

Executive Summary

Innovation and technology are increasingly important and bring challenges to economic development around the world. Various countries enthusiastically promote science, technology, engineering and mathematics (STEM) education to incubate talent and enhance international competitiveness.

The Trends in International Mathematics and Science Study (TIMSS) in 2015 showed that the science performance of primary school students in Hong Kong ranked 5th worldwide, lagging slightly behind Asian competitors Singapore and Korea. The Programme for International Student Assessment (PISA) also found that the science performance of secondary school students in Hong Kong ranked 2nd worldwide in 2012 but had dropped to 9th in 2015. However, the 2016 Global Competitiveness Report indicated that the competitiveness of Hong Kong's technological infrastructure dropped from 1st in the whole world in 2012 and 2013 to 14th in 2016. It also showed that from 2012 to 2016 Hong Kong scored only 4.4 out of 7.0 in innovation competitiveness.

The above-mentioned figures have given rise to concern about STEM development in Hong Kong. The government of the Hong Kong Special Administrative Region promised, in its 2015 and 2016 policy addresses, to work on STEM education and to encourage students to build diverse STEM-related capabilities. The project has some shortcomings, however. Some primary schools have encountered time, labour and subvention shortages that greatly hinder progress in promoting STEM education.

The earlier children receive STEM education, the more they can learn to improve their capabilities. Therefore, this study aims to explore senior primary school students' and teachers' perception of STEM education, and provides recommendations by examining the obstacles to implementation that primary schools currently face.

Major Findings

- 1. Over 40% of primary students polled were not familiar with STEM education. Experts and educators said that HK's atmosphere does not favour the promotion of STEM.**

The questionnaire survey found that 45.2% of 520 respondents were familiar with STEM education while 40.8% were not. This shows that the primary school students had heard about STEM, but did not have a deep understanding of it.

Some of the experts and educators interviewed pointed out that the atmosphere of Hong Kong does not favour the promotion of STEM. They said that parents or the social environment as a whole encourages students to pursue finance or business studies due to Hong Kong's long-recognised image as an international financial centre. This probably reduces students' motivation and interest in studying STEM-related subjects.

- 2. Students believed that their teacher was the most important person encouraging their interest in science and mathematics. Teachers' attitude to STEM education can greatly affect their pedagogy.**

More than one-third (35.0%) of students polled said they believed that their teacher was the person most important in encouraging their interest in science; 39.6% believed this was the case for mathematics.

Most of the educators claimed that primary school teachers lacking confidence about teaching STEM education could have a different attitude to it, which could greatly affect their pedagogy and the learning experience of their students.

- 3. Students self-assessed that their creativity and problem-solving skills were mediocre. Experts and educators commented that students had room for**

improvement.

Students were invited to self-evaluate some of their practical and life skills in the survey. They gave their creativity and problem-solving skills scores of 5.95 and 5.79 respectively. This shows that students' level in both capabilities are mediocre.

The experts interviewed explained that this may be because students often have inadequate hands-on learning experience or training. In addition, students in Hong Kong are used to searching for the best answer to score higher in exams. They do not feel comfortable with the STEM education experience, which requires learning through repeating trial and error processes.

4. Few primary students join STEM learning activities in schools frequently. The activities are usually confined to a few choices.

According to the survey undertaken, few primary students frequently join the STEM learning activities in their schools. Around half of the respondents said that they (frequently and often) joined activities like field visits (54.25%), coding programmes (52.3%) and software learning classes (51.3%). Nearly 40% said that they (frequently and often) participated in experiments (38.6%) and classes on how to make 3D models (37.7%).

However, some students said they had never participated in situational activities (43.1%), Lego or robot-building classes (39.0%), detective games (34.6%) or activities in which they can create inventions with peers (20.6%). This may mean that the activities are not sufficient, because they are often confined to few choices.

5. Excessive assignments, the high cost of activity classes and a lack of interest in related subjects are the main reasons why students do not participate in STEM-related learning activities.

The primary school students polled who did not participate in any kind

of STEM learning activity did so because they had too many assignments (49.8%), the classes were too costly (36.2%) or they were not interested (36.0%).

Some educators added that even if they wanted to incorporate STEM learning activities into their classes, the current general studies classes were not long enough to run such activities comprehensively and smoothly.

Main Discussion

After collating the results of the questionnaire survey and interviews with experts and educators, the following five points are made.

1. The value of STEM education in primary school must be affirmed. It helps strengthen related knowledge, interest and capabilities of children.

In line with the development of STEM education worldwide, the government of the Hong Kong Special Administrative Region introduced STEM education in 2015. With regard to the experience of Singapore, this policy aims to enhance the knowledge base and capabilities of primary school students. Some experts and educators interviewed believed that students could learn practical capabilities like creativity, cooperation and problem-solving skills through participation in STEM learning activities. STEM education helps improve the science and mathematics knowledge of students and strengthens their practical skills; it is worth implementing STEM in primary schools.

2. There is a structural problem with teachers' qualifications which must be solved. Teachers have an important role in encouraging students' interest in STEM-related subjects. The Education Bureau and universities must reform the problem of teacher qualifications.

The survey undertaken found that teachers have an important role in encouraging students' interest in STEM-related subjects. Teachers' attitude and pedagogy certainly have an impact on the implementation outcomes of STEM education. Although the Education Bureau and other professional bodies have frequently organised STEM workshops, seminars and talks which have offered different training sessions to teachers, some educators interviewed claimed that most of these activities focused on theoretical rather than practical matters. While people without a science background can also study for the local Teacher's Certificate, Post-graduate

Diploma, Certificate in Education etc., most general studies teachers have no advanced knowledge of science or mathematics. This is a structural problem which must be solved if the Education Bureau wishes to promote STEM education in a sustainable manner.

3. There are difficulties obstructing implementation which must be overcome. Primary schools encounter obstacles like having insufficient subventions, class time and teachers. Schools could promote sustainable STEM education if the government provided the resources needed.

Due to the sudden nature of the education reform, schools were unprepared and encountered many obstacles in the implementation of STEM education, including insufficient subventions, class time and teachers. A few of the educators polled said that 10,000 government subventions on STEM education for primary schools were only enough for its promotion in the short term. Moreover, students could not understand STEM-related subjects because tight schedules denied them enough class time. Some educators asserted that primary school teachers were always busy teaching many subjects and, therefore, did not have the motivation or the energy necessary to implement STEM education, even when their schools were willing to spare the money or class periods for it. Relevant bureaus might consider giving further support to eradicate the obstacles identified by educators.

4. Students need time and space to learn, to cultivate their knowledge of and interest in science and mathematics. Schools might consider alleviating their assignment burden and giving them time to explore relevant knowledge.

Many of the senior primary students polled claimed that other than their teacher, no one encouraged them to take an interest in science and mathematics. This shows that students need space and time to cultivate interests on their own. Therefore, schools doing nothing might consider alleviating students' burden of assignments and allow

them more time to explore relevant knowledge. In addition, students in Hong Kong are used to searching for the best answer to score higher in exams. They do not feel comfortable with the STEM education experience, which requires learning through trial and error. Schools deciding to introduce STEM education might consider establishing another set of assessment tools that put less academic pressure on students.

5. HK society gives less attention to innovation and technology. Laymen do not fully understand or support STEM education. The relevant bureau might actively develop innovation and technology and create jobs to arouse public awareness.

This study found that stakeholders do not fully understand or support the implementation of STEM education. Some experts noted that STEM-related industries are not prosperous in Hong Kong. Because there is little or no demand for the science and mathematics knowledge and professions, secondary schools and universities give more attention to students' language or other abilities. Education reform requires the support of teachers, schools, bureaus and parents. The government must recognise this situation and help parents to understand the spirit of STEM education. In the long run, the government must actively develop innovation and technology, and create job vacancies to arouse public awareness of STEM and encourage students to study related subjects.

Recommendations

Based on the major findings and discussion above, five recommendations are made:

- 1. Introduce a scholarship scheme to reward undergraduates who study STEM-related subjects and want to be primary school teachers. This would encourage talented young people to develop STEM education at the primary level.**

- 2. Extend the scope of the existing paid non-local study leave scheme for secondary school teachers to include primary school teachers. This would enrich their pedagogy and give them on-site experiential learning in other countries.**

- 3. Create an online STEM forum. Discussions between school teachers, parents or other stakeholders may increase transparency regarding fees, quality and service details of STEM-related learning activities.**

- 4. Increase cooperation between parents, schools and professional organisations, and encourage them to establish an STEM learning community. This would raise parents' and wider public awareness of STEM's importance.**

- 5. Encourage the use of social media like teleconferences and provide training to primary school teachers. They could thus utilise this technology to exchange on pedagogy with teachers from renowned STEM schools around the world.**