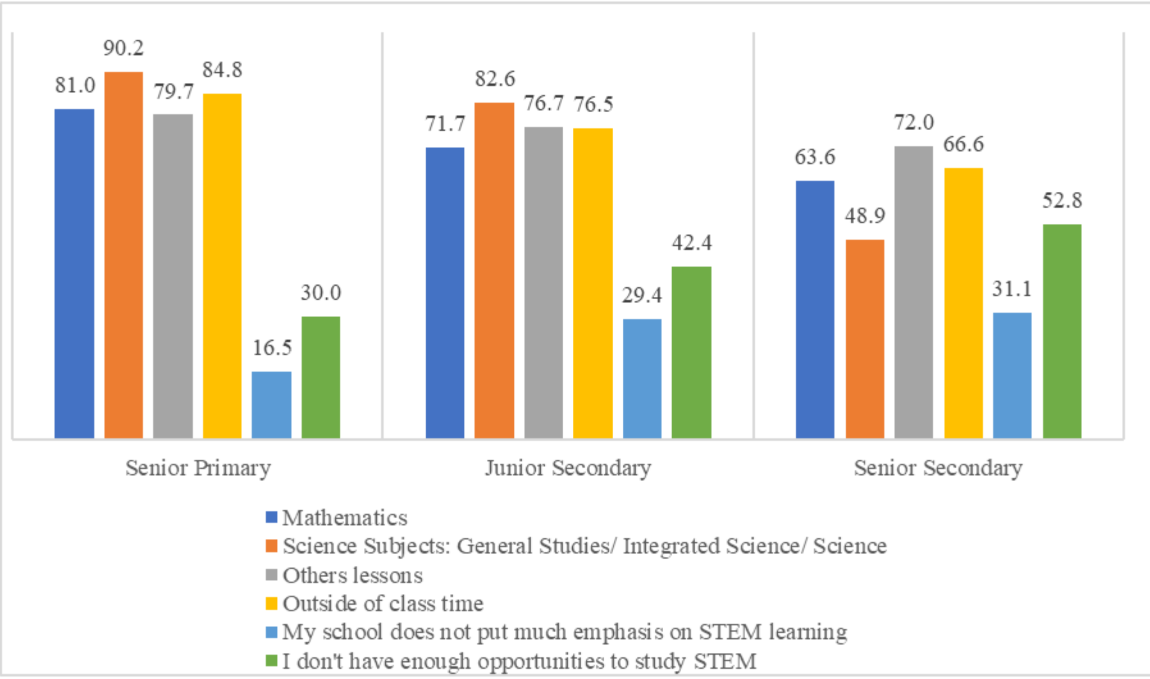

Figure 3.11. Percentage of students agreeing with the provision of school STEM learning opportunities.

3.6.2 Quality of STEM Education in School

Students' rating of the quality of STEM education in school is presented in Figure 3.12 with the following perspectives:

- I don't understand teachers' teaching of STEM content

- I can learn something interesting in STEM activities/lessons
- I feel that teachers love STEM
- I wonder if teachers lack STEM understanding
- STEM activities/lessons make me excited
- I look forward to STEM learning opportunities

In general, students from senior primary schools rated the quality of STEM education provided by schools higher than their junior and senior secondary school counterparts did. Only about 10.8% of the senior primary school students agreed that they don’t understood the teaching of STEM content, while about 17% of the secondary students agreed with it.

Around 70% of the senior primary school students agreed that they had learnt something interesting from STEM activities/lessons and the STEM activities/lessons were exciting, while only about half of the secondary school students agreed with this.

About 70% of the senior primary school students agreed that their teachers love STEM, with roughly 50% of the secondary school students agreeing with this. Only a few (around 10%) of students from all key stages agreed that, their teachers lack STEM knowledge.

About 69% of the senior primary school students claimed that they looked forward to the future STEM learning opportunities, whilst only about 45% of the secondary school students agreed with the above two statements.

The one-way ANOVA results showed that there were significant differences in the quality of STEM education in schools by three key stages ($F = 242.979$, $P = 0.000$, $\eta^2 = 0.109$). This means that senior primary school students ($M = 3.23$, $SD = 0.47$) rated the teaching quality from their schools significantly higher than the junior ($M = 2.99$, $SD = 0.37$) and senior secondary school students did ($M = 2.87$, $SD = 0.39$).

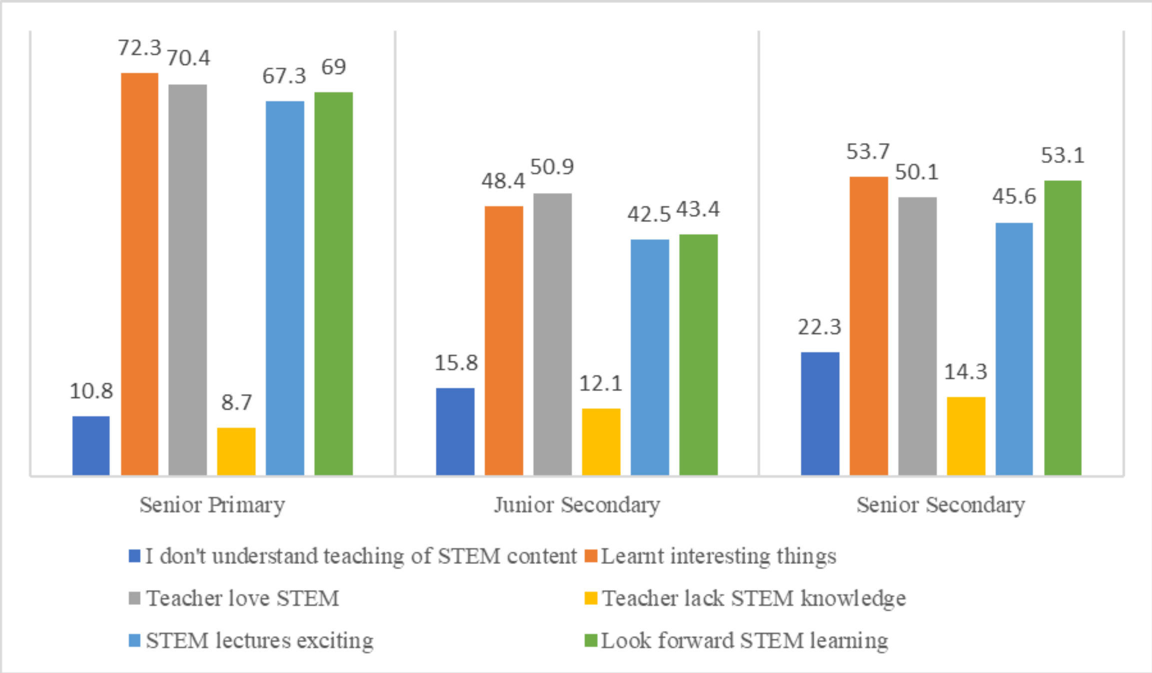

Figure 3.12. Percentage of students agreeing with the quality of STEM education in school.

3.7 Perceived Parental Support

3.7.1 Perceptions of Parental Expectations

Students' ratings of perceptions of parental expectations for seven aspects are listed in Figure 3.13.

- It is important for my parents that I try my best in school.
- My parents know well how I am doing in school.
- My parents will attend parents' activities in school.
- It is important for my parents that I have good academic performance.
- My parents think that not attending university means failure.
- My parents expect me to find a job that makes a lot of money in the future.
- My parents think that achieving personal goals is more important than earning money.

In general, students of the three learning stages all perceived high parental expectations. The majority of senior primary students claimed that they had high parental expectations. For instance, 91.4% of the senior primary students agreed that their parents considered good academic performance as being important, with percentages of 84.3% and 82.9% for junior secondary and senior secondary students respectively; 86.6% of the senior primary students agreed that their parents considered that achieving personal goals was more important than earning money, while the proportions were slightly lower for junior secondary (82.6%) and senior secondary students (78%).

Moreover, about half (53-59%) of all students agreed that their parents regarded not attending university meant failure of education outcomes.

ANOVA that examined the impact of key stages on students' perceived parental support was conducted. The results revealed that there were significant differences in students' perceived parental expectations among the three key stages (F = 125.220, P = 0.000, η^2 = 0.059). That is, senior primary school students (M = 3.18, SD = 0.42) reported that they had higher parental expectations than junior (M = 3.01, SD = 0.49) and senior secondary school students (M = 2.90, SD = 0.40). In addition, although there was a significant difference in students' perceived parental expectations by gender (F = 5.268, P = 0.022), the effect size was quite small (η^2 = 0.001). This may be due to the larger sample size, making the result reach a statistically significant level. The results revealed that students' perceptions of parental expectations might not in fact differ by gender.

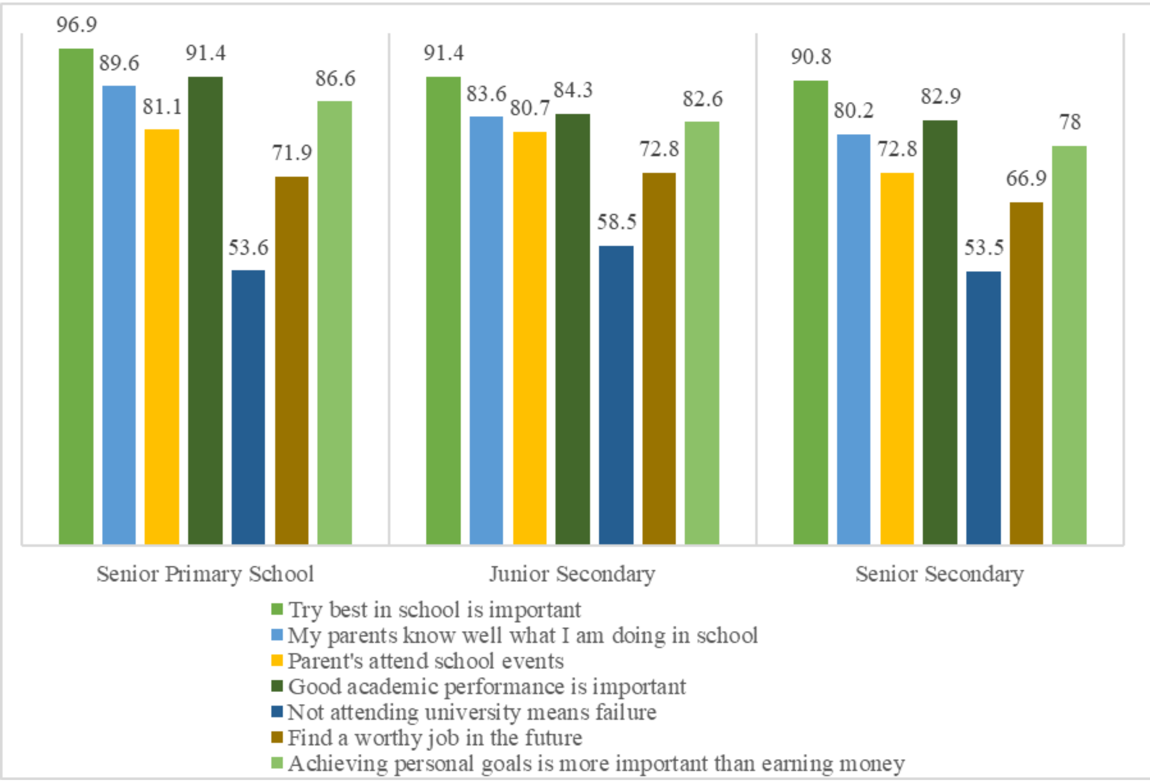

Figure 3.13. Percentage of students' perceptions of their parental expectations.

3.7.2 Influence of Parents' Education Level and Occupation

According to the demographic profile, about 39.8% of the students' fathers and 36.8% of their mothers had attended university. From the t-test analysis, there were significant differences for some aspects between students' parents who attended university and those who did not (Table 3.3). For the students whose parents had attended university, the mean values of STEM aspirations, mathematics self-efficacy, science self-efficacy, frequency of STEM-related museum and exhibition visits, frequency of STEM-related reading, and perceived parental expectations were significantly higher than those of students whose parents had not attended university.

Table 3.3

T-test results of STEM aspirations and the other variables by parents' education level

Aspects	Fathers			Mothers		
	Not attended	Attended University	*t*	Not attended	Attended University	*t*
Image of STEM professionals	2.80 (0.51)	2.82 (0.54)	-0.806	2.80 (0.51)	2.82 (0.53)	-1.017
Family reasons to study STEM	2.38 (0.85)	2.43 (0.90)	-1.601	2.38 (0.85)	2.43 (0.90)	-1.917
Social reasons to study STEM	2.94 (0.63)	2.96 (0.67)	-1.078	2.92 (0.63)	2.98 (0.67)	-2.438*
STEM aspirations	2.34 (0.65)	2.40 (0.71)	-2.603**	2.33 (0.64)	2.40 (0.72)	-3.119**
Mathematics self-efficacy	2.74 (0.76)	2.87 (0.76)	-4.979***	2.75 (0.77)	2.86 (0.76)	-4.260***
Science self-efficacy	2.85 (0.64)	2.96 (0.65)	-4.796***	2.85 (0.64)	2.95 (0.65)	-4.593***
Opportunities for STEM education in school	2.93 (0.53)	2.97 (0.56)	-2.170*	2.92 (0.54)	2.99 (0.55)	-3.858***
Quality of STEM education in school	3.08 (0.44)	3.12 (0.48)	-2.386*	3.09 (0.44)	3.11 (0.48)	-1.521
Frequency of STEM-related visits	1.70 (0.86)	1.88 (0.93)	-5.840***	1.69 (0.86)	1.92 (0.93)	-7.361***
Frequency of STEM-related reading	2.78 (0.92)	2.94 (0.93)	-5.196***	2.77 (0.94)	2.98 (0.89)	-6.538***
Perceived parental expectations	3.06 (0.43)	3.14 (0.45)	-5.097***	3.06 (0.44)	3.15 (0.44)	-5.535***
Social identity	2.98 (0.63)	2.98 (0.69)	0.191	2.98 (0.64)	2.99 (0.68)	-0.788

According to the demographic profile, about 44.1% of all the students' fathers' jobs were STEM-related and 12.1% of their mothers' jobs were STEM-related.

There was no noteworthy difference in the mean values of parents' occupation (STEM-related and not STEM-related) and most of the variables. However, for perceived parental expectations, as the students reported, for the students whose parents' occupations were STEM-related, their perceived parental expectations were lower than those whose parents' jobs were not STEM-related (Table 3.4).

Table 3.4

T-test results of STEM aspirations and the other variables by parents' occupation

Subjects	Fathers			Mothers		
	Not STEM related	STEM related	*t*	Not STEM related	STEM related	*t*
Family reasons to study STEM	2.40 (0.87)	2.40 (0.88)	0.153	2.40 (0.87)	2.38 (0.88)	0.580
Social reasons to study STEM	2.96 (0.66)	2.94 (0.65)	1.246	2.96 (0.65)	2.89 (0.68)	2.757**
Image of STEM professionals	2.82 (0.52)	2.79 (0.52)	1.825	2.81 (0.51)	2.76 (0.53)	2.771**
STEM aspirations	2.34 (0.69)	2.37 (0.67)	-0.982	2.35 (0.67)	2.36 (0.69)	-0.258
Math self-efficacy	2.83 (0.75)	2.79 (0.77)	1.314	2.81 (0.76)	2.76 (0.79)	1.404
Science self-efficacy	2.91 (0.65)	2.90 (0.63)	0.255	2.91 (0.65)	2.87 (0.63)	1.403
Opportunities for STEM education in school	2.96 (0.54)	2.94 (0.56)	0.803	2.95 (0.55)	2.94 (0.55)	0.430
Quality of STEM education in school	3.11 (0.46)	3.10 (0.45)	0.952	3.10 (0.46)	3.11 (0.46)	-0.180
Frequency of STEM-related visits	1.77 (0.88)	1.78 (0.92)	-0.351	1.78 (0.89)	1.76 (0.93)	0.423
Frequency of STEM-related reading	2.86 (0.93)	2.83 (0.93)	0.866	2.86 (0.93)	2.79 (0.96)	1.681
Perceived parental expectations	3.12 (0.45)	3.07 (0.44)	3.643***	3.11 (0.44)	3.04 (0.48)	3.668***
Social identity	3.00 (0.66)	2.98 (0.65)	1.127	3.01 (0.64)	2.92 (0.69)	3.220***

3.8 Social Identity

Regarding social identity, large percentages of the students were found to be proud of the scientific achievement, economic development and culture of Hong Kong and of China (Figure 3.14).

- I am proud of China's scientific achievements.
- I am proud of China's economic development.
- I am very interested in Chinese culture.
- I have a sense of belonging to People's Republic of China.
- I am proud of Hong Kong's scientific achievements.
- I am proud of Hong Kong's economic development.
- I am very interested in Hong Kong's culture.
- I have a sense of belonging to Hong Kong Special Administrative Region.

Specifically, 89.5%, 89.3% and 84.4% of the senior primary school students were proud of the scientific achievement, economic development and culture of Hong Kong, whereas 83.4%, 82.0% and 75.1% claimed that they were proud of these aspects of China. Consistent findings can be found for junior and senior secondary school students.

Besides, the majority of the senior primary, junior secondary and senior secondary students agreed with their sense of belonging to Hong Kong with the percentages of 86.3%, 77.6% and 71.1% respectively, while for their sense of belonging to People's Republic of China the percentages were 80.4%, 61.6% and 46.6% correspondingly, showing a low percentage of senior secondary students having a sense of national belonging.

An ANOVA was carried out to examine the influence of the three key stages and gender on students' social identity. Results showed that there were significant differences in students' social identity among the students in the three key stages (F = 193.530, P = 0.000, η^2 = 0.089), with senior primary school students (M = 3.16, SD = 0.64) having significantly higher social identity than junior secondary (M = 2.84, SD = 0.65) and senior secondary school students (M = 2.68, SD = 0.57). In addition, although there was a significant gender difference in students' social identity (F = 4.885, P = 0.027), the effect size was quite small (η^2 = 0.001). This was possibly due to the large sample size in this study, which made the difference reach a statistically significant level. This indicated that students' social identity might not differ between boys and girls.

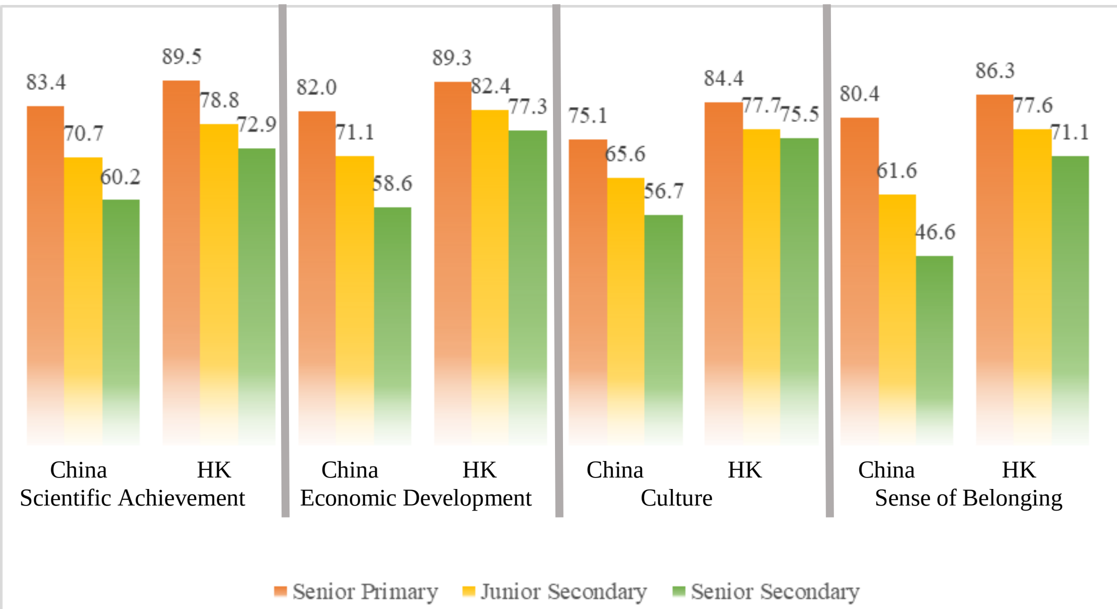

Figure 3.14. Percentage of students' perceptions of the scientific achievement, economic development, culture of China and Hong Kong, and their sense of belonging.

3.9 Significant Predictors of Future STEM Subject Choices (for Primary and Junior Secondary students only)

A logistic regression was performed to predict the probability that students would choose STEM subjects. The predictor variables included students' gender, key stage, science and mathematics self-efficacy, opportunities and quality STEM education in school, informal STEM activities including STEM-related readings, STEM-related museum and exhibition visits, and mobile use, perceived parental expectations, and social identity. A test of the full model versus a zero model with intercept only was statistically significant, χ^2 (12, 3326) = 629.817, P < .001. The overall success rate in classification has improved from 62.3% (the zero model) to 71.2% (the full model); 17.3% of the variance of future STEM subject choices can be explained by the full model.

The logistic regression coefficient, the Wald test, and the odds ratio for each of the predictors are presented in Table 3.5. The six variables of gender, images of STEM professionals, self-efficacy in science, self-efficacy in mathematics, quality of STEM education in school, and STEM-related readings, had significant partial effects. The odds ratios for these variables indicate that:

- Boys were 0.677 times more likely to choose STEM subjects than girls.
- Students' positive images of STEM experts had an increase of 1.900.
- The odds of choosing STEM for students who had self-efficacy in science or mathematics are 1.674 or 1.251 times higher than those who did not have self-efficacy.
- The quality of STEM education was more influential for students to choose STEM subjects, with a one point increase in School STEM education quality being associated with the odds of choosing STEM increasing by a multiplicative factor of 2.547.
- Reading STEM related-books increased the odds of choosing STEM by 1.379.

Table 3.5

Results of the logistic regression on students' future STEM-related subject choices

	B	Wald χ^2	P	Odds Ratio
	-6.883	210.170	<0.001	0.001
Gender (boys)[a]	-0.390	23.135	<0.001	0.677
Key stages (Junior secondary)	-0.168	7.015	.071	0.845
Images of STEM professionals	0.688	30.132	<0.001	1.990
Self-efficacy in learning mathematics	0.224	36.696	<0.001	1.251
Self-efficacy in learning science	0.515	13.523	<0.001	1.674
Opportunities for STEM education in school	-0.054	4.227	.550	0.947
Quality of STEM education in school	0.935	75.059	<0.001	2.547
Frequency of STEM-related reading	0.321	36.097	<0.001	1.379

Frequency of STEM related visits	0.095	3.746	0.056	1.099
Frequency of mobile use	-0.022	0.327	0.571	0.978
Perceived parental expectations	-0.041	0.964	0.688	0.960
Social identity	-0.013	6.192	0.855	0.987

Note. Boys, junior secondary schools, and having STEM experience were reference categories for the categorical variables of gender, key stages, and past experiences

3.10 Significant Predictors of Students' STEM Career Aspirations

To determine which factors would be more predictive of students' STEM career choices in the future, multiple regression analyses were conducted. The predictors consisted of image of STEM professionals, self-efficacy in learning mathematics, self-efficacy in learning science, opportunities for STEM education in school, quality of STEM education in school, STEM-related museum and exhibition visits, STEM-related reading, frequency of mobile use, perceived parental expectations, social identity, and gender. The results of regression analyses on STEM career choices of primary, junior secondary, and senior secondary school students are presented in Table 3.6.

Results showed that:

- Boys showed significantly higher STEM career aspirations than girls across key stages.
- Image of STEM professionals was the most important predictor of STEM career aspirations among students in all stages.
- Self-efficacy in learning mathematics was more predictive of STEM career aspirations for primary and junior school students, while self-efficacy in learning science was more predictive for senior secondary school students.
- Opportunities for STEM education in school was the significant predictor of STEM career aspirations only for senior secondary school students.
- STEM-related reading and STEM-related museum and exhibition visits were important predictors for students of all key stages.
- Compared to formal STEM education, informal STEM activities appeared to be more critical for students to pursuit STEM careers, as STEM-related reading, STEM-related museum and exhibition visits, and frequency of mobile use together accounted for more variance of STEM career aspirations (3.8% -5.6%) than opportunities for and quality of STEM education in school (0.3% – 2%).
- Perceived parental expectation was more influential for junior secondary school students than for students from the other two key stages.

- Society identity was the significant predictor of students for all key stages.
- Overall, these variables explained 23%, 28.9%, and 23.8% of variances of STEM career choices for primary, junior secondary, and senior secondary school students.
- Overall, self-efficacy in learning science and mathematics, informal STEM activities including reading, and visiting museums and exhibitions are the more important predictors of STEM career aspirations.

Table 3.6

Multiple regression analysis of STEM career aspirations of primary, junior secondary, and senior secondary school students

	STEM career aspirations					
	Senior primary		Junior secondary		Senior secondary	
	B	ΔR^2	B	ΔR^2	B	ΔR^2
Constant	-.115		.037		.137	
Gender	.246***	.056***	.224***	.047***	.194***	.027***
Images of STEM professionals	.339***	.100***	.309***	.141***	.272***	.107***
Self-efficacy in learning mathematics	.081***	.022***	.104***	.037***	-.141	.014**
Self-efficacy in learning science	.008		.066*		.305**	
Opportunities for STEM education in school	-.052	.003*	.034	.005*	.092*	.020***
Quality of STEM education in school	.059		-.054		-.032	
Frequency of STEM-related reading	.127***		.049**		.112***	
Frequency of STEM-related visits	.068***	.041***	.085***	.038***	.054*	.056***
Frequency of mobile use	-.004		-.004		-.061*	
Perceived parental expectations	.098**	.004**	.154***	.015	.104	.007*
Social identity	.079**	.004**	.076**	.005**	.098*	.007*

Note. "/" = inapplicable. **P* < 0.05, ***P* < 0.01, ****P* < 0.001.

3.11 Relations between School STEM Education, STEM Professional Images, Self-efficacy and STEM Career Aspirations

To explore the associations between perceived quality and opportunities for STEM education in schools, images of STEM professionals, and self-efficacy in learning mathematics and science, and STEM career aspirations across key stages, a multiple-group path analysis was conducted. Model fit indices (PCMIN/DF = 5453, GFI = .995, IFI = .982, TLI = .932, CFI = .982, and RMSEA = .033) indicated that the model fits the data well. The models for students of each key stage are shown in Figure 3.15a – Figure 3.15c.

Results showed that:

- Quality and opportunities for STEM education in school positively influenced images of STEM professionals, and self-efficacy in learning science and mathematics, and subsequently STEM career aspirations for senior primary and junior secondary school students.
- For senior secondary school students, quality and opportunities for STEM education in school positively influenced images of STEM professionals, and subsequently STEM career aspirations.

That is, for senior primary and junior secondary school students, more opportunities for quality STEM education in school might benefit them concurrently in developing more positive images of STEM professionals, and in establishing higher confidence in learning science and mathematics, both of which were important predictors of STEM career aspirations. For senior secondary school students, those with more exposure to quality STEM education in school were likely to see STEM professionals more positively, and showed higher STEM career aspirations.

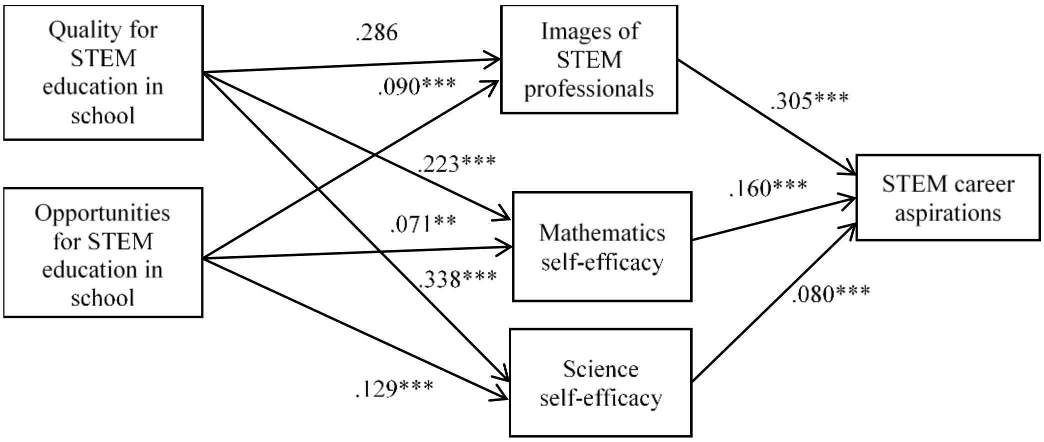

Figure 3.15a. Path analysis of perceived school STEM education and STEM career aspirations with senior primary school students (**P* < 0.05; ***P* < 0.01, ****P* < 0.001)

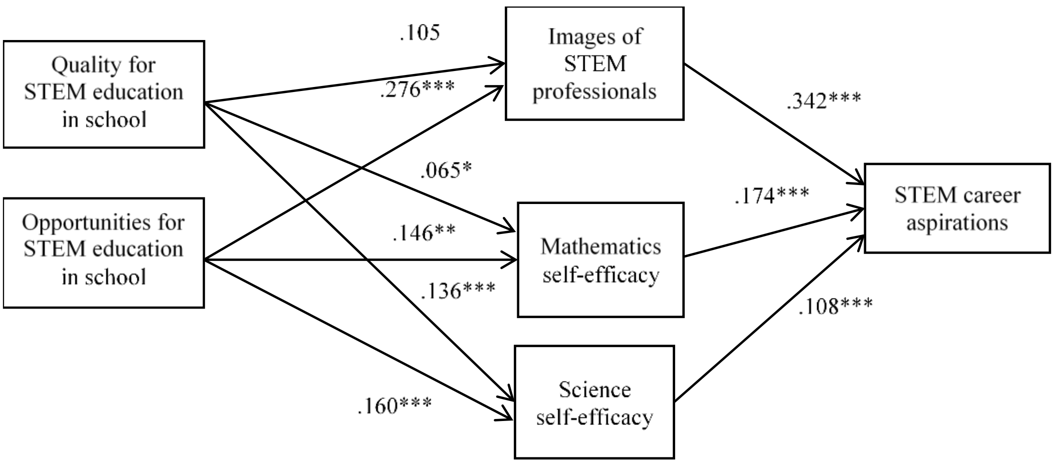

Figure 3.15b. Path analysis of perceived school STEM education and STEM career aspirations with junior secondary school students (**P* < 0.05; ***P* < 0.01, ****P* < 0.001)

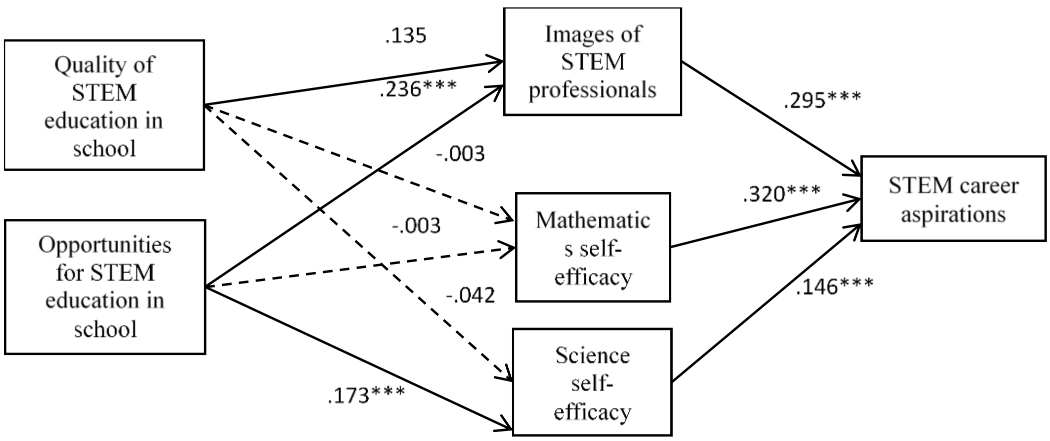

Figure 3.15c. Path analysis of perceived school STEM education and STEM career aspirations with senior secondary school students (*$P < 0.05$; **$P < 0.01$, ***$P < 0.001$)

3.12 Relations between Perceived Parental Expectations, Informal STEM Activities, STEM Professional Images, Self-efficacy and STEM Career Aspirations

To explore the associations between perceived parental expectations, informal STEM activities, images of STEM professionals, and self-efficacy in learning mathematics and science, and STEM career aspirations across key stages, a multiple-group path analysis was conducted through Amos 8.0. Model fit indices (PCMIN/DF = 4.492, GFI = .999, IFI = .996, TLI = .942, CFI = .996, and RMSEA = .030) indicated that the model fits the data well. The models for students of each key stage are shown in Figure 3.16a – Figure 3.16c.

Results showed that:

- In addition to direct effect, perceived parental expectations positively influenced STEM career aspirations through images of STEM professionals, regardless of key stages.
- Perceived parental expectations also positively influenced informal STEM activities, which was linked to images of STEM professionals and self-efficacy in learning mathematics, and STEM career aspirations, regardless of key stages.
- Perceived parental expectations positively influenced informal STEM activities, which was linked to self-efficacy in learning science, and subsequently STEM career aspirations for junior secondary school students, while not for senior primary and senior secondary school students.

That is, for all students, those who perceived higher parental expectations were likely to develop more positive images of STEM professionals, and thereafter they would have higher aspirations for STEM careers. They were also more likely to be engaged in more informal STEM activities. The more they attended STEM activities outside school, the more likely they were to develop better understanding of STEM professionals and more confidence in their abilities of learning mathematics, and the stronger STEM career aspirations they would have. For junior secondary school students, in particular, more informal activities might also increase their confidence in learning science, which might then increase their STEM career aspirations.

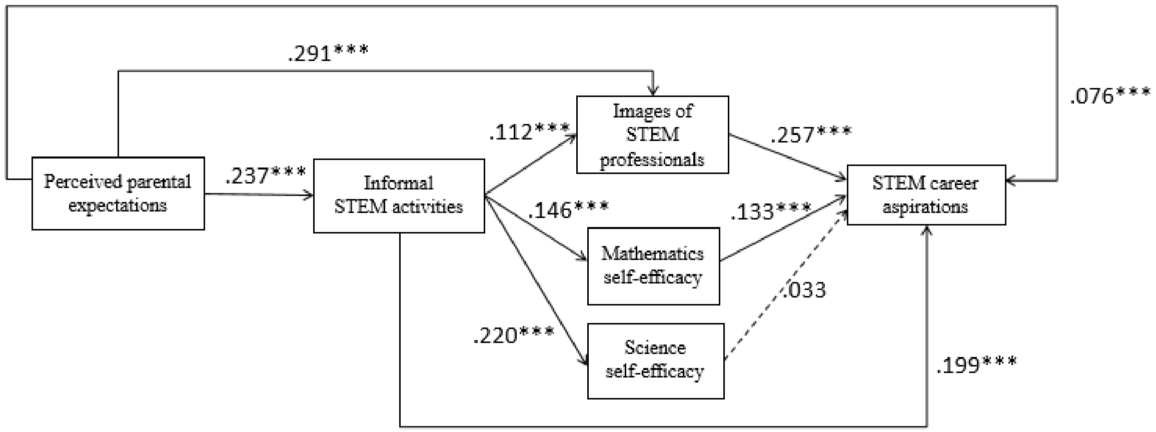

Figure 3.16a. Path analysis of perceived parental expectations and STEM career aspirations with senior primary school students (*$P < 0.05$; **$P < 0.01$, ***$P < 0.001$)

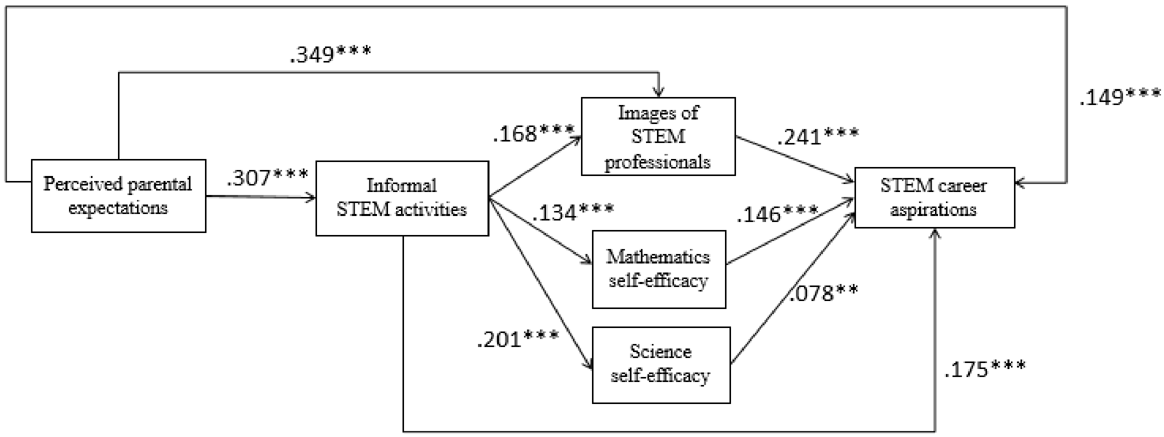

Figure 3.16b. Path analysis of perceived parental expectations and STEM career aspirations with junior secondary school students (*P < 0.05; **P < 0.01, ***P < 0.001)

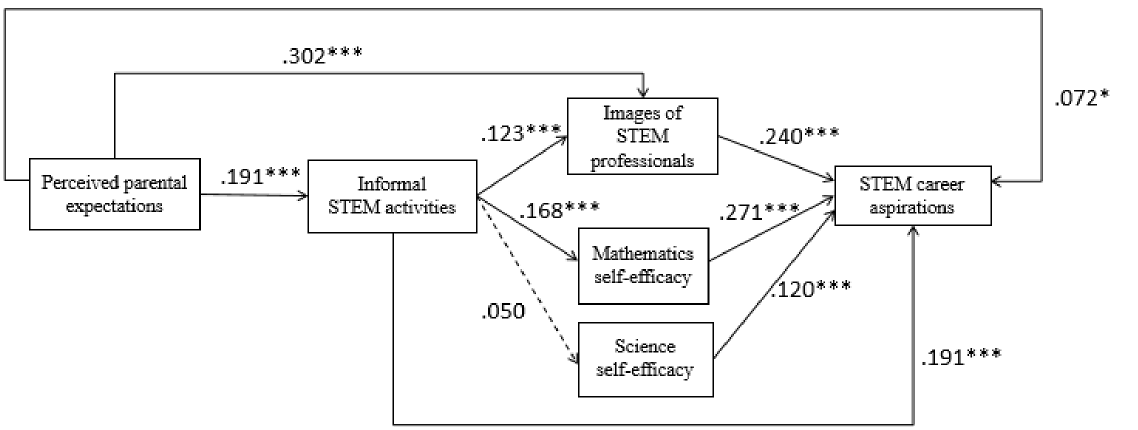

Figure 3.16c. Path analysis of perceived parental expectations and STEM career aspirations with senior secondary school students (*$p < 0.05$; **$p < 0.01$, ***$p < 0.001$)

3.13 Relations between Perceived Parental Expectations, STEM Education in Schools, STEM Professional Images, Social Identity, and STEM Career Aspirations

To explore the associations between perceived parental expectations, STEM education in school, images of STEM professionals, social identity, and STEM career aspirations across the key stages, a multiple-group path analysis was conducted through Amos 8.0. Model fit indices (PCMIN/DF = 4.154, GFI = .998, IFI = .995, TLI = .960, CFI = .995, and RMSEA = .038) indicated that the model fits the data well. The models for students of each key stage are shown in Figure 3.17a – Figure 3.17c.

Results showed that:

- Perceived parental expectations influenced social identity directly and positively, but also indirectly and positively through images of STEM professionals among the students for all key stages.
- Opportunities for STEM education in schools directly and positively influenced social identity among the students for all key stages.
- Quality of STEM education positively influenced social identity for the students, except for junior secondary school students.
- Social identity had a direct and positive impact on STEM career aspirations among the students of all key stages.

That is, the students who perceived high parental expectations, and those who had more opportunities for quality STEM education in schools were more likely to develop stronger social identity. In addition, the students who viewed STEM professionals less stereotypically were likely to have a stronger social identity. When the students had a stronger sense of belonging to the local society and to China, they would pursue STEM careers to a greater extent.

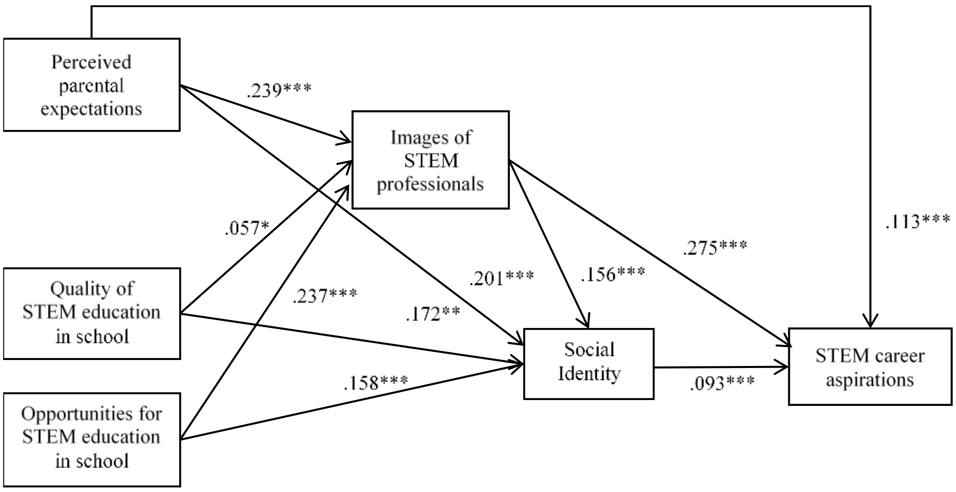

Figure 3.17a. Path analysis of social identity and STEM career aspirations with senior primary school students (*P < 0.05; **P < 0.01, ***P < 0.001)

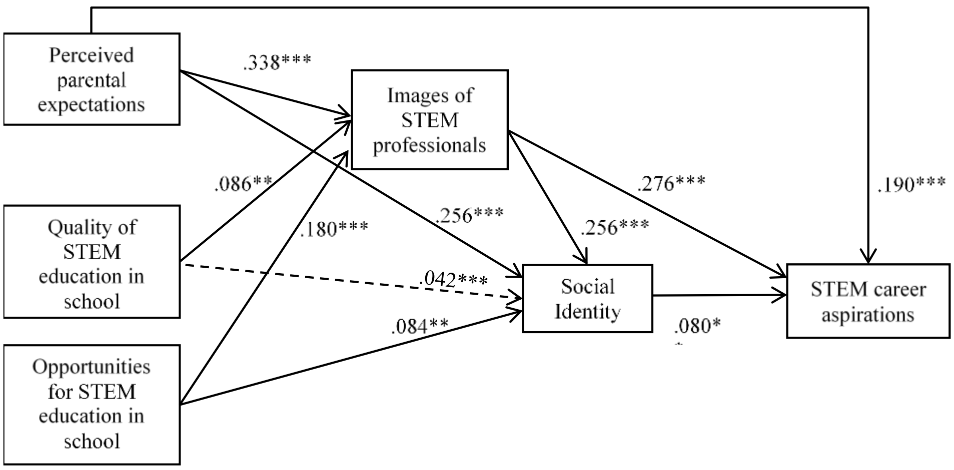

Figure 3.17b. Path analysis of social identity and STEM career aspirations with junior secondary school students *(*P < 0.05; **P < 0.01, ***P < 0.001)*

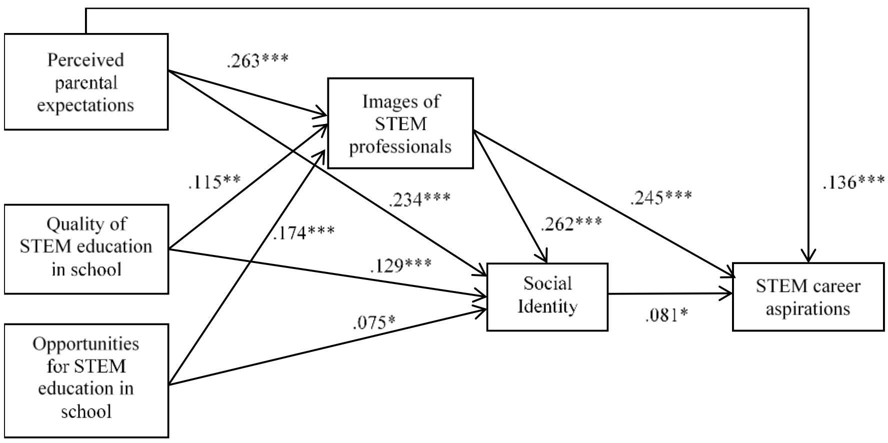

Figure 3.17c. Path analysis of social identity and STEM career aspirations with senior secondary school students *(*P < 0.05; **P < 0.01, ***P < 0.001)*

Chapter 4 Policy Implications and Recommendations

4.1 Make STEM Opportunities Available for all Students

The findings indicate that school STEM opportunities significantly predict senior secondary students' STEM career aspirations. Primary school students have higher self-efficacy in science and mathematics than secondary school students. Primary and junior secondary students with higher self-efficacy in science and mathematics are more likely to choose to study STEM subjects.

- To cope with the challenges of the present and future eras, STEM education for our young generation is more than just about knowledge, skills and thinking processes; it is a matter of literacy that all school leavers should acquire. In the current senior secondary curriculum, students are required to take four core subjects (Chinese Language, English Language, Mathematics and Liberal Studies) focusing on languages, numeracy and thinking skills. These core subjects take up 45-55% of students' learning time, while the rest of their time is devoted to elective subjects of students' own choice[1]. With such a curriculum design, the logical solution to enable all students to acquire a certain level of STEM literacy up to senior secondary level is to infuse STEM learning elements into the core subjects, especially Mathematics and Liberal Studies at the senior secondary level.
- The findings also point to self-efficacy in science and mathematics, which has significant bearing on senior secondary students' choice of STEM subjects, as the starting point for the development of STEM-related human resources. To this end, it is vital to develop interest in STEM starting at primary level, and their interest needs to be maintained or even enhanced during their junior secondary schooling to foster their STEM career aspirations. Fortunately, it is not difficult to identify STEM-related teaching points/topics in the subjects of Mathematics and General Studies of the primary curriculum for P4-6 students; and in Mathematics and Integrated Science in the junior secondary curriculum.

4.2 Narrow the Gender Gap in STEM Aspiration

Boys of all three key stages are more confident in science-related subjects and mathematics, as well as having higher STEM career aspirations than girls. Primary and junior secondary school boys are more likely to choose STEM subjects than girls.

- It is a matter of principle for equity and an issue of expanding human resources that we should do something to overcome the stereotyping of STEM professions being male-biased so that

[1] Task Force on Review of School Curriculum https://www.edb.gov.hk/attachment/en/about-edb/press/consultation/TF_CurriculumReview_Consultation_e.pdf

more females will enter and contribute to these professions. Mass or public education might be the starting point for this endeavour.

- Public education programmes from teams of various STEM-related Government departments and the Education Bureau in particular can focus more on engaging more girls in gender-based STEM learning opportunities for girls to enhance their exposure to female STEM role models that serve in both Government and Non-governmental organizations.
- Media are a powerful way to educate and promote STEM to the masses. It is suggested that more promotion of female STEM professionals could be introduced by such means to eliminate the gender stereotype of STEM learning or careers. Despite the introduction of the tremendous contribution by local scientists in the RTHK programme "Our Scientist", it is suggested that more representation of female professionals should be included. It is never enough to change young girls' perception that "STEM is male-dominant"; the general masses also play a role in reshaping gender stereotypes.

4.3 Enhance Parent Education on Students' Study and Career Choices

The findings show that the majority of students perceive high parental expectations. Parental expectations positively and directly influence students' STEM career aspirations, particularly for junior secondary school students. Perceived parental expectations first have a positive influence on engagement in informal STEM activities, which is in turn linked to image of STEM professionals, self-efficacy in mathematics and ultimately students' STEM career aspirations.

- Parent education is important to allow parents to recognize themselves as schools' partners in education for their children and that they also play a vital role in their children's learning and the development of their career aspirations. To this end, the Task Force on Home-School Co-operation and Parent Education review report in April 2019 highlighted the design and development of a curriculum framework for parent education to enhance their understanding of the developmental needs as well as the career aspirations of their children[2].
- To support our next generation to contribute to the sustainable development of our society through STEM, we have to enhance parents' social awareness of the various STEM professions for them to guide their children to develop STEM career aspirations. Parents also need to be more adaptable to the changing Hong Kong economy and key industries so as to provide informed advice on their children's choice of subject and studies.

[2] Report of the Task Force on Home-School Co-operation and Parent Education https://www.e-c.edu.hk/doc/en/publications_and_related_documents/education_reports/Report_TF%20on%20HSC_en.pdf

- The “Science in the Public Service” programme run by Government bureaus and departments has been an effective public science education channel[3]. This could be enhanced with emphasis on STEM education by way of the publication of leaflets and story books for public consumption.

4.4 Build STEM Capital to Bridge the Social Economic Status Gap

There are findings that students with parents who attended university have higher STEM career aspirations and higher self-efficacy in mathematics and science. They are provided more informal STEM activities by parents and perceived higher parental expectations. More informal STEM activities is one of the significant predictors of students' STEM career aspirations.

- Family socioeconomic status (SES) is considered rather constant when compared to other influencing factors in students' career aspirations such as school STEM opportunities and academic self-efficacy due to parents' education level and occupation. STEM may not be an easy topic for parents who do not have an academic basis in it. It is therefore suggested that more effort can be put into the promotion of informal STEM learning and public STEM literacy for parents and students to link STEM to our everyday lives.

- Museum exhibits and other exhibitions help to delineate the implications of STEM knowledge in daily life, ranging from basic scientific theories to more advanced technological breakthroughs. This can enrich the STEM knowledge of both parents and children, and more importantly enable parents of lower SES to keep up with the rapid developments of Hong Kong society and the world. Such action will hopefully build up the family's STEM Capital (*Making reference to the science capital used by Dewitt, Archer and Mau (2016), STEM capital refers to STEM-related qualifications, knowledge about STEM and how it works, interest and social contact with STEM-related jobs*). The annual Hong Kong Book Fair is one of the opportunities for both parents and their children to build interest and knowledge in STEM as there are increasing numbers of exhibitors of STEM books, toys and other educational materials. To encourage more families of low SES to actively participate in informal STEM learning activities, the Government can consider subsidizing these families with purchase coupons or free entrance tickets to enhance their access to STEM books and learning kits.

4.5 Articulate STEM Learning Progression across Key Stages

There are findings showing significant differences in an array of factors affecting students' STEM learning across key stages of schooling. These include provision of STEM learning opportunities,

[3] “Science in the Public Service” programme https://www.science.gov.hk/

quality of STEM education, mathematics self-efficacy, science self-efficacy, perceived parent expectations, family reasons to study STEM, social identity, social reasons to study STEM, reading activities and museum visits. Moreover, senior secondary students lack STEM learning opportunities in science-related subjects in comparison with primary or junior secondary students.

- The possible reasons for the lack of STEM learning opportunities include: firstly, senior secondary students are more examination-focused with heavy curriculum content, and secondly, the lack of a systematic progression framework for STEM education hinders the provision of STEM learning relevant to students' ability and interest.
- Although the flock to STEM education activities available from the market or designed by teachers offers opportunities for different types of STEM learning, the lack of vigorous education research on their learning effectiveness makes it difficult to shape the learning outcomes and drive the development of quality STEM education. Research and development have always been closely associated with new educational initiatives. Thus, STEM education will need a special task group comprising researchers, educators, industries and teachers to develop the progression framework based on research evidence and the needs of the society.

4.6 Integrate STEM Career Understanding into School Education

One of the major findings is that students who have more positive images of STEM professionals are more likely to choose STEM subjects, and image of STEM professionals is the most important predictor of STEM career aspirations for all students. This brings us to the need to better connect school learning to the contemporary STEM world.

- School learning has long been criticized for not being closely related to the daily experience of students. This might be particularly true for STEM education in relation to STEM-related occupations.
- To meet this challenge, curriculum developers might consider bringing some kind of STEM career elements into relevant parts of the school curriculum. This could be in the form of exposition of real-life STEM-related occupations linked to or expanded within the relevant curriculum content. To effectively achieve this, curriculum support materials/services such as learning packages, videos on STEM-related professionals at work, and facilitation of linking students up with these professionals are needed.
- Most of the STEM learning activities nowadays are centred around coding/programming, robotics and, more recently, artificial intelligence. This could easily lead to the misconception that these are the only STEM professions. As such, it has become imperative that introduction

of the whole range of STEM professions be placed strategically into the school curriculum to strengthen students' exposure to examples of STEM occupations that they can consider pursuing in their future careers. For example, elements of the work of nutritionists could be mentioned in science or biology classes, and the work of actuaries or accountants can be introduced in advanced mathematics lessons.

4.7 Highlight STEM Contributions to the Society and Country

The findings show that social identity has direct and positive influences on students' STEM career aspirations. They also reveal that senior secondary school students have relatively lower social identity compared to students of other key stages. This weakens the desire for junior secondary students to study STEM for the purpose of contributing to the local society, the national goal and global concerns.

- STEM education should be closely related to the daily operation and development of the local community, which could cascade to the nation at large. To strengthen this linkage, policy makers may consider stepping up and pitching the public education programmes from various STEM-related Government departments towards our young generation. Their services, ranging from architecture, drainage, fire protection to water supply, could be laid out for youngsters to feel and relate their STEM learning to everyday life.

- Promotion of STEM through the mass media will not only benefit students but their parents as well. This might have some impact on steering our young generation towards STEM professions, contributing to our local and national goal of economic development through science and technology. The RTHK program "Our Scientist" which highlighted the achievement of local scientists and at the same time can demystify their image as nerdy people[4] is an example to highlight STEM contributions to the society and country.

- One of the objectives of Liberal Studies (LS) is to enhance students' social awareness. Such social awareness should include the impact of science and technology on human beings, both in the positive sense of providing better living conditions and its negative environmental consequences. Such awareness could be extended to national and global perspectives. As such, it is high time that the LS curriculum put more emphasis on STEM-related issues so as to enable all senior secondary students, irrespective of their choice of electives and subsequent career pathway, to be exposed to STEM thinking processing and to become STEM-literate citizens.

[4] RTHK "Our Scientist" https://www.rthk.hk/tv/dtt31/programme/ourscientists?lang=en

4.8 Improve the Quality of STEM Education

The findings show that the quality of school STEM education influences students' STEM aspirations through image of STEM professionals, and/or self-efficacy in mathematics and science. Primary and junior secondary students who rate the quality of school STEM education more positively are more likely to choose STEM subjects.

- STEM education needs to catch up with the rapid advancements in science and technology. To better equip our teachers for quality STEM education, they need to be exposed to the latest technologies and pedagogy. To this end, policy makers should lead by providing resource support to universities for the development of strategies and pedagogy for STEM education and the provision of continuous teacher education programmes. Museum learning should also take on a more prominent role to facilitate STEM learning. The Hong Kong Science Museum and other relevant museums could play an active role in this regard. At the same time, relevant professional and quasi-governmental organizations such as the Hong Kong Institution of Engineers, the Hong Kong Science and Technology Parks, the Cyberport, etc. could help with exposing teachers to the latest developments in science and technology.
- STEM education in Hong Kong and other parts of the world has started with an array of independent initiatives. Some are commercial in nature, but all in all they lack a holistic and evidence-based theoretical underpinning. This may lead to (a) achieving diverse and unfocused goals, if any, in STEM education, (b) incoherency in the practices of STEM education, and (c) the inability to sustain and further develop STEM education. To remedy this, upfront and continuous rigorous education research should be in place to shed light on and to direct the sustainable implementation and development of STEM education.

Chapter 5 Details of the Public Dissemination Held

The preliminary findings of this research was first presented to the conference participants in the "London International Conference on Education" held on 9th December 2019 in London, with the presentation title of "*Understanding Youths' Science, Technology, Engineering and Mathematics (STEM) Aspiration*".

The findings of the exploratory study with 330 Hong Kong Academy of Gifted Education (HKAGE) members were jointly presented to the conference participants in collaboration with HKAGE with the title "*Public Policy Research: Challenges and Opportunities with Hong Kong Students' STEM Aspirations*" in the "International Conference on Advances in STEM Education" held on 18th Dec 2019 in the Education University of Hong Kong.

In the teacher professional development programme for primary school teachers held on 20th Dec 2019 in the Education University of Hong Kong, research background and findings were also shared to 30 primary teachers.

In a teacher professional development workshop with three government schools held on 15th Jan 2020 in Tseung Kwan O Government Primary School, key findings related to primary students were shared with the participating teachers and government officials.

The major findings were also published in the newsletter of the Department of Science and Environmental Studies, Education University of Hong Kong (Appendix E) in December 2019. The newsletters were sent to all primary and secondary schools in Hong Kong, with an estimation of at least 2500 readers.

An article focusing on the factor of gender difference on students' STEM aspirations (Appendix F) has been accepted for published in Mingpao.

To thank for the support from the participating schools in this research, a two-paged poster showing the findings of the corresponding key stages and a leaflet showing the eight policy recommendations in individual, family, school and social levels were designed and provided to each of the participating schools (Appendix G for the sample posters for each key stage and Appendix H for the leaflet).

Chapter 6 Conclusion

STEM education is one of the most prominent topics in the contemporary world given that innovation and technology are considered as the driving forces of economic growth. As such, nurturing the STEM workforce is fundamental to sustaining our future economy. The importance of innovation and technology as "an important growth engine for future economic development" is once again stressed in the 2020-21 Budget by Hong Kong government[5], and subsidies have been set aside for internships for students taking STEM programmes in local universities. However, there are still insufficient concrete and strategic measures and policies to nurture our youngsters' STEM aspirations, which could translate into STEM studies and subsequent STEM careers.

Over the past years, STEM education has been evolving from a convenient clustering of four overlapping disciplines toward a more cohesive knowledge base and skill set critical for the 21st century[6] (NSTA, 2020). Although STEM education has been taken seriously as an education initiative by policy makers and researchers, without the benefit of a theoretical framework, educators, students and parents in Hong Kong continued to conceive STEM as a subject or curriculum which deviates significantly from the aforesaid concept of a cohesive knowledge base and skill set. STEM education is neither a single subject nor a curriculum. STEM is an interdisciplinary and integrated approach to learning that provides opportunities for students to work on authentic issues related to scientific, technological, environmental, personal, social, economic, and political perspectives, to subsequently help develop new competences. All in all, this is considered as STEM literacy. The call for a STEM-literate generation and workforce is needed for the sustainable development of our society working towards a healthy life, safe food, clean air, a green environment and new inventions.

Cheng and So (in press) in their discussion of managing STEM Learning, stated that it would be problematic to implement STEM learning without a theoretical conceptualization of its nature as well as its complicated relationship with processes and outcomes in education. This may induce misconceptions and a mismatch between aims and means, and the misuse of the integration conception in curriculum design, classroom teaching and student learning. This will then result in confusion for students and teachers, which will eventually negatively affect the effectiveness of learning and teaching.

This research aims to study Hong Kong youths' STEM aspirations across the different key stages in order to provide the government and the public with reference data to support future optimisation of

[5] The 2020-21 Budget https://www.budget.gov.hk/2020/eng/budget14.html

[6] NSTA Position Statement – STEM Education Teaching and Learning https://www.nsta.org/about/positions/stem.aspx

STEM education and curriculum policy. Conducted by way of an online survey with reference to other international studies in questionnaire design, a sufficient amount of data was obtained and thus meaningful findings could be identified. Questionnaires for key stages 2, 3, and 4 were designed to understand Hong Kong students' views on STEM learning, factors that affect their participation, opportunities, achievement and progression in STEM, and most importantly their aspirations regarding their education and career.

It was found that students who are more likely to choose to study STEM subjects tend to have higher self-efficacy in science and mathematics, as well as having more positive images of STEM professionals. Meanwhile primary and junior secondary school boys are more likely to choose STEM subjects than girls. Regarding STEM career aspirations, image of STEM professionals and informal STEM activities are significant predictors for all students, while school STEM opportunities significantly predict senior secondary students' STEM career aspirations. Parental expectations and social identity also directly and positively influence students' STEM career aspirations, but it is notable that senior secondary school students have relatively lower social identity than students of other key stages. Boys across the three key stages are more confident in science-related subjects and mathematics. They also show higher STEM career aspirations than girls.

The above findings echo the STEM learning ecosystem mentioned in Chapter 1 in which factors influencing youth's STEM aspirations consist of different levels: individual, family, school and society. Policy recommendations focusing on strengthening students' STEM-related subject choices and STEM career aspirations were provided with respect to the factors concerned (Figure 6.1). Promotion of STEM education to nurture Hong Kong's future STEM talent requires joint-force of various stakeholders with new approaches and new definitions of learning outcomes. It is hoped that policy makers and educators can work in collaboration to undertake necessary action with consideration of the recommendations.

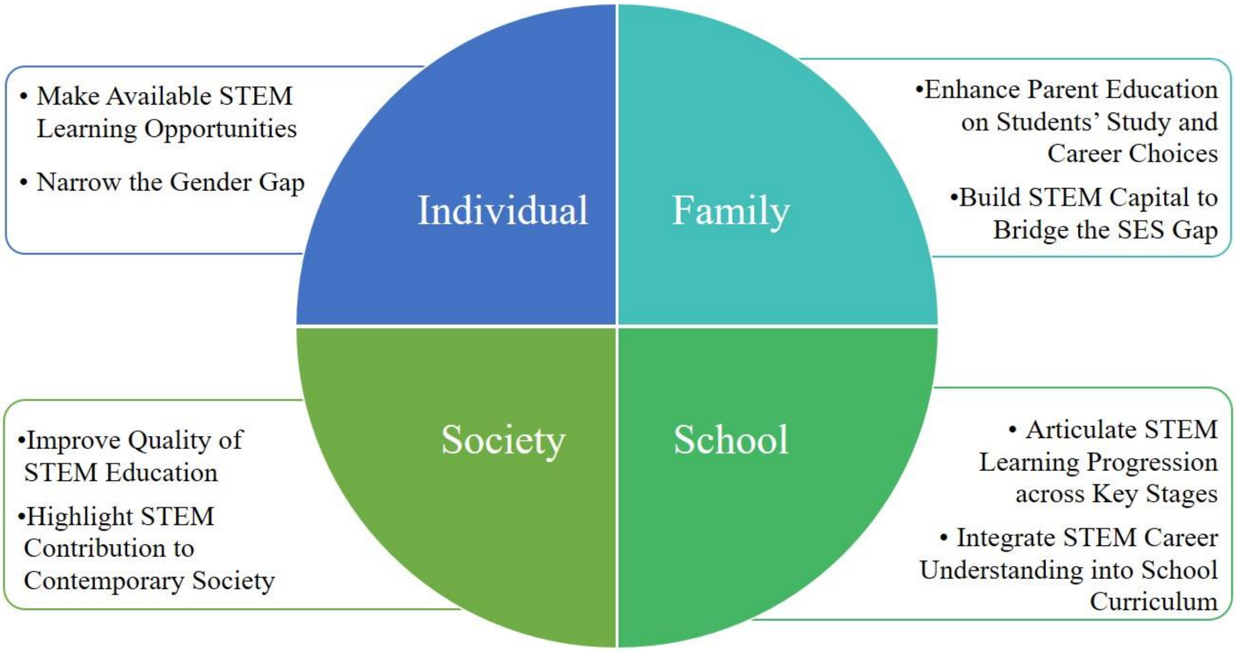

Figure 6.1. Policy implications at the individual, family, school and social levels

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Appendix A: List of Research Schools

中華基金中學
中華基督教會協和小學（長沙灣）
中華基督教會基全小學
大埔崇德黃建常紀念學校
中華傳道會安柱中學
大埔舊墟公立學校
仁濟醫院靚次伯紀念中學
民生書院小學
可風中學（嗇色園主辦）
西貢崇真天主教學校（中學部）
何文田官立中學
李求恩紀念中學
余振強紀念第二中學
英皇書院同學會小學
迦密愛禮信中學
保良局金銀業貿易場張凝文學校
香港紅卍字會大埔卍慈中學
香港資優教育學苑
荃灣潮州公學
馬鞍山靈糧小學
粉嶺公立學校
港島民生書院
港澳信義會小學
聖士提反堂中學
獅子會何德心小學
聖公會基愛小學
聖公會聖紀文小學
聖公會嘉福榮真小學
聖伯多祿天主教小學
滙基書院（東九龍）
慈雲山聖文德天主教小學
慕光英文書院
滬江小學
瑪利諾修院學校（小學部）
鳳溪第一小學
鄧鏡波學校
潔心林炳炎中學
樂善堂余近卿中學
樂善堂楊葛小琳中學

Appendix B: Survey Questions for Students at Three Key Stages

小學生STEM教育調查

調查旨在了解你的看法，問題沒有既定答案。所提供的資料將會絕對保密，並以不記名方式處理。

STEM 指科學、科技、工程及數學知識及技巧的綜合和應用。

第一部分

班別*____________ **出生年份***____________ **性別*** ☐ 男 ☐女

出生地* ☐ 香港 ☐ 中國內地 ☐ 其他，請填寫____________

如非香港出生, 居港時間 ☐ 少於1 年 ☐ 1-3 年 ☐ 4-7年 ☐ 7年以上

家住哪區*

☐ 灣仔	☐ 東區	☐ 中西區	☐ 南區	☐ 觀塘
☐ 九龍城	☐ 黃大仙	☐ 旺角	☐ 深水埗	☐ 油尖
☐ 西貢	☐ 沙田	☐ 離島	☐ 荃灣	☐ 葵青
☐ 大埔	☐ 屯門	☐ 元朗	☐ 北區	☐ 內地

第二部分

參與閒暇活動的次數是…？*	約一星期一次	約一個月一次	約半年一次	約一年一次	從不
閱讀書籍或雜誌、觀看電影節目	☐	☐	☐	☐	☐
閱讀科學/科技/工程/數學/大自然的書籍、雜誌或觀看相關的電視節目	☐	☐	☐	☐	☐
瀏覽科學/科技/工程/數學相關的網頁	☐	☐	☐	☐	☐
去科學館/科學園/太空館/動物園/植物園/海洋公園/自然教育徑...等	☐	☐	☐	☐	☐
參觀展覽（如: 動漫展、書展、花卉展、電腦通訊節、創新科技展、家居博覽...等）	☐	☐	☐	☐	☐

玩手機/電腦的時間是多少？*	3小時或以上	約2小時	約1小時	少於30分鐘	從不
以每天計..	☐	☐	☐	☐	☐

第三部分

父母或監護人有否上大學？*（注意：只需回答父母或監護人）

父親 ☐ 有 ☐ 沒有 ☐ 不適用

母親 ☐ 有 ☐ 沒有 ☐ 不適用

監護人 ☐ 有 ☐ 沒有 ☐ 不適用

家裡有多少與科學/ 科技/ 工程/ 數學相關的書籍（課本及練習簿除外）*	多過 50本	21-50本	10-20本	少過 10本	沒有
例如兒童的科學、十萬個為什麼、Magic School Bus、Science Adventure、大偵探福爾摩斯、國家地理雜誌等...）？	☐	☐	☐	☐	☐

最常看的科學/ 科技/ 工程/ 數學相關書籍是... ____

第四部分

哪項描述你父母（或監護人）的工作最為恰當？*（注意: 只需選回答父母或監護人）

父親

☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工）
☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理）
☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師）
☐ 從事文職的工作（如: 文員，秘書）
☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師）
☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技）
☐ 是主管或經理
☐ 是商人
☐ 是科學家
☐ 在家中照顧家庭
☐ 失業/退休
☐ 我不知道
☐ 不適用

母親

☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工）
☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理）
☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師）
☐ 從事文職的工作（如: 文員，秘書）
☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師）
☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技）
☐ 是主管或經理
☐ 是商人
☐ 是科學家
☐ 在家中照顧家庭
☐ 失業/退休
☐ 我不知道
☐ 不適用

監護人

☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工）
☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理）
☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師）
☐ 從事文職的工作（如: 文員，秘書）
☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師）
☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技）

- ☐ 是主管或經理
- ☐ 是商人
- ☐ 是科學家
- ☐ 在家中照顧家庭
- ☐ 失業/退休
- ☐ 我不知道
- ☐ 不適用

第五部分

有關父母對你學習情況的掌握或期望, 請選出你對下列各題敘述內容的同意程度。*	十分同意	同意	不同意	十分 不同意
我在學校盡力學習對父母來說很重要。	☐	☐	☐	☐
父母知道我在校內的情況。	☐	☐	☐	☐
父母會出席學校的家長活動。	☐	☐	☐	☐
我有好的學業成績對父母來說很重要。	☐	☐	☐	☐
父母會認為未能升讀大學是一件很失敗的事。	☐	☐	☐	☐
父母期望我將來找到一份賺很多錢的工作。	☐	☐	☐	☐
父母認為我長大後能實踐個人志願比賺很多錢重要。	☐	☐	☐	☐

第六部分

學校提供學習STEM的機會*	十分同意	同意	不同意	十分 不同意
學校在數學科有提供學習STEM的機會。	☐	☐	☐	☐
學校在常識科有提供學習STEM的機會。	☐	☐	☐	☐
學校在其他科目有提供學習STEM的機會。	☐	☐	☐	☐
在課堂以外時間，學校有提供學習STEM的機會。	☐	☐	☐	☐
我覺得學校不重視STEM。	☐	☐	☐	☐
我沒有足夠機會參與STEM學習。	☐	☐	☐	☐

你有否參與過STEM學習？* ☐ 有 ☐ 沒有

若曾有機會參與STEM 學習, 請回答以下各題

	十分同意	同意	不同意	十分 不同意
我不明白老師指導STEM的內容。	☐	☐	☐	☐
我在STEM的活動或課堂裡學習到有趣的事。	☐	☐	☐	☐

	十分同意	同意	不同意	十分 不同意
我覺得老師喜愛STEM。	☐	☐	☐	☐
我覺得老師缺乏STEM知識。	☐	☐	☐	☐
STEM的活動或課堂讓人很興奮。	☐	☐	☐	☐
我期待學習STEM的機會。	☐	☐	☐	☐

第七部分

有關你在STEM相關的學科學習的情況，請選出你對下列各題敘述內容的同意程度。

數學*	十分同意	同意	不同意	十分 不同意
我覺得學習數學很困難。	☐	☐	☐	☐
我明白數學的大部分內容。	☐	☐	☐	☐
我就是不擅長數學。	☐	☐	☐	☐
我在數學的學習表現很好。	☐	☐	☐	☐

常識（科學相關單元）*	十分同意	同意	不同意	十分 不同意
我覺得學習常識中與科學相關的單元很困難。	☐	☐	☐	☐
我明白常識中與科學相關的單元的大部分內容。	☐	☐	☐	☐
我就是不擅長常識中與科學相關的單元。	☐	☐	☐	☐
我在常識中與科學相關的單元的學習表現很好。	☐	☐	☐	☐

第八部分

你是否希望將來中學選修STEM相關的科目？* ☐ 是 ☐ 否

你對以下哪些與STEM相關的科目感興趣？（請選出不多於3個科目）*

☐ 生物 ☐ 化學 ☐ 物理 ☐ 資訊科技 ☐ 以上皆非

第九部分

你對STEM的世界觀, 請選出你對下列各題敘述內容的同意程度。*	十分同意	同意	不同意	十分不同意
我對中國的科研成就感到驕傲。	☐	☐	☐	☐
我對中國的經濟發展感到驕傲。	☐	☐	☐	☐
我對中華文化感到濃厚興趣。	☐	☐	☐	☐
我對中華人民共和國有歸屬感。	☐	☐	☐	☐
我對香港的科研成就感到驕傲。	☐	☐	☐	☐
我對香港的經濟發展感到驕傲。	☐	☐	☐	☐
我對香港文化感到濃厚興趣。	☐	☐	☐	☐
我對香港特別行政區有歸屬感。	☐	☐	☐	☐

我學習STEM原因是…*	十分同意	同意	不同意	十分不同意
迎合著重高科技的世界潮流。	☐	☐	☐	☐
為改善現今世界生活的不足。	☐	☐	☐	☐
為貢獻世界的可持續發展。	☐	☐	☐	☐
為國家富強出力。	☐	☐	☐	☐
為貢獻中國科技發展。	☐	☐	☐	☐
為貢獻中國經濟。	☐	☐	☐	☐
為了成為香港社會未來人才。	☐	☐	☐	☐
為貢獻香港經濟。	☐	☐	☐	☐
配合香港創新科技的需要。	☐	☐	☐	☐
迎合父母的選科要求。	☐	☐	☐	☐
迎合父母對我未來職業的要求。	☐	☐	☐	☐
為了獲得親戚朋友的認同。	☐	☐	☐	☐
滿足個人的好奇心和興趣。	☐	☐	☐	☐
為將來能選讀心儀科目。	☐	☐	☐	☐
裝備自己應付未來的工作。	☐	☐	☐	☐

第十部分

在你印象中，工作需使用STEM的人是：*	十分同意	同意	不同意	十分不同意
可以改變世界。	☐	☐	☐	☐
賺很多錢的。	☐	☐	☐	☐
從事讓人興奮/刺激的工作。	☐	☐	☐	☐
聰明的。	☐	☐	☐	☐
奇怪的。	☐	☐	☐	☐
受人尊敬的。	☐	☐	☐	☐
大部分時間都是自己工作的。	☐	☐	☐	☐
沒有太多其他興趣的。	☐	☐	☐	☐

第十一部分

我有想過當我長大後… *	十分同意	同意	不同意	十分不同意
會從事醫療工作(如護理、治療、製藥...)。	☐	☐	☐	☐
會從事科學工作(如化驗、營養科學、環境科學...)。	☐	☐	☐	☐
會從事工程工作(如土木工程、汽車工程、建築設計...)。	☐	☐	☐	☐
會從事需使用科技的工作(如軟件開發、多媒體設計、電腦系統管理...)。	☐	☐	☐	☐
會從事需使用數學的工作(如精算、會計、保險...)。	☐	☐	☐	☐
會從事STEM相關的工作(如產品設計、測量、環境監測..)。	☐	☐	☐	☐
會成為一個發明家。	☐	☐	☐	☐

以下是一些香港主要行業，你最想從事哪一行業？（只選一個）*

☐ 酒店／旅遊　☐ 貿易及物流專業服務　☐ 文化及創意

☐ 公共行政、社會及個人服務業　☐ 醫療　☐ 檢測及認證

☐ 金融服務　☐ 專業服務 (如法律、會計、建築及測量)　☐ 教育

☐ 創新科技　☐ 環保產業　☐ 其他

第十二部分

具體來說，當你長大後，你最想做的工作是（請用文字輸入，選擇填寫）

____

初中學生STEM教育調查

調查旨在了解你的看法，問題沒有既定答案。所提供的資料將會絕對保密，並以不記名方式處理。

STEM 指科學、科技、工程及數學知識及技巧的綜合和應用。

第一部分

班別*_____________ **出生年份***_____________ **性別*** ☐ 男 ☐ 女

出生地* ☐香港 ☐ 中國內地 ☐ 其他，請填寫_____________

如非香港出生，居港時間 ☐ 少於1 年 ☐ 1-3 年 ☐ 4-7年 ☐ 7年以上

家住哪區*

☐ 灣仔	☐ 東區	☐ 中西區	☐ 南區	☐ 觀塘
☐ 九龍城	☐ 黃大仙	☐ 旺角	☐ 深水埗	☐ 油尖
☐ 西貢	☐ 沙田	☐ 離島	☐ 荃灣	☐ 葵青
☐ 大埔	☐ 屯門	☐ 元朗	☐ 北區	☐ 內地

第二部分

參與閒暇活動的次數是…？*	約一星期一次	約一個月一次	約半年一次	約一年一次	從不
閱讀書籍或雜誌、觀看電影節目	☐	☐	☐	☐	☐
閱讀科學/科技/工程/數學/大自然的書籍、雜誌或觀看相關的電視節目	☐	☐	☐	☐	☐
瀏覽科學/科技/工程/數學相關的網頁	☐	☐	☐	☐	☐
去科學館/科學園/太空館/動物園/植物園/海洋公園/自然教育徑...等	☐	☐	☐	☐	☐
參觀展覽（如: 動漫展、書展、花卉展、電腦通訊節、創新科技展、家居博覽...等）	☐	☐	☐	☐	☐

玩手機/電腦的時間是多少？*	3小時或以上	約2小時	約1小時	少於30分鐘	從不
以每天計..	☐	☐	☐	☐	☐

第三部分

父母或監護人有否上大學？*（注意：只需回答父母或監護人）

父親 ☐ 有 ☐ 沒有 ☐ 不適用

母親 ☐ 有 ☐ 沒有 ☐ 不適用

監護人 ☐ 有 ☐ 沒有 ☐ 不適用

家裡有多少與科學/ 科技/ 工程/ 數學相關的書籍（課本及練習簿除外）*	多過50本	21-50本	10-20本	少過10本	沒有
例如十萬個為什麼、國家地理雜誌、Horrible science、科學怪人、科學人雜誌等...）？	☐	☐	☐	☐	☐

最常看的科學/ 科技/ 工程/ 數學相關書籍是... ______________________________

第四部分

哪項描述你父母（或監護人）的工作最為恰當？*（注意: 只需選回答父母或監護人）

父親	☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工） ☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理） ☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師） ☐ 從事文職的工作（如: 文員，秘書） ☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師） ☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技） ☐ 是主管或經理 ☐ 是商人 ☐ 是科學家 ☐ 在家中照顧家庭 ☐ 失業/退休 ☐ 我不知道 ☐ 不適用
母親	☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工） ☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理） ☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師） ☐ 從事文職的工作（如: 文員，秘書） ☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師） ☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技） ☐ 是主管或經理 ☐ 是商人 ☐ 是科學家 ☐ 在家中照顧家庭 ☐ 失業/退休 ☐ 我不知道 ☐ 不適用
監護人	☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工） ☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理） ☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師） ☐ 從事文職的工作（如: 文員，秘書） ☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師） ☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技）

- ☐ 是主管或經理
- ☐ 是商人
- ☐ 是科學家
- ☐ 在家中照顧家庭
- ☐ 失業/退休
- ☐ 我不知道
- ☐ 不適用

第五部分

有關父母對你學習情況的掌握或期望, 請選出你對下列各題敘述內容的同意程度。*	十分同意	同意	不同意	十分 不同意
我在學校盡力學習對父母來說很重要。	☐	☐	☐	☐
父母知道我在校內的情況。	☐	☐	☐	☐
父母會出席學校的家長活動。	☐	☐	☐	☐
我有好的學業成績對父母來說很重要。	☐	☐	☐	☐
父母會認為未能升讀大學是一件很失敗的事。	☐	☐	☐	☐
父母期望我將來找到一份賺很多錢的工作。	☐	☐	☐	☐
父母認為我長大後能實踐個人志願比賺很多錢重要。	☐	☐	☐	☐

第六部分

學校提供學習STEM的機會*	十分同意	同意	不同意	十分 不同意
學校在數學科有提供學習STEM的機會。	☐	☐	☐	☐
學校在科學科有提供學習STEM的機會。	☐	☐	☐	☐
學校在其他科目有提供學習STEM的機會。	☐	☐	☐	☐
在課堂以外時間，學校有提供學習STEM的機會。	☐	☐	☐	☐
我覺得學校不重視STEM。	☐	☐	☐	☐
我沒有足夠機會參與STEM學習。	☐	☐	☐	☐

你有否參與過STEM學習？* ☐ 有 ☐ 沒有

若曾有機會參與STEM 學習, 請回答以下各題

	十分同意	同意	不同意	十分 不同意
我不明白老師指導STEM的內容。	☐	☐	☐	☐

	十分同意	同意	不同意	十分 不同意
我在STEM的活動或課堂裡學習到有趣的事。	☐	☐	☐	☐
我覺得老師喜愛STEM。	☐	☐	☐	☐
我覺得老師缺乏STEM知識。	☐	☐	☐	☐
STEM的活動或課堂讓人很興奮。	☐	☐	☐	☐
我期待學習STEM的機會。	☐	☐	☐	☐

第七部分

有關你在STEM相關的學科學習的情況, 請選出你對下列各題敘述內容的同意程度。

數學*	十分同意	同意	不同意	十分 不同意
我覺得學習數學很困難。	☐	☐	☐	☐
我明白數學的大部分內容。	☐	☐	☐	☐
我就是不擅長數學。	☐	☐	☐	☐
我在數學的學習表現很好。	☐	☐	☐	☐

科學*	十分同意	同意	不同意	十分 不同意
我覺得學習科學很困難。	☐	☐	☐	☐
我明白科學的大部分內容。	☐	☐	☐	☐
我就是不擅長科學。	☐	☐	☐	☐
我在科學的學習表現很好。	☐	☐	☐	☐

第八部分

你是否希望將來高中選修STEM相關的科目？* ☐ 是 ☐ 否

你對以下哪些與STEM相關的科目感興趣？ (請選出不多於3個科目) *

☐ 生物　☐ 化學　☐ 物理

☐ 設計與應用科技　☐ 資訊及通訊科技　☐ 科學 : 綜合科學

☐ 科學 : 組合科學　☐ 科技與生活　☐ 應用學習科目　☐ 以上皆非

第九部分

你對STEM的世界觀, 請選出你對下列各題敘述內容的同意程度。*	十分同意	同意	不同意	十分不同意
我對中國的科研成就感到驕傲。	☐	☐	☐	☐
我對中國的經濟發展感到驕傲。	☐	☐	☐	☐
我對中華文化感到濃厚興趣。	☐	☐	☐	☐
我對中華人民共和國有歸屬感。	☐	☐	☐	☐
我對香港的科研成就感到驕傲。	☐	☐	☐	☐
我對香港的經濟發展感到驕傲。	☐	☐	☐	☐
我對香港文化感到濃厚興趣。	☐	☐	☐	☐
我對香港特別行政區有歸屬感。	☐	☐	☐	☐

我學習STEM原因是…*	十分同意	同意	不同意	十分不同意
迎合著重高科技的世界潮流。	☐	☐	☐	☐
為改善現今世界生活的不足。	☐	☐	☐	☐
為貢獻世界的可持續發展。	☐	☐	☐	☐
為國家富強出力。	☐	☐	☐	☐
為貢獻中國科技發展。	☐	☐	☐	☐
為貢獻中國經濟。	☐	☐	☐	☐
為了成為香港社會未來人才。	☐	☐	☐	☐
為貢獻香港經濟。	☐	☐	☐	☐
配合香港創新科技的需要。	☐	☐	☐	☐
迎合父母的選科要求。	☐	☐	☐	☐
迎合父母對我未來職業的要求。	☐	☐	☐	☐
為了獲得親戚朋友的認同。	☐	☐	☐	☐
滿足個人的好奇心和興趣。	☐	☐	☐	☐
為將來能選讀心儀科目。	☐	☐	☐	☐
裝備自己應付未來的工作。	☐	☐	☐	☐

第十部分

在你印象中，工作需使用STEM的人是：*	十分同意	同意	不同意	十分不同意
可以改變世界。	☐	☐	☐	☐
賺很多錢的。	☐	☐	☐	☐
從事讓人興奮/刺激的工作。	☐	☐	☐	☐
聰明的。	☐	☐	☐	☐
奇怪的。	☐	☐	☐	☐
受人尊敬的。	☐	☐	☐	☐
大部分時間都是自己工作的。	☐	☐	☐	☐
沒有太多其他興趣的。	☐	☐	☐	☐

第十一部分

我有想過當我長大後… *	十分同意	同意	不同意	十分不同意
會從事醫療工作(如護理、治療、製藥...)。	☐	☐	☐	☐
會從事科學工作(如化驗、營養科學、環境科學...)。	☐	☐	☐	☐
會從事工程工作(如土木工程、汽車工程、建築設計...)。	☐	☐	☐	☐
會從事需使用科技的工作(如軟件開發、多媒體設計、電腦系統管理...)。	☐	☐	☐	☐
會從事需使用數學的工作(如精算、會計、保險...)。	☐	☐	☐	☐
會從事STEM相關的工作(如產品設計、測量、環境監測..)。	☐	☐	☐	☐
會成為一個發明家。	☐	☐	☐	☐

以下是一些香港主要行業，你最想從事哪一行業？（只選一個）*

☐ 酒店／旅遊　☐ 貿易及物流專業服務　☐ 文化及創意

☐ 公共行政、社會及個人服務業　☐ 醫療　☐ 檢測及認證

☐ 金融服務　☐ 專業服務 (如法律、會計、建築及測量)　☐ 教育

☐ 創新科技　☐ 環保產業　☐ 其他

第十二部分

具體來說，當你長大後，你最想做的工作是（請用文字輸入，選擇填寫）

____

高中學生STEM教育調查

調查旨在了解你的看法，問題沒有既定答案。所提供的資料將會絕對保密，並以不記名方式處理。

STEM 指科學、科技、工程及數學知識及技巧的綜合和應用。

第一部分

班別*_____________ **出生年份***_____________ **性別*** ☐ 男 ☐ 女

出生地* ☐香港 ☐ 中國內地 ☐ 其他，請填寫_____________

如非香港出生，居港時間 ☐ 少於1 年 ☐ 1-3 年 ☐ 4-7年 ☐ 7年以上

家住哪區*

☐ 灣仔	☐ 東區	☐ 中西區	☐ 南區	☐ 觀塘
☐ 九龍城	☐ 黃大仙	☐ 旺角	☐ 深水埗	☐ 油尖
☐ 西貢	☐ 沙田	☐ 離島	☐ 荃灣	☐ 葵青
☐ 大埔	☐ 屯門	☐ 元朗	☐ 北區	☐ 內地

你有否選修下列科目？如有，請選出。

選修科目一： ☐ 物理 ☐ 化學 ☐ 生物 ☐ 數學科伸延部分

選修科目二： ☐ 物理 ☐ 化學 ☐ 生物 ☐ 數學科伸延部分

選修科目三： ☐ 物理 ☐ 化學 ☐ 生物 ☐ 數學科伸延部分

第二部分

參與閒暇活動的次數是…？*	約一星期一次	約一個月一次	約半年一次	約一年一次	從不
閱讀書籍或雜誌、觀看電影節目	☐	☐	☐	☐	☐
閱讀科學/科技/工程/數學/大自然的書籍、雜誌或觀看相關的電視節目	☐	☐	☐	☐	☐
瀏覽科學/科技/工程/數學相關的網頁	☐	☐	☐	☐	☐
去科學館/科學園/太空館/動物園/植物園/海洋公園/自然教育徑...等	☐	☐	☐	☐	☐
參觀展覽（如: 動漫展、書展、花卉展、電腦通訊節、創新科技展、家居博覽...等）	☐	☐	☐	☐	☐

玩手機/電腦的時間是多少？*	3小時或以上	約2小時	約1小時	少於30分鐘	從不
以每天計..	☐	☐	☐	☐	☐

第三部分

父母或監護人有否上大學？*（注意：只需回答父母或監護人）

父親 ☐ 有 ☐ 沒有 ☐ 不適用

母親 ☐ 有 ☐ 沒有 ☐ 不適用

監護人 ☐ 有 ☐ 沒有 ☐ 不適用

家裡有多少與科學/ 科技/ 工程/ 數學相關的書籍（課本及練習簿除外）*	多過 50本	21-50本	10-20本	少過 10本	沒有
例如十萬個為什麼、國家地理雜誌、人體的奧秘、科學人、牛頓 Newton 雜誌等...）？	☐	☐	☐	☐	☐

最常看的科學/ 科技/ 工程/ 數學相關書籍是... ____

第四部分

哪項描述你父母（或監護人）的工作最為恰當？*（注意: 只需選回答父母或監護人）

父親

☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工）
☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理）
☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師）
☐ 從事文職的工作（如: 文員，秘書）
☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師）
☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技）
☐ 是主管或經理
☐ 是商人
☐ 是科學家
☐ 在家中照顧家庭
☐ 失業/退休
☐ 我不知道
☐ 不適用

母親

☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工）
☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理）
☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師）
☐ 從事文職的工作（如: 文員，秘書）
☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師）
☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技）
☐ 是主管或經理
☐ 是商人
☐ 是科學家
☐ 在家中照顧家庭
☐ 失業/退休

☐ 我不知道
☐ 不適用

監護人

☐ 從事不需學歷的工作（如: 清潔工人，洗碗工人，雜工）
☐ 從事客戶服務工作（如: 接聽電話，銷售工作，餐廳侍應，物業管理）
☐ 從事照顧人的工作（如: 幼兒工作者，看護，理髮師，美容師）
☐ 從事文職的工作（如: 文員，秘書）
☐ 從事技術性的工作（如: 水管工，電工，建築工，機械修工，司機，廚師）
☐ 從事專業工作（如: 醫生，律師，教師，會計師，護士，治療師，銀行家，資訊科技）
☐ 是主管或經理
☐ 是商人
☐ 是科學家
☐ 在家中照顧家庭
☐ 失業/退休
☐ 我不知道
☐ 不適用

第五部分

有關父母對你學習情況的掌握或期望, 請選出你對下列各題敘述內容的同意程度。*	十分同意	同意	不同意	十分 不同意
我在學校盡力學習對父母來說很重要。	☐	☐	☐	☐
父母知道我在校內的情況。	☐	☐	☐	☐
父母會出席學校的家長活動。	☐	☐	☐	☐
我有好的學業成績對父母來說很重要。	☐	☐	☐	☐
父母會認為未能升讀大學是一件很失敗的事。	☐	☐	☐	☐
父母期望我將來找到一份賺很多錢的工作。	☐	☐	☐	☐
父母認為我長大後能實踐個人志願比賺很多錢重要。	☐	☐	☐	☐

第六部分

學校提供學習STEM的機會*	十分同意	同意	不同意	十分 不同意
學校在數學科有提供學習STEM的機會。	☐	☐	☐	☐
學校在通識教育有提供學習STEM的機會。	☐	☐	☐	☐
學校在選修科目有提供學習STEM的機會。	☐	☐	☐	☐
在課堂以外時間，學校有提供學習STEM的機會。	☐	☐	☐	☐
我覺得學校不重視STEM。	☐	☐	☐	☐
我沒有足夠機會參與STEM學習。	☐	☐	☐	☐

若曾有機會參與STEM 學習, 請回答以下各題	十分同意	同意	不同意	十分不同意
我不明白老師指導STEM的內容。	☐	☐	☐	☐
我在STEM的活動或課堂裡學習到有趣的事。	☐	☐	☐	☐
我覺得老師喜愛STEM。	☐	☐	☐	☐
我覺得老師缺乏STEM知識。	☐	☐	☐	☐
STEM的活動或課堂讓人很興奮。	☐	☐	☐	☐
我期待學習STEM的機會。	☐	☐	☐	☐

第七部分

有關你在STEM相關的學科學習的情況, 請選出你對下列各題敘述內容的同意程度。

數學*	十分同意	同意	不同意	十分不同意
我覺得學習數學很困難。	☐	☐	☐	☐
我明白數學的大部分內容。	☐	☐	☐	☐
我就是不擅長數學。	☐	☐	☐	☐
我在數學的學習表現很好。	☐	☐	☐	☐

生物	十分同意	同意	不同意	十分不同意
我覺得學習生物很困難。	☐	☐	☐	☐
我明白生物的大部分內容。	☐	☐	☐	☐
我就是不擅長生物。	☐	☐	☐	☐
我在生物的學習表現很好。	☐	☐	☐	☐

物理	十分同意	同意	不同意	十分不同意
我覺得學習物理很困難。	☐	☐	☐	☐
我明白物理的大部分內容。	☐	☐	☐	☐
我就是不擅長物理。	☐	☐	☐	☐
我在物理的學習表現很好。	☐	☐	☐	☐

化學	十分同意	同意	不同意	十分不同意
我覺得學習化學很困難。	☐	☐	☐	☐
我明白化學的大部分內容。	☐	☐	☐	☐
我就是不擅長化學。	☐	☐	☐	☐
我在化學的學習表現很好。	☐	☐	☐	☐

數學科延伸部分	十分同意	同意	不同意	十分不同意
我覺得學習數學科延伸部分很困難。	☐	☐	☐	☐
我明白數學科延伸部分的大部分內容。	☐	☐	☐	☐
我就是不擅長數學科延伸部分。	☐	☐	☐	☐
我在數學科延伸部分的學習表現很好。	☐	☐	☐	☐

第八部分

你最希望將來在大學選修的科目是…*

☐ 物理

☐ 化學

☐ 生物

☐ 數學

☐ 其他科學（如：天文學、生命科學、地球科學等）

☐ 設計與資訊科技（如：電腦、多媒體設計、數碼圖像傳意、電子等）

☐ 法律

☐ 語文

☐ 工程及生產（如：屋宇設備、土木、建築等）

☐ 應用科學（如：醫學、動物護理、健康科學等）

☐ 酒店及旅遊

☐ 社會科學（如：歷史、地理、心理等）

☐ 人文學科和藝術（如：文學、宗教、藝術、音樂等）

☐ 商科（如：經濟、會計、金融等）

☐ 教育

☐ 其他

第九部分

你對STEM的世界觀, 請選出你對下列各題敘述內容的同意程度。*

	十分同意	同意	不同意	十分不同意
我對中國的科研成就感到驕傲。	☐	☐	☐	☐
我對中國的經濟發展感到驕傲。	☐	☐	☐	☐
我對中華文化感到濃厚興趣。	☐	☐	☐	☐
我對中華人民共和國有歸屬感。	☐	☐	☐	☐

	十分同意	同意	不同意	十分不同意
我對香港的科研成就感到驕傲。	☐	☐	☐	☐
我對香港的經濟發展感到驕傲。	☐	☐	☐	☐
我對香港文化感到濃厚興趣。	☐	☐	☐	☐
我對香港特別行政區有歸屬感。	☐	☐	☐	☐

我學習STEM原因是…*	十分同意	同意	不同意	十分不同意
迎合著重高科技的世界潮流。	☐	☐	☐	☐
為改善現今世界生活的不足。	☐	☐	☐	☐
為貢獻世界的可持續發展。	☐	☐	☐	☐
為國家富強出力。	☐	☐	☐	☐
為貢獻中國科技發展。	☐	☐	☐	☐
為貢獻中國經濟。	☐	☐	☐	☐
為了成為香港社會未來人才。	☐	☐	☐	☐
為貢獻香港經濟。	☐	☐	☐	☐
配合香港創新科技的需要。	☐	☐	☐	☐
迎合父母的選科要求。	☐	☐	☐	☐
迎合父母對我未來職業的要求。	☐	☐	☐	☐
為了獲得親戚朋友的認同。	☐	☐	☐	☐
滿足個人的好奇心和興趣。	☐	☐	☐	☐
為將來能選讀心儀科目。	☐	☐	☐	☐
裝備自己應付未來的工作。	☐	☐	☐	☐

第十部分

在你印象中，工作需使用STEM的人是：*

	十分同意	同意	不同意	十分不同意
可以改變世界。	☐	☐	☐	☐
賺很多錢的。	☐	☐	☐	☐
從事讓人興奮/刺激的工作。	☐	☐	☐	☐
聰明的。	☐	☐	☐	☐

	十分同意	同意	不同意	十分不同意
奇怪的。	☐	☐	☐	☐
受人尊敬的。	☐	☐	☐	☐
大部分時間都是自己工作的。	☐	☐	☐	☐
沒有太多其他興趣的。	☐	☐	☐	☐

第十一部分

我有想過當我長大後⋯ *	十分同意	同意	不同意	十分不同意
會從事醫療工作(如護理、治療、製藥...)。	☐	☐	☐	☐
會從事科學工作(如化驗、營養科學、環境科學...)。	☐	☐	☐	☐
會從事工程工作(如土木工程、汽車工程、建築設計...)。	☐	☐	☐	☐
會從事需使用科技的工作(如軟件開發、多媒體設計、電腦系統管理...)。	☐	☐	☐	☐
會從事需使用數學的工作(如精算、會計、保險...)。	☐	☐	☐	☐
會從事STEM相關的工作(如產品設計、測量、環境監測..)。	☐	☐	☐	☐
會成為一個發明家。	☐	☐	☐	☐

以下是一些香港主要行業，你最想從事哪一行業？（只選一個）*

☐ 酒店／旅遊	☐ 貿易及物流專業服務	☐ 文化及創意
☐ 公共行政、社會及個人服務業	☐ 醫療	☐ 檢測及認證
☐ 金融服務	☐ 專業服務 (如法律、會計、建築及測量)	☐ 教育
☐ 創新科技	☐ 環保產業	☐ 其他

第十二部分

具體來說，當你長大後，你最想做的工作是（請用文字輸入，選擇填寫）

____

Appendix C: Interview Questions for Students, Parents and Teachers

香港學生對 STEM 抱負的挑戰與機遇 – 小學生

您好，我們是來自香港教育大學科學與環境學系的研究人員，感謝您參與是次訪談。

訪談旨在了解您對 STEM 教育的看法，問題沒有既定答案。所提供的資料將會絕對保密，並以不記名方式處理。以下訪談將會被錄音以作記錄。

STEM 指科學、科技、工程及數學知識及技巧的綜合和應用。

以下訪談有 6 個部分：

1. **STEM 的自我認同及自我效能的建立**

- 您在以下 STEM 相關學科的學習情況 (例如：喜歡? 明白? 困難? 擅長? 表現如何?)
  - 數學、常識（科學相關單元）

2. **在校外及校內 STEM 的學習經驗及看法**

- 對以下的<u>校外</u> STEM 相關學習/活動有沒有興趣？請舉例。
  - 閱讀書籍或雜誌
  - 觀看電影節目
  - 瀏覽科學/科技/工程/數學相關的網頁
  - 科學館/科學園/太空館/動物園/植物園/海洋公園/自然教育徑
  - 參觀展覽(如: 動漫展、書展、花卉展、電腦通訊節、創新科技展、家居博覽
- **您會否希望參加更多以上哪一類活動？**
- 對以下的<u>校內</u>的 STEM 相關學習/活動的看法？請舉例。
  - <u>課堂內</u>的 STEM 學習/活動
    （有沒有興趣？足夠嗎？由老師指導或是自己做？）
  - 老師指導的 STEM 學習/活動
    （覺得老師有沒有熱誠？老師有沒有相關知識？）
  - <u>課堂外</u>的 STEM 學習/活動 （如課後興趣小組）
    （有沒有興趣？足夠嗎？由學校老師還是校外人員指導？）
  - 學校重視 STEM 嗎？
  - 期待未來有更多 STEM 學習機會嗎？

3. **對 STEM 抱負的發展**

- 你學習 STEM **是否**因為以下因素？請分別說明。
  - 為世界 （如為改善現今世界生活的不足、迎合著重高科技的世界潮流、為貢獻世界的可持續發展等）
  - 為國家（如為國家富強出力、為貢獻中國科技發展、為貢獻中國經濟等）
  - 為香港社會（如為了成為香港社會未來人才、為貢獻香港經濟、配合香港創新科技的需要等）
  - 為家庭及朋友（如迎合父母的選科要求、迎合父母對我未來職業的要求、為了獲得親戚朋友的認同等）
  - 個人理想（如滿足個人的好奇心和興趣、為將來能選讀心儀科目、裝備自己應付未來的工作等）

4. **你對 STEM 專業人士的印象**

- 在你印象中，工作需使用 STEM 的人怎樣的

5. **將來中學選修的科目**

- 對以下哪些與 STEM 相關的科目感興趣？請說明
  生物 / 化學 / 物理 / 資訊科技 / 數學 / 其他

6. **未來的職業選擇**

- 你未來選擇職業的要素是什麼？
- 你希望長大後從事哪個職業？

香港學生對 STEM 抱負的挑戰與機遇 – 初中生

您好，我們是來自香港教育大學科學與環境學系的研究人員，感謝您參與是次訪談。
訪談旨在了解您對 STEM 教育的看法，問題沒有既定答案。所提供的資料將會絕對保密，並以不記名方式處理。以下訪談將會被錄音以作記錄。
STEM 指科學、科技、工程及數學知識及技巧的綜合和應用。
以下訪談有 6 個部分：

1. **STEM 的自我認同及自我效能的建立**

- 您在以下 STEM 相關學科的學習情況 (例如：喜歡? 明白? 困難? 擅長? 表現如何?)
  - 數學、科學

2. **在校外及校內 STEM 的學習經驗及看法**

- 對以下的校外 STEM 相關學習/活動有沒有興趣？請舉例。
  - 閱讀書籍或雜誌
  - 觀看電影節目
  - 瀏覽科學/科技/工程/數學相關的網頁
  - 科學館/科學園/太空館/動物園/植物園/海洋公園/自然教育徑
  - 參觀展覽(如: 動漫展、書展、花卉展、電腦通訊節、創新科技展、家居博覽
- **您會否希望參加更多以上哪一類活動？**
- 對以下的校內的 STEM 相關學習/活動的看法？請舉例。
  - 課堂內的 STEM 學習/活動
    （有沒有興趣？足夠嗎？由老師指導或是自己做？）
  - 老師指導的 STEM 學習/活動
    （覺得老師有沒有熱誠？老師有沒有相關知識？）
  - 課堂外的 STEM 學習/活動 （如課後興趣小組）
    （有沒有興趣？足夠嗎？由學校老師還是校外人員指導？）
  - 學校重視 STEM 嗎？
  - 期待未來有更多 STEM 學習機會嗎？

3. **對 STEM 抱負的發展**

- 你學習 STEM **是否**因為以下因素？請分別說明。
  - 為世界 （如為改善現今世界生活的不足、迎合著重高科技的世界潮流、為貢獻世界的可持續發展等）
  - 為國家（如為國家富強出力、為貢獻中國科技發展、為貢獻中國經濟等）
  - 為香港社會（如為了成為香港社會未來人才、為貢獻香港經濟、配合香港創新科技的需要等）
  - 為家庭及朋友（如迎合父母的選科要求、迎合父母對我未來職業的要求、為了獲得親戚朋友的認同等）
  - 個人理想（如滿足個人的好奇心和興趣、為將來能選讀心儀科目、裝備自己應付未來的工作等）

4. **你對 STEM 專業人士的印象**

- 在你印象中，工作需使用 STEM 的人怎樣的

5. **將來中學選修的科目**

- 對以下哪些與 STEM 相關的科目感興趣？請說明
  生物 / 化學 / 物理 /資訊及通訊科技 /科學：組合科學/ 其他

6. **未來的職業選擇**

- 你未來選擇職業的要素是什麼？
- 你希望長大後從事哪個職業？

香港學生對 STEM 抱負的挑戰與機遇 – 高中生

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- 在你印象中，工作需使用 STEM 的人怎樣的

5. **將來大學選修的科目**

- 對以下哪些與 STEM 相關的科目感興趣？請說明
  生物 / 化學 / 物理 /其他

6. **未來的職業選擇**

- 你未來選擇職業的要素是什麼？
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以下訪談有 7 個部分：

1. **你的教學背景**
   a. 你任教的科目？
   b. 任教初中還是高中？
   c. 教學年資
   d. 有什麼 STEM 教學的經驗（如設計校內的 STEM 活動）
2. **學生的 STEM 自我認同**
   - 學生在您任教科目中的學習情況 (例如：明白? 困難? 擅長? 表現如何?)
3. **學生的校內及校外 STEM 學習經驗**
   - 您的學生對校內的 STEM 學習/活動的看法
     - 請舉例有什麼活動
     - 學生有沒有興趣？
   - 您會否建議學生參加更多校外 STEM 活動（如參觀 STEM 相關展覽、科學館/科學園/太空館/動物園、閱讀 STEM 書籍等）？為什麼？
4. **您對校內的 STEM 學習活動的看法，請舉例：**
   - 您認為學校重視 STEM 嗎？
   - 校內的 STEM 學習活動是否由老師設計 / 準備？
   - 您認為現時的校內 STEM 學習活動足夠嗎？
   - 您認為在校內推動 STEM 教育有什麼困難？
   - 您認為校內 STEM 的學習活動有沒有使更多學生對 STEM 有興趣，甚至有 STEM 抱負
   - 校內現時有沒有向學生介紹 STEM 職業的活動？（例如高中學生的職業導向活動等）為什麼？
5. **您的學生對 STEM 專業人士的印象**
   - 您認為提高學生對 STEM 專業人士的印象可以如何幫助他們的：
     - 對 STEM 職業的認識
     - STEM 抱負
     - 在 STEM 科目上的自我認同/ 自信
6. **您的學生在升高中以及升讀大學選修科目的情況**
   - 以您所知，學生在升高中（中四）時選修 STEM 相關科目的情況如何？
     - 哪一科 STEM 相關科目**最多** & **最少**學生選修，你認為有什麼原因？
     - 男女生選修 STEM 相關科目比例？
   - 以您所知，學生在升大學時選修 STEM 相關科目的情況如何？
     - 整體來說於高中選修 STEM 相關科目的學生，會否選修大學 STEM 相關科目？
     - 男女生選修 STEM 相關科目比例？
7. **您的學生未來的職業選擇**
   - 您認為學生未來選擇職業的要素是什麼？

Appendix D: A Summary with Interview Transcriptions

STEM Subject Choices

Most of the interviewees showed their interest in STEM and said they were willing to choose science related subjects such as biology, chemistry or physics in their future study.

一位小學女生表示，因為我從小的志願就是當醫生，所以我想中學的時候選擇生物、化學或物理科目。我期待通過未來學習化學及生物的知識，了解其他生物與人類的不同。同時我也很喜歡做實驗，覺得做實驗應該很有趣，不會那麼悶。(Student 5)

一位初中男生表示，我想高中選擇物理和化學科。一方面是因為自己對這兩個科目很有興趣。為了將來的職業方向，物理工程，所以想選擇這兩個科目；另一方面我覺得這兩個科目很重要，也希望未來可以設計東西幫助殘障人士有更好的生活。(Student 7)

一位高中男生表示，目前對未來要選的科目沒有什麼概念，想再讀多一段時間，根據自己的成績和興趣再決定。(Student 8)

Reasons to Study STEM

All the students being interviewed claimed that their parents respected their own opinions. The answers from the parents also support that the parents did not make the students study STEM.

In addition, the students reported that learning STEM was simply because of their curiosity and personal interests. Social reasons, such as society, national and global reasons meant too many responsibilities and were not their primary reasons to study STEM. However, the students were still willing to help Hong Kong people in the future through their study of STEM.

一位初中男生表示，家人對我的能力程度很了解，也知道我要如何發展。他們沒有強迫我去學習 STEM，給了我很多自由。學習 STEM 主要是我自己的個人興趣。(Student 8)

一位小學女生家長表示，我們從來不會強求她去學習 STEM。我們只是希望她可以多學一些知識，更好地了解世界。不會特地要求她學什麼科目，也不會硬性限制。我們會讓她自由發展。我覺得她為了家庭要求的因素才學習 STEM 的幾率很小，幾乎為 0。(Parent 5)

一位小學男生表示，我未來想當醫生，所以希望可以通過學習 STEM 知識貢獻香港，成為人才為香港出一分力。不過我沒有想過要為了香港社會的原因學習 STEM。(Student 6)

一位高中男生表示，我是因為個人興趣學習 STEM 的，世界和國家的層面太大了，我可能沒有那麼大的實力和能力去改變國家和世界。(Student 8)

一位小學女生表示，雖然我不是為了成為香港人才而學習 STEM，但是如果可以用 STEM 知識為香港作出貢獻也是好的。(Student 5)

STEM Career Aspirations

Most of the interviewees expressed their interest in pursuing STEM-related jobs in the future, such as doctors, architects, researchers, etc.

一位小學女生表示，我未來首選要當醫生。不過也要視乎上中學後各個科目表現如何。現階段很難很清楚地知道以後哪些方面比較擅長。(Student 5)

一位高中男生表示，未來我想做建築師或設計師，因為我很喜歡現在學的室內設計。我對這個科目很有興趣，通過對它的學習，讓我的未來發展方向更加明確。(Student 9)

一位初中男生表示，未來想做研究人員服務人類，幫助到真正有需要的人，讓他們可以有更好的生活。(Student 7)

Image of STEM Professionals

Some of the students being interviewed mentioned that STEM professionals were 'smart people', they were 'innovative' and can 'invent new materials to help people', but 'may not make lots of money'. However, some of the interviewees also considered that STEM professionals were like ordinary people, but they were just specialized in particular areas.

一位小學女生稱，STEM 專業人士對 STEM 知識有非常深入的認知。他們好勁，很有創意，可以用 STEM 專業知識去做平時難以想像的事情。例如，科學家發明了很多高科技的東西，為我們的生活帶來便利。(Student 5)

一位初中男生表示，STEM 專業人士很聰明，他們對專業知識有很深入的了解，很創新，可以設計不同的工具，幫到其他人，為地球帶來更好的未來。(Student 7)

同時有幾位學生均表示，STEM 專業人士很細心很謹慎，他們很注重我們平常生活中的細節。例如數學中的一個小錯誤就會影響最終結果或者令系統癱瘓。(Student 7, 8, 9, 10)

一位高中男生家長表示，STEM 專業人士跟普通人一樣。STEM 是大範疇的東西。每個人的專長都不同。不同類型的人都專門研究各自範疇的領域，在相關領域有專業的知識。(Parent 10)

Self-efficacy in Science-related Learning

Most of the students being interviewed reported that they could generally master the knowledge of science-related subjects. Some teachers claimed that students from lower levels may find it more difficult to master science-related subjects than higher level students because they lacked STEM-related experience. However, as there were no cross-subject projects carried out, students might not have a strong overall sense of STEM.

一位年資三年的電腦科初中老師表示，大部分學生平時都有接觸過相關電腦科目，所以基本上都可以掌握到這些知識。部分同學由於對 STEM 科目有興趣，平時自己會特別留意學習，所以會覺得很容易很擅長學習 STEM。(Teacher 3)

一位小學女生表示，我喜歡常識科。視乎課題內容，如機械或關於原理的課題我會覺得比較有興趣。我在常識科目表現不錯。(Student 5)

一位初中男生稱，我很小的時候每天都想問為什麼，從小到大都愛看科學書。這是我的興趣所以我很鐘意科學科目。我明白老師上課講的知識，不覺得難。其中化學和工程是我最擅長的科目，平時表現都不錯。(Student 7)

一位高中男生稱，我鍾意科學。平時老師上課講的知識也能掌握。物理比較複雜，concept 清晰的時候我就知道怎麼去做，但是 concept 不清晰的時候就不是很懂。較其他科目，我比較擅長科學，表現也不錯。通過學習科學知識，運用科技設計可以拓展思維想法，解決生活難題。(Student 9)

一位初中老師稱，一部分同學會覺得科學有較多困難，所以學校有從外面請一些工程師專門過來指導學生。一些低齡學生即使有參加過比賽，他們沒有接觸過 programming language，所以會覺得很難。其實科目知識不難，只不過低年級學生平時很難接觸到這些內容，經驗比較少。不過初中生和高中生因為以前做過 coding，經驗比較成熟，所以較容易上手。現在，

學校基本是分開 STEM 科目來教學生，很少有 cross-subject 的 project 給學生去做 ，所以學生對 STEM 整體認同感不強，也未必會使用 STEM cross-subject 的工具。(Teacher 1)

Self-efficacy in Mathematics Learning

Senior primary school students being interviewed generally reported that mathematics was not difficult, they liked it and they considered that their performance was good. However, secondary school students claimed that mathematics learning in the secondary school stage was getting more difficult than it was in the primary school stage. Mathematics was fun, but it was also difficult to study.

一位小學女生稱，平時老師講課我都很明白。算是頗喜歡數學，因為學習數學經常有思考的機會，雖然有難度挑戰，不過當我解答完難題也會有滿足感，覺得很開心。但有些複雜或要寫很多文字的題目，我會覺得難，但通常聽完老師的講解，我就會明白其中的原理和計算過程。 (Student 5)

一位初中男生表示，我好鍾意數學。上課的時候，老師會講解得很清楚，我也明白上課的內容。但是如果有需要思維轉彎的時候，我就不是很清晰。中學數學的難度比小學難很多，我開始不是很習慣。我覺得自己沒有那麼擅長，平時考試 65-70 分左右。不過功課上有不會的問題我會請教老師。(Student 8)

一位高中男生表示，我鍾意數學。因為鍾意所以現在有選修數學延伸科。老師上課講得很清晰明白，所以很容易理解數學課堂上講的內容。我也很喜歡解答難題把答案找出來。困難一定是有的，但是老師答疑的時候，會用輕鬆容易理解的方式列出來答案，讓我們容易理解。我覺得自己數學表現一般，還要努力。(Student 10)

一位初中老師表示，大部分學生通過對書本的閱讀，對 STEM 有一定的了解及知識基礎。80%的學生會抽出 10%-15% 的課後時間培養自己的興趣。例如一些學生會參加學校的數學 STEM 活動。大部分同學掌握的還是不錯的，不過有些難理解的知識，有部分同學就會覺得有些困難。(Teacher 1)

Informal STEM Learning

All the students being interviewed claimed that they had visited all the museums and exhibitions that were mentioned on the interview question sheet, such as science museum, Science Park, space museum, animation exhibition and books fair. They were very interested in joining these informal STEM activities. However, there were also secondary students who reported that some of the facilities in the museums were tiring and it was difficult to attract the students to visit now.

一位小學女生表示，這些課外活動我都有去過。我非常喜歡有關科學的展覽，有空就會常去。有一些活動是學校帶著我去的，有一些是家長帶著我去的。不過也要視乎我的父母有空與否。(Student 6)

一位小學男生表示，我很喜歡去博物館、科學館和太空館。因為有很多新穎的東西可以看，還可以親身試做，不會覺得悶。(Student 5)

一位高中男生稱，這些博物館和展覽我都有去過，也有興趣。小學的時候我就有去參觀過很多次了。不過館內一些設施比較舊，能看的東西都差不多，而且以前也去過很多次了。自己小時候覺得很新奇，會有很大興趣想去玩，但是現在這些展館比較難吸引我去參觀了。(Student 10)

STEM-related Reading

Senior primary school students being interviewed preferred reading books which contained lots of pictures and watching STEM-related television programmes. Most of the senior primary school students did not know the method to search for STEM knowledge online to solve their questions, whereas the secondary school students being interviewed reported that they preferred watching YouTube videos to explore more information about STEM.

一位小學男生表示，我很有興趣看書和雜誌，平時我都會看一些，譬如：兒童的科學，科學發明王和兒童的學習。我還很喜歡看一些科學漫畫書。因為這一類書不是純文字的形式，裡面有很多圖片，所以不會覺得悶，還可以學到知識。我有看創新科技電視節目(不太記得節目名) ，電視裡介紹了飛行的車及當中原理。我比較少看 STEM 網頁，不知道怎麼找有確實性的網頁來解答我的問題。(Student 6)

一位高中男生稱，我有興趣看書，但是不是每天都會看。平時有看 STEM 實驗的電視節目，例如介紹科技、物聯網、大數據在中國的應用等等。但是目前電視節目種類比較少，所以我看的也比較少。我比較喜歡上網看 YouTube，例如上課聽不懂的知識點，我就會用 YouTube 搜索相關講解數學和物理的知識視頻。因為我對拆機器人非常感興趣，我也會搜索關於製作機器人的視頻。(Student 8)

Opportunities for STEM Education in School

All the interviewees reported that their schools attached great importance to STEM. For example, the teachers encouraged and helped the students to participate in more outside class competitions and more STEM classrooms were set up with advanced equipment.

一位教學年資 11 年的初中數學老師稱，學校管理層很重視 STEM，也願意投入資金發展 STEM 項目, 推進 STEM 的學習活動。近兩年來，學校開始設立 STEM Room 課室，也陸續擺放一些設備進去。 我會設計課程內容，也會輔導學生的數學比賽。另外我們還有一些課外活動，例如，會帶學生參與一些校外比賽。我們也有請外面的電子工程師和機構來幫助學生解決比賽技術難題，例如用微型電腦教學生做 Python。不過學校的配套硬件和教學空間裝修等都在加強中。(Teacher 1)

一位小學男生稱，我對課堂內的 STEM 學習活動很有興趣。因為這些課堂活動不只是講課，還需要動手做，所以不會很無聊。我也有參加一些比賽，所以我覺得學校提供的 STEM 機會尚算足夠。不過對於沒有參加過 STEM 小組的同學，可能覺得 STEM 的學習機會不太足夠。 (Student 6)

Quality of STEM Education in School

As revealed in the in-depth interviews, all the students reported that their teachers were very professional with rich knowledge, enthusiasm and dedication. The answers by parents also support this view. They indicated that the students understood the content of knowledge, the teachers were very responsible and enthusiastic and their children were greatly helped and encouraged by the teachers.

一位小學女生表示，我能感覺到老師很喜歡 STEM。例如編程老師很努力地為我們講解知識，與我們一起解決問題。他們有非常專業的知識。不過有時候如果遇到有些很複雜的問題，他們也會跟其他幾位老師一起討論，之後再向我們分享意見。(Student 5)

一位初中男生表示，學校會幫助我們報名參與 STEM 比賽，老師也會積極幫助我們報名查詢這一方面的信息。老師非常專業。例如，編程老師會提前將一些程式寫好再給我們看。他們

寫出來的編程都是完美無瑕疵的。每次我們向老師請教 STEM 相關問題，他們都會講解很久。 (Student 8)

一位高中男生表示，老師真心希望我們未來可以運用到這些 STEM 知識。例如他們會提前花很多時間，選好容易上手方便製作的機器人，再拿到課堂上讓我們製作，課後還會解決我們的雜難問題。(Student 10)

一位初中女生家長表示，老師很負責任，投入了很多時間。有時候即使不是他們教授的課程，他們也願意抽時間幫助學生，還經常鼓勵他們。不過我不知道老師是否非常專業，應該是有相關的專業知識和證書吧。(Parent 5)

Perceptions of Parental Expectations

Some parents being interviewed claimed that they knew a lot about their children's performance in school and they also participated in the schools' parental activities. Most of the parents reported that they hope their children can pursue a career based on personal interests rather than on money.

一位小學女生家長稱，她上課有動手製作吸塵機、車和船。她覺得很好玩也有興趣，因為始終不是對著書本，需要動手。女孩子喜歡動手、做手工，比如用石膏粉去做模型。學校有 STEM 活動開放日，我也有去參觀過，當時看到老師示範指導學生。我希望她可以按照她的性格，從事她有興趣的職業，例如醫學或工程類的工作。(Parent 1)

一位小學生家長表示，小朋友對校內的 STEM 活動很有興趣。基本上一有機會就會去參加。他有參加過一些比賽，比如用吸管做三角塔。STEM 活動是由老師指導的。因為他很喜歡，所以不會覺得現有的 STEM 活動機會足夠，當然希望越多越好。他非常喜歡太空的知識，所以我希望他可以未來從事 NASA 工程師這樣的工作。工作是否賺錢不是最重要。(Parent 4)

一位小學男生家長表示，小朋友期待未來有更多 STEM 的學習機會。他未來的職業發展是根據自己的興趣選擇，是否賺錢並不重要，主要要看他的能力如何。(Parent 5)

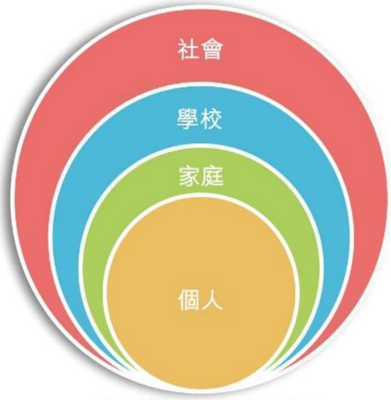
Appendix E: Newsletter Distributed

公共政策研究資助計劃 (Public Policy Research Funding Scheme)
—由香港特別行政區政府政策創新與統籌辦事處資助
香港學生對科學、科技、工程及數學的抱負的挑戰與機遇

蘇詠梅教授 教大科學與環境學系
趙永佳教授 教大社會科學學系

自2015年施政報告提出STEM（科學、科技、工程和數學）教育後，政府制定了各種STEM教育策略，各持份者亦紛紛提出不同形式的STEM教育活動，坊間亦有不少關於STEM教育的調查研究。然而這些研究結果未能有助全面了解現時香港學生於學習STEM的能力和態度，以及學校、家長和社會等因素對學生參與STEM教育及其成就的關係。

本研究為多了解青少年的職業偏好，提供相關資料促進STEM專才培育，以提升香港的競爭力，並審視現時STEM教育策略，以更有效推動STEM教育。由於並非單一因素影響學生的STEM學習，本研究旨在透過橫斷面方法去了解高小，初中及高中生對於STEM的抱負和看法，以及當中影響他們學習STEM的因素（圖1）。研究主要參照英國一項對於青年人的科學抱負的研究為設計藍本[1]，並參考聯合國教科文組織協會2017年一份研究報告中提到的STEM系統概念[2]。問卷包括十一部分（圖2），讓學生在網上回應，方便收集數據。另安排訪談，進一步了解學生的回應，及其父母的想法。



▲ 圖1. 影響學生STEM抱負的因素

研究將探討多種因素對學生的STEM學習及其抱負的影響：

個人因素：學生性別、出生地、對STEM學習表現的自我認知和自我效能、學生在STEM中的參與程度、是否決定學習STEM以及對STEM的抱負和職業偏好。

家庭因素：父母的教育和職業背景、父母對學生在STEM學習的期望度以及學生參與課外活動和興趣小組。

學校因素：學校STEM學習機會的提供、教學質素、教師教學經驗和專業知識。

社會因素：社會文化，學生是否因為社會或國家層面的原因如，科研成就、經濟發展、對文化的興趣以及社會歸屬感，學習STEM。

▲ 圖2. 調查問卷

截止2019年7月底，已經收到3991份有效問卷。初步調查數據分析顯示，有49.1%的學生希望未來從事科學工作，47.3%希望未來從事醫療工作，46.0%的學生希望從事科技工作。下一步，將對研究結果進行詳細的統計分析，為政府及教育界推動STEM教育及課程政策上提供寶貴的參考資料。

[1] Archer, L., & DeWitt, J. (2017), Understanding young people's science aspirations: How students form ideas about "becoming a scientist". New York: Routledge.

[2] UNESCO. (2017). Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM). Paris, UNESCO.

Appendix F: An Article Submitted to Press

香港欠「STEM 女生」

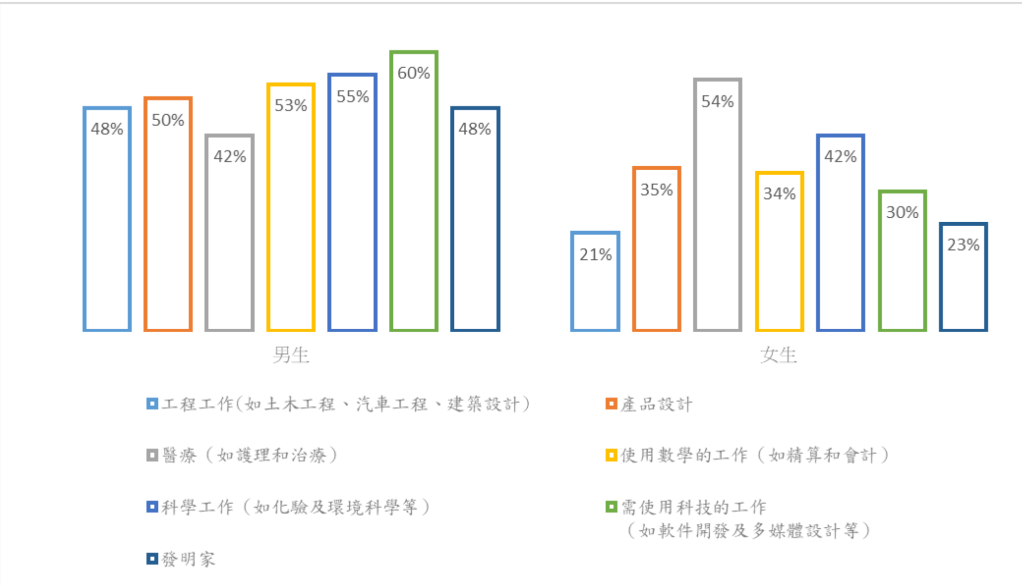
受國際推動 STEM 教育的影響，香港政府亦推出相關文件及高層次的策略，更重要是提供撥款。可惜無論教育界或其他界別都認為成效不大。況且稱得上與 STEM 有關的機構紛紛按自身的理解和利益來做 STEM 教育，結果是一大堆標榜著 STEM 的機械人、創意思維、編程課程及工具進入學校，使本來已課時緊張的中小學成為各「創新」計劃的試驗場。有些老師覺得吃不消，最後唯有敷衍了事，甚至放棄。其實善用原有學校課程中的教與學才是重點。究竟政府所投放的資源能否有效提昇學生對 STEM 的學習興趣，在選科時選擇 STEM 相關學科，配合香港創科發展所需的人力資源？這是值得研究探討的問題。

傳統來說，一般都是較多男生選擇 STEM 相關學科。但 2018 PISA 數據卻反映香港女生科學能力明顯高於男生，成績差距為 9 分。這與考評局的 2019 年香港中學文憑考試成績統計中男女生的表現相若，在生物、化學、數學必修部分與物理科取得 2 級或以上的女生比例相比男生高。

但在成績較佳的學生中並沒有出現同一現象。2019 年文憑試在理科（生物、化學、數學和物理）獲得 5 級以上成績的考生中，男比女多出 1.2 至 4.2 個百分點。這與香港教育大學博文及社會科學學院的研究「香港學生對科學、科技、工程及數學的抱負的挑戰與機遇」的結果呼應。該研究以問卷調查了 39 所中小學，約 4000 名高小、初中及高中的學生，探討學生的 STEM 抱負。

男女生的 STEM 抱負

調查以學生的 STEM 相關學科及工作選擇作為他們的 STEM 抱負指標，男女生的回應有非常明顯差異。更多男生表示會從事需使用科技的工作（60%），科學工作（55%），需使用數學的工作（53%），工程工作 （48%）以及醫療工作（42%）。較多女生對從事醫療（54%），科學工作（42%）以及產品設計（35%）感興趣，相反較少女生表示會從事工程工作（21%）和科技的工作（30%）。



影響男女生 STEM 抱負的因素

女生的 STEM 抱負顯著低於男生。數據顯示對比男生，女生的 STEM 抱負更易受到她們對 STEM 專業人士的印象和家長期望的影響。女生對 STEM 專家的印象稍遜於男生，且她們認為

家長對她們成為 STEM 專業人士的期望較低，使女生愈加表現出較低的 STEM 抱負。另一方面，男生的數學自我效能顯著高於女生，且有較高的數學學習信心，有助於激發 STEM 抱負，從而擴大男女生的 STEM 抱負差異。

女生對學習 STEM 信心低

研究又發現三個組別(高小、初中及高中)的男生在 STEM 相關科目（如數學及科學，高中的物理及化學科）的自我效能均比女生明顯地高。特別在數學科，近七成男生認為自己學習表現很好，女生卻只有五成。其他有男女明顯差異的學科包括小學常識科，初中科學科，高中物理及化學科。女生對 STEM 相關科目欠自信，這亦反映於她們的大學選科，根據大學教育資助委員會秘書處的數字，於 2018/19 年度修讀理學科的學生，平均十人只有四個是女生（整體女生人數已比男生略多），修讀工程科和科技科的男女比例更是七比三，情況令人憂慮，未來男女生在 STEM 專業的參與差異將更大。

男女生對 STEM 專業人士印象

無論高小、初中或高中生多同意 STEM 專業人士是「聰明的」、「可以改變世界」、「受人尊敬的」，及「從事讓人興奮/刺激的工作」。可見學生對 STEM 專業人士的看法均為正面，但都是男生擁有較正面的看法。事實上，大眾媒體也沒太多女性 STEM 專業人士的資訊。例如 2017 年港台的「我們的科學家」節目中，六個受訪的科學家只有一位女性。從事 STEM 工作的女性形象不鮮明，一直以來與科學及 STEM 相關的報導都是男性為主，女主持都是「扮傻」及「無知」女生，性別定型的現象會否影響女生進修 STEM 學科的意願？

在另一個有關「學校-STEM 專家合作」的研究發現，小學生對 STEM 專家的認識與他們的 STEM 興趣有顯著的正相關。該研究中，五年級女學生參與一項有女性環境學家指導的 STEM 學習活動後，較男生更顯著地提高了對 STEM 人士的認識與興趣。若在小學階段讓女生多認識 STEM 的女性榜樣，更有助於她們改變對 STEM 專業人士的性別偏見，從而提高對從事 STEM 事業的興趣。

女生對家長期望的想法

研究也發現女生們認為家長對她們的學習情況掌握及期望，都較男生所認為的略低。在學習情況掌握方面，認為家長知道她們在校內的情況以及會出席學校家長活動的女生均比男生低；在對學生的期望方面，較少女生認為父母關注她們有沒有好的學業成績，以及能否升讀大學。覺得父母認為她們長大後能實踐個人志願比賺錢重要的女生亦比男生略少。

結語

從研究得知香港女生對 STEM 專業人士的認同、父母期望以及她們的數學信心都比較男生低，導致她們的 STEM 抱負不高，影響未來 STEM 專業的男女性參與及平衡發展。

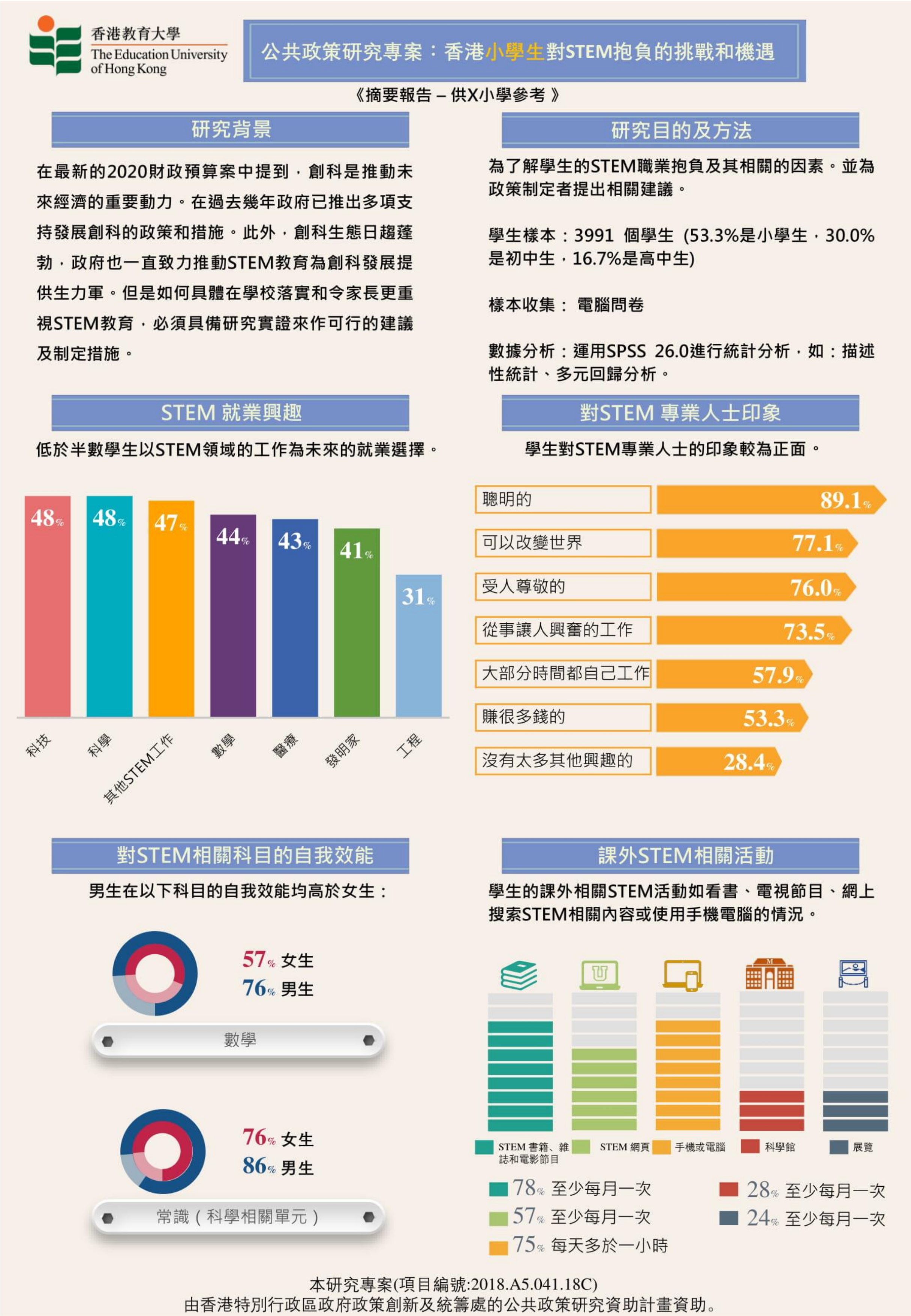
雖然從學生的回應得知學校提供了平等機會讓男女生都可參與 STEM 學習，可是要提高女生的 STEM 抱負，**學校**要在課程方面多下功夫拉近男女生的差距，加強女生的數學學習信心。**家長**的角色也責無旁貸，應探討如何提升父母對女生的期望。改變女生的 STEM 抱負亦不可能單靠家長與學校的努力，**社會**各界人士特別是媒體要避免突顯 STEM 專業人士的性別差異，加強女生對 STEM 專業人士形象的了解及認同感也是任重道遠。

香港教育大學博文及社會科學學院

蘇詠梅教授及趙永佳教授

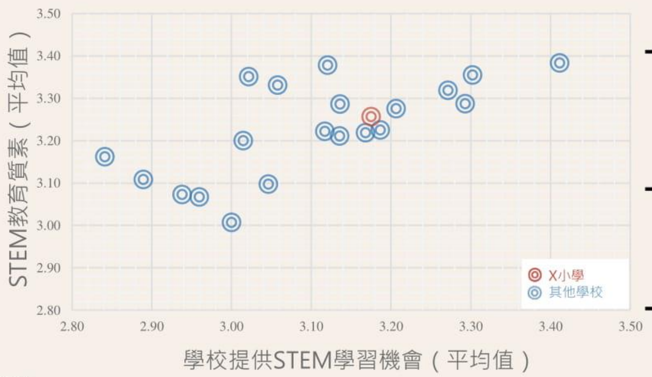
Appendix G: School Posters with Key Findings

Senior Primary School



學校提供的STEM學習機會

大部分學校能提供有質素的STEM學習機會。



備註:
學校提供STEM學習機會平均值: 貴校為3.18，參與研究的小學為3.11
學校STEM教育質素平均值: 貴校為3.26，參與研究的小學為3.23

對於有STEM學習經歷的學生：

70% 認同有足夠STEM學習的機會。

85% 表示STEM的活動或課堂讓人很興奮。

88% 期待未來學習STEM的機會。

學習STEM的原因

個人、社會、國家和世界是學生學習STEM的主要原因。

個人	家庭	社會	國家	世界
為滿足個人好奇心和興趣；為將來能選讀心儀科目；為裝備自己應付未來的工作。	為迎合父母的選科要求；為迎合父母對未來職業的要求；為獲親戚朋友的認同。	為成為香港社會未來人才；為貢獻香港經濟；為配合香港創新科技的需要。	為國家富強出力；為貢獻中國科技發展；為貢獻中國經濟。	為迎合高科技的世界潮流；為改善現今世界生活的不足；為貢獻世界的可持續發展。
83%	48%	83%	76%	80%

影響STEM抱負的因素

對STEM專業人士的印象、性別以及閱讀STEM相關書籍最能影響學生的STEM抱負。

強影響

對STEM專業人士的印象	$B = 0.339$
性別	$B = 0.246$
閱讀STEM相關書籍	$B = 0.127$
認為家長對自己的期望	$B = 0.098$
數學的自我效能	$B = 0.081$
社會身份認同	$B = 0.079$
STEM相關的參觀活動	$B = 0.068$

弱影響

B（貝塔係數）
B值越高的因素對學生的STEM職業抱負影響越大

研究團隊: 蘇詠梅教授、趙永佳教授

Junior Secondary School

公共政策研究專案：香港初中生對STEM抱負的挑戰和機遇

《摘要報告 – 供Y初中參考 》

研究背景

在最新的2020財政預算案中提到，創科是推動未來經濟的重要動力。在過去幾年政府已推出多項支持發展創科的政策和措施。此外，創科生態日趨蓬勃，政府也一直致力推動STEM教育為創科發展提供生力軍。但是如何具體在學校落實和令家長更重視STEM教育，必須具備研究實證來作可行的建議及制定措施。

研究目的及方法

為了解學生的STEM職業抱負及其相關的因素。並為政策制定者提出相關建議。

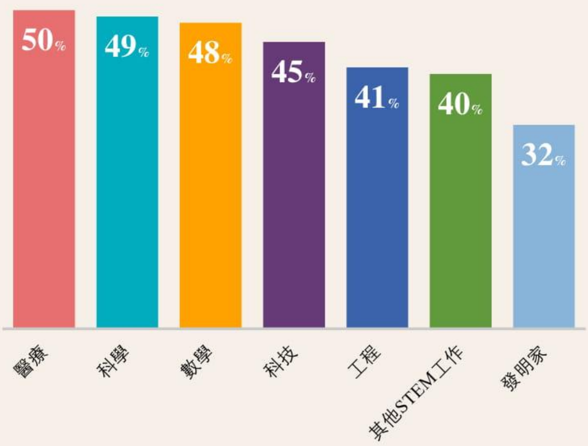
學生樣本：3991 個學生 (53.3%是小學生，30.0%是初中生，16.7%是高中生)

樣本收集： 電腦問卷

數據分析：運用SPSS 26.0進行統計分析，如：描述性統計、多元回歸分析。

STEM 就業興趣

約半數學生以STEM領域的工作為未來的就業選擇。

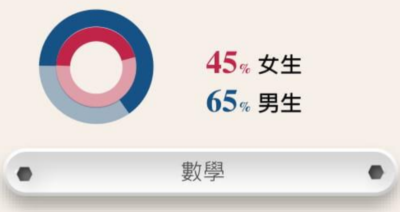


對STEM 專業人士印象

學生對STEM專業人士的印象較為正面。

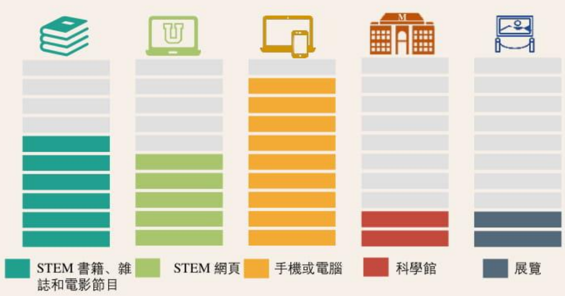
對STEM相關科目的自我效能

男生在以下科目的自我效能均高於女生：



課外STEM相關活動

學生的課外相關STEM活動如看書、電視節目、網上搜索STEM相關內容或使用手機電腦的情況。



57% 至少每月一次

45% 至少每月一次

94% 每天多於一小時

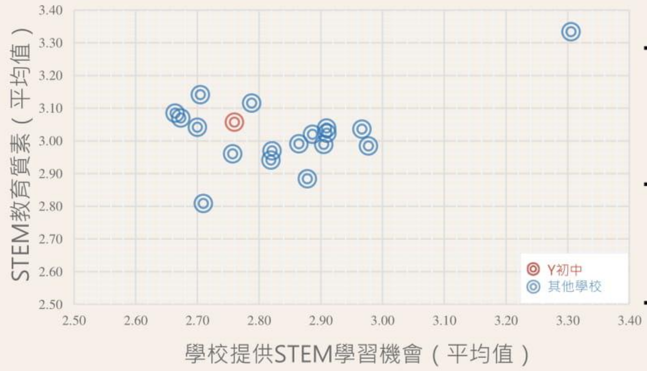
17% 至少每月一次

19% 至少每月一次

本研究專案(項目編號:2018.A5.041.18C)
由香港特別行政區政府政策創新及統籌處的公共政策研究資助計畫資助。

學校提供的STEM學習機會

大部分學校能提供有質素的STEM學習機會。



備註:
學校提供STEM學習機會平均值: 貴校為2.76，參與研究的初中為2.82
學校STEM教育質素平均值: 貴校為3.06，參與研究的初中為2.99

對於有STEM學習經歷的學生：

58% 認同有足夠STEM學習的機會。

74% 表示STEM的活動或課堂讓人很興奮。

76% 期待未來學習STEM的機會。

學習STEM的原因

個人、社會、國家和世界是學生學習STEM的主要原因。

個人
為滿足個人好奇心和興趣；
為將來能選讀心儀科目；
為裝備自己應付未來的工作。
79%

家庭
為迎合父母的選科要求；
為迎合父母對未來職業的要求；
為獲親戚朋友的認同。
46%

社會
為成為香港社會未來人才；
為貢獻香港經濟；
為配合香港創新科技的需要。
78%

國家
為國家富強出力；
為貢獻中國科技發展；
為貢獻中國經濟。
64%

世界
為迎合高科技的世界潮流；
為改善現今世界生活的不足；
為貢獻世界的可持續發展。
80%

影響STEM抱負的因素

對STEM專業人士的印象、性別以及認為家長對自己的期望最能影響學生的STEM抱負。

強影響

對STEM專業人士的印象	$B = 0.309$
性別	$B = 0.224$
認為家長對自己的期望	$B = 0.154$
數學的自我效能	$B = 0.104$
STEM相關的參觀活動	$B = 0.085$
社會身份認同	$B = 0.076$
科學的自我效能	$B = 0.066$
閱讀STEM相關書籍	$B = 0.049$

弱影響

B（貝塔係數）
B值越高的因素對學生的STEM職業抱負影響越大

研究團隊: 蘇詠梅教授、趙永佳教授

Senior Secondary School

香港教育大學
The Education University of Hong Kong

公共政策研究專案：香港高中生對STEM抱負的挑戰和機遇

《摘要報告 – 供Z高中參考 》

研究背景

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樣本收集： 電腦問卷

數據分析：運用SPSS 26.0進行統計分析，如：描述性統計、多元回歸分析。

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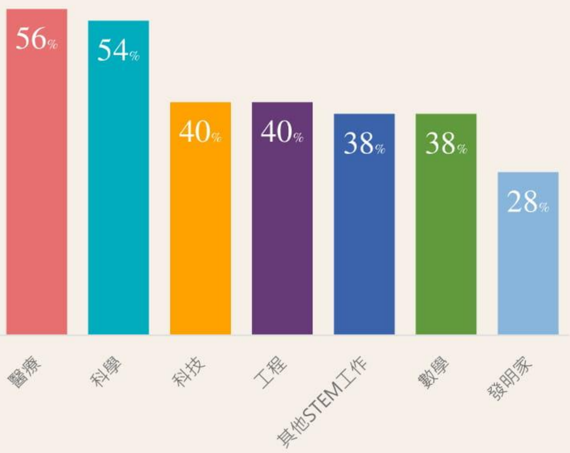
約半數學生以STEM領域的工作為未來的就業選擇。



對STEM 專業人士印象

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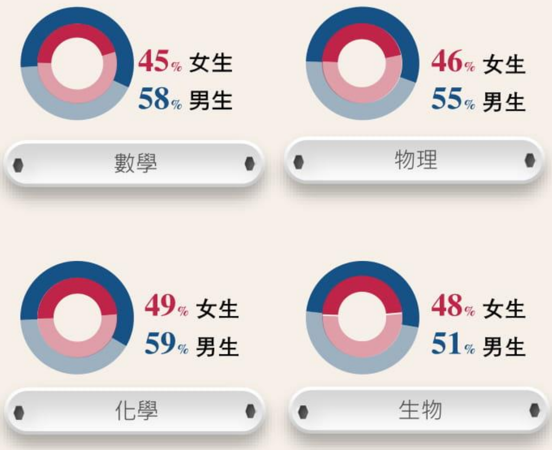
對STEM相關科目的自我效能

男生在以下科目的自我效能均高於女生：



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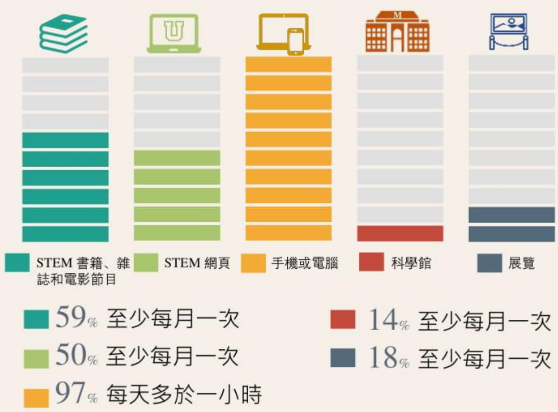

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大部分學校能提供有質素的STEM學習機會。

備註:
學校提供STEM學習機會平均值: 貴校為2.71，參與研究的高中為2.63
學校STEM教育質素平均值: 貴校為2.94，參與研究的高中為2.87

對於有STEM學習經歷的學生：

- 47% 認同有足夠STEM學習的機會。
- 65% 表示STEM的活動或課堂讓人很興奮。
- 76% 期待未來學習STEM的機會。

學習STEM的原因

個人、社會和世界是學生學習STEM的主要原因。

個人	家庭	社會	國家	世界
為滿足個人好奇心和興趣；為將來能選讀心儀科目；為裝備自己應付未來的工作。	為迎合父母的選科要求；為迎合父母對未來職業的要求；為獲親戚朋友的認同。	為成為香港社會未來人才；為貢獻香港經濟；為配合香港創新科技的需要。	為國家富強出力；為貢獻中國科技發展；為貢獻中國經濟。	為迎合高科技的世界潮流；為改善現今世界生活的不足；為貢獻世界的可持續發展。
78%	36%	74%	49%	75%

影響STEM抱負的因素

科學的自我效能、對STEM專業人士的印象以及性別最能影響學生的STEM抱負。

強影響

科學的自我效能	$B = 0.305$
對STEM專業人士的印象	$B = 0.272$
性別	$B = 0.194$
閱讀STEM相關書籍	$B = 0.112$
社會身份認同	$B = 0.098$
學校提供STEM學習機會	$B = 0.092$
STEM相關的參觀活動	$B = 0.054$

弱影響

B（貝塔係數）
B值越高的因素對學生的STEM職業抱負影響越大

研究團隊: 蘇詠梅教授、趙永佳教授

Appendix H: Leaflet with Policy Recommendations

家庭層面

建議（四）提高家長對瞬息萬變社會的認識

加強家長對學生學習和職業選擇的教育

研究發現：家長對學生的期望
直接並正面影響其的STEM職業抱負

學校層面

建議（五）建基於教育研究的理論框架，在各學習階段

闡明「STEM學習進程架構」

研究發現：個人、家庭、學校和社會因素
於三個學習階段有顯著性差異

建議（六）將STEM專業元素納入學校課程

整合STEM專業內容的認識

研究發現：學生對STEM專業人士的印象愈正面，
愈願意在未來選修STEM科目

社會層面

建議（七）通過公眾教育、大眾媒體以及通識教育課程

強調STEM在社會和國家中的貢獻

研究發現：社會認同感直接並正面
影響學生的STEM職業抱負

建議（八）開展持續的教師培訓和教育研究

提高STEM教育的質素

研究發現：學校STEM教育質素通過學生對
STEM專業人士的看法影響其STEM職業抱負