

Report on Promotion of STEM Education - Unleashing Potential in Innovation

Executive Summary

Background

In the 2015 and 2016 Policy Addresses, the Government pledged to renew and enrich the curricula and learning activities of Science, Technology and Mathematics, enhance the training of teachers, step up efforts to promote STEM¹ education and encourage students to pursue the study of STEM-related subjects.

2. The promotion of STEM education aligns with the worldwide trend of equipping students for the rapid economic, scientific and technological developments, as well as the changes and challenges in society and around the world. In the context of the Hong Kong school curriculum, STEM education is promoted through the Science, Technology and Mathematics Education Key Learning Areas (KLAs) in primary and secondary schools.

Aims and Objectives

3. The promotion of STEM education aims to develop students to become lifelong learners of science, technology and mathematics, enabling them to meet the challenges in the 21st century, and from a wider perspective, nurturing versatile talents with different levels of knowledge and skills for enhancing the international competitiveness of Hong Kong, and in so doing contributes to national developments.

4. The major objectives to achieve in STEM education include developing a solid knowledge base among students and enhancing their interest in Science, Technology and Mathematics; strengthening their ability to integrate and apply knowledge and skills; nurturing their creativity, collaboration and problem solving skills; and developing talents/experts in STEM-related areas to foster the development of Hong Kong.

¹STEM is an acronym that refers collectively to the academic disciplines of Science, Technology, Engineering and Mathematics.

Expected Outcomes

5. The expected outcomes of the promotion of STEM education are:
- (i) **Students'** ability to integrate and apply knowledge and skills across disciplines to solve authentic problems is strengthened through STEM-related learning activities. Their creativity, collaboration and problem solving skills are enhanced while potential in innovation is unleashed.
 - (ii) **Teachers'** expertise in organising and implementing STEM-related learning activities is enhanced through sharing with their counterparts of relevant KLAs and exchange with academics/specialists of STEM-related fields, with professional capacity of teachers and collaboration within and across schools strengthened.
 - (iii) **School leaders** in STEM education are nurtured for planning the implementation of STEM education holistically and effectively at school level according to their school context to suit the needs and interests of students.
 - (iv) **Other stakeholders** are actively engaged in the promotion of student learning in STEM-related areas.
 - (v) **Hong Kong as a whole** can gain benefits from the nurturing of a range of talents with different capabilities and at different knowledge and skill levels that fulfill the needs of economic, scientific and technological developments in the contemporary world, hence helping maintain the international competitiveness of Hong Kong.

Major Feedback from Consultation

6. In November 2015, the Education Bureau (EDB) released the consultation document *Promotion of STEM Education – Unleashing Potential in Innovation* for consultation. The six strategies initially proposed in the consultation document include: (1) renewing the curricula of the Science, Technology and Mathematics Education KLAs; (2) enriching learning activities for students; (3) providing learning and teaching resources; (4) enhancing professional development of schools and teachers; (5) strengthening

partnerships with community key players; and (6) conducting review and disseminating good practices.

7. Very good responses were received from the school sector and other stakeholders during the consultation. Principals and frontline teachers shared the view that the promotion of STEM education involves the enrichment of learning and teaching activities in the Science, Technology and Mathematics Education KLAs inside and outside the classroom. They agreed that there is a need to strengthen students' ability in **integrating and applying knowledge and skills across STEM-related disciplines**. They also supported the proposed direction of updating the curricula of relevant KLAs/subjects. Besides, provision of hands-on and minds-on activities for students to solve daily life problems with practical solution and innovative design is considered essential.

8. Among the views from stakeholders, there are only minor concerns from some individuals over the sufficiency of lesson time, availability of resources support, teachers' workload and readiness, challenges on cross-KLA collaboration, level of expertise of some primary school teachers, etc. With these concerns taken into account, EDB has fine-tuned the proposed six strategies and arrived at the following final recommendations for the promotion of STEM education.

Final Recommendations

9. The recommended actions below align with the six strategies initially proposed for the promotion of STEM education.

(I) Updating the curricula of the KLAs concerned to align with the ongoing renewal of the school curriculum with the focus on nurturing students' creativity, collaboration, problem solving skills and innovativeness through student-centred pedagogies, and pave the way for nurturing students' entrepreneurial spirit in senior secondary subjects such as Applied Learning courses.

Recommended Actions

Updating the curriculum frameworks and contents

I-1 The updated KLA Curriculum Guides of Science, Technology and Mathematics Education will be available in the 2016/17 school year as planned. The updated Curriculum Guides would serve as useful references for schools on the design of school-based curriculum, learning and teaching, as well as assessment for the three KLAs, with recommendations also given on the flexible use of curriculum time, more cross-KLA collaboration and strategies to embrace learner diversity.

I-2 The Science (S1-3) curriculum has been updated to enable students to keep abreast of the rapid development in science and technology, especially in the field of life sciences. The curriculum is available for those schools which are more ready to pilot/adopt the strategies in learning and teaching from the 2016/17 to 2017/18 school years. It is also planned that the curriculum is recommended for territory-wide implementation in schools in the 2018/19 school year.

I-3 The Technology Education (S1-3) curriculum has been enriched. There is 30% curriculum time under the Information and Communication Technology (ICT) knowledge context for the study of programming. Full implementation of the curriculum from S1 to S3 is in place in the 2016/17 school year.

I-4 The senior secondary ICT curriculum has been updated with enhancement of the “algorithm testing” part in Basic Programming Concepts of the compulsory part. The updated curriculum starts to be implemented in S4 from the 2016/17 school year.

I-5 The review of the Mathematics curriculum (P1-S6) is now in progress. The results of the review of primary and junior secondary curricula would be announced in the 2016/17 school year, whereas the senior secondary curriculum framework will be announced in 2017.

I-6 The primary General Studies curriculum is under review and will be ready for consultation in the 2016/17 school year. The updated curriculum puts more emphasis on the relevance of science and technology to daily life. The revised curriculum will be available in the 2017/18 school year. For those schools which show more readiness, they could pilot the learning and teaching in the same school year. It is also planned that the curriculum is

recommended for territory-wide implementation in schools in the 2018/19 school year.

Promoting student-centred pedagogies

I-7 Pedagogies that could facilitate the integration and application of knowledge and skills in problem solving to create solutions and make inventions with hands-on and minds-on activities are advocated for implementing the above-mentioned updated curricula. Examples include the use of scientific investigation, project learning, problem-based learning, mathematical modeling, design and make, etc.

I-8 At the primary level, coding is recommended to be introduced to develop students' computational thinking. Teachers of information technology and other subjects, including General Studies, are encouraged to collaborate and provide opportunities for students to acquire and apply skills of coding through appropriately designed learning activities.

I-9 The learning and application of three-dimensional (3D) printing technology provides a typical example of STEM education. Schools are encouraged to make good use of 3D printing technology to enhance student learning in the Science, Technology and Mathematics Education KLAs.

I-10 STEM education provides ample opportunities to nurture the qualities² related to an entrepreneurial spirit among students through the updated curricula in various KLAs and promotion of student-centred pedagogies. This helps pave ways to enhance students' entrepreneurial spirit in senior secondary subjects. For example, Applied Learning offers many courses, like those under the areas of studies of Applied Science and Engineering and Production, which provide contexts for promoting an entrepreneurial spirit in students through STEM-related topics and learning activities.

I-11 EDB would make continued reference to international practices, as well as the latest worldwide trend in learning, teaching and assessment.

I-12 Assessment for the STEM-related learning activities should align with the objectives and pedagogies adopted to reflect the learning progress and the capability of students as independent/collaborative

² Possessing creativity and innovativeness, taking initiative and responsibilities, taking calculated risks and upholding perseverance, etc. are generally regarded as the qualities embedded in an entrepreneurial spirit.

learners.

(II) Strengthening the provision of quality learning experiences to students through support to schools on whole-school curriculum planning and collaboration with relevant organisations

Recommended Actions

Key events for students

II-1 EDB will continue to partner with relevant bodies in organising some large-scale STEM-related events for students similar to the Students Education Fair on Science, Technology and Mathematics 2016. These events would provide quality learning experiences for students to enhance their interests, creativity, and innovation and to strengthen their ability in integrating and applying both knowledge and skills in solving authentic problems.

II-2 As part of the programmes of the WorldSkills Hong Kong Competition cum Carnival 2017 to be hosted by the Vocational Training Council (VTC) in June 2017, a collection of activities including STEM-related competitions and demonstrations will be organised by EDB for secondary school students to showcase the skills-related learning outcomes and to develop their early career interests.

Planning for other STEM-related learning opportunities

II-3 Schools are advised to adopt whole-school curriculum planning, with flexible use of curriculum time, to incorporate elements of STEM education into the school curriculum for broadening students' learning experiences through time-tabled lessons and other life-wide learning activities beyond the classroom, including arranging for students to participate in various local, national, and/or international STEM-related competitions/events/study tours.

II-4 EDB will strengthen the school-based support to schools on holistic curriculum planning, including collaboration among KLAs in organising various STEM-related activities.

II-5 EDB will strengthen the collaboration with various STEM bodies, e.g. The Academy of Sciences of Hong Kong, Hong Kong Science and Technology Parks Corporation, in providing STEM-related activities for enriching students' learning experiences.

II-6 EDB will continue to review and strengthen the existing Applied

Learning courses of both the areas of studies on “Applied Science” and “Engineering and Production”.

II-7 Flexibility is provided for schools to implement their school-based STEM-related learning activities.

II-8 EDB will continue to stretch the potential of the gifted students by partnership with the Hong Kong Academy for Gifted Education (HKAGE) to provide them with challenging off-site enrichment and extension learning opportunities.

II-9 EDB will collaborate with other relevant organisations for the provision of quality learning experiences to students through their participation in STEM-related competitions and events.

(III) Offering KLA-based and cross-KLA resource materials to schools to enhance learning and teaching on STEM-related areas and providing additional resources support for catering to their school-based needs

Recommended Actions

One-off grant for schools

III-1 EDB has disbursed a one-off grant for the promotion of STEM education to all government, aided and Direct Subsidy Scheme (DSS) primary schools, including special schools with a primary section, in March 2016. Given the flexibility of using the grant, schools may make use of it to purchase equipment/resource materials and organise STEM-related learning activities, etc. to meet their school-based needs. We are exploring the feasibility of disbursing a one-off grant of a similar nature to secondary schools for the promotion of STEM education as well.

Resources development for updated curricula

III-2 For the updated Science (S1-3) curriculum, EDB has initiated relevant curriculum development projects with the production of learning and teaching resources for schools’ reference.

III-3 For the updated Technology Education (S1-3) curriculum, relevant learning resources for all modules of Design & Technology (D&T) and Food

and Textile Science have been developed and uploaded onto the EDB website. Besides, a learning and teaching resource package for programming is being developed.

III-4 For the Mathematics curriculum, Seed Projects relevant to STEM education starts in the 2016/17 school year for the development and production of learning and teaching resources for primary and secondary schools.

III-5 For the primary General Studies curriculum, four STEM-related resources packages on different STEM-related topics have been disseminated to teachers for reference. More packages of resources will be developed in the coming year.

III-6 For the primary level, a Computer Awareness Programme (CAP) of 8 modules has been revised and coding is newly introduced.

III-7 EDB will review printed textbooks and e-textbooks for the updated curricula submitted by publishers to ensure the availability of quality textbooks for learning and teaching that can help promote STEM education.

III-8 Two ETV programmes on promoting STEM education have been developed and other relevant programmes to support the learning and teaching of the updated curricula will continue to be developed.

Cross-disciplinary resources development

III-9 A website for dissemination of information about the promotion of STEM education has been developed and launched in September 2016.

III-10 Existing assets/centres such as the Arts and Technology Education Centre (ATEC) in Lok Fu and Young Achievers' Gallery (YAG) at the Kowloon Tong Education Services Centre are used more intensively to support the promotion of STEM education.

(IV) Strengthening the professional capacity, knowledge transfer and cross-fertilisation among schools and teachers for building communities of practice on STEM education

Recommended Actions

IV-1 EDB will continue to organise symposia for curriculum leaders of schools on a regular basis. These events provide a platform of partnering with

the school sector, relevant professional/STEM-related bodies for the promotion of STEM education among schools.

IV-2 EDB will enhance the collaboration with STEM-related professional bodies, such as The Academy of Sciences of Hong Kong and Hong Kong Science and Technology Parks Corporation, to organise professional development programmes for curriculum leaders, middle managers and teachers.

IV-3 Various professional development programmes (PDPs) on promoting STEM education will be organised from 2016 onwards. For the primary level, different PDPs will be arranged for school leaders/ Primary School Master (Curriculum Development) [PSM(CD)] and General Studies/mathematics teachers respectively. For the secondary level, cross-KLA and KLA-based programmes will be organised, with the former mainly for school leaders and teachers, and the latter for KLA coordinators/ panel heads/ middle managers/ teachers.

IV-4 To expand the learning communities for effective sharing and knowledge transfer, four schools with exemplary practices in learning and teaching and a good sharing culture in STEM education are designated as Professional Development Schools (PDS) for promoting STEM education in the 2016/17 school year. These PDS will work with partner schools to generate good practices for dissemination to other schools. In the near future, Quality Education Fund Thematic Network (QTN) would also help promote good practices of STEM education in schools.

IV-5 To address the concerns of professional capacity in primary schools, programmes targeted at PSM(CD) and primary General Studies teachers on knowledge enrichment as well as pedagogies related to e-learning are being planned. Workshops, including those on enhancing students' computational thinking, will also be included to better equip teachers of information technology with the necessary strategies and skills. More school network activities using the QTN are being planned.

IV-6 EDB will continue to provide STEM-education-related training programmes for school laboratory technicians so that they can more effectively assist in implementing STEM-related activities in secondary schools.

(V) Synchronising the contributions from different community key players to enhance the promotion of STEM education in the territory

Recommended Actions

V-1 EDB will communicate with local curriculum advisory committees and the school sector regularly to seek their advice as well as to report on the progress of promoting STEM education.

V-2 EDB will strengthen the collaboration with various institutions, including government organisations and STEM-related bodies for different initiatives, to foster synergy within the community for the promotion of STEM education.

V-3 EDB will also strengthen the partnerships with tertiary institutions and professional bodies, such as Hong Kong Association for Science and Mathematics Education, in various strategies for promoting STEM education.

V-4 EDB will tap information about the future career opportunities (e.g. direction of STEM development, job vacancies in different sectors) through liaison with related bodies/organisations/business firms/employers in planning different strategies for promoting STEM education.

V-5 Updated information on STEM-related activities will be regularly posted on the STEM website for reference.

V-6 A closer liaison with parents-related organisations, e.g. Committee on Home-School Co-operation, will be made to enhance parents' understanding and engage them in various strategies on STEM education.

(VI) Adopting actions to review the development of STEM education, consolidate the good practices for dissemination and generate knowledge for transfer

Recommended Actions

VI-1 More conscientious efforts would be made on identifying innovative pedagogies and student projects for dissemination and knowledge transfer. Apart from the PDS of the 2016/17 school year, participating schools of the QTN would also help disseminate good practices not necessarily funded by

QEF. It is hoped that these STEM centres would be located strategically to enhance accessibility to schools.

VI-2 STEM education has been included in the “Priority Themes” of the QEF to encourage the education sector to apply for funding to foster innovativeness.

VI-3 Experiences from STEM-education-related QEF Projects and other quality projects would be researched to generate new knowledge and insights so that they can be transferred to other situations.

VI-4 To monitor the progress of implementation of STEM education, ongoing collection of feedback and evaluation will be conducted on the six strategies and on the impact of STEM education. Advisory curriculum committees, the school sector, tertiary institutions, professional organisations, parents and employers would be engaged in the process.

A Summary of Key Milestones

10. The promotion of STEM education in schools should ensure continuous development in the Science, Technology and Mathematics Education KLAs. A progressive approach with concerted efforts of different stakeholders is adopted for the sustainable development of STEM education in schools. A summary of the key milestones in the next three years is shown in Appendix 1.

Summary of Key Milestones for the Promotion of STEM Education

Strategies	2016/17	2017/18	2018/19	Remarks
1. Renewing curricula	<p><u>Release of curriculum documents</u></p> <ul style="list-style-type: none"> • STEM Report and Executive Summary • Science, Technology and Mathematics Education Key Learning Areas Curriculum Guides • Science (S1-3) • Primary General Studies • Mathematics curriculum (P1-S6) <p><u>Implementation of updated curriculum</u></p> <ul style="list-style-type: none"> • Enriched Technology Education (S1-3) curriculum - full implementation 	<p><u>Release of curriculum documents</u></p> <ul style="list-style-type: none"> • Supplementary booklets on Updated Learning Objectives of Mathematics Curriculum (P1-S6) 	<p><u>Implementation of updated curricula</u></p> <ul style="list-style-type: none"> • Science (S1-3) • Primary General Studies 	

Strategies	2016/17	2017/18	2018/19	Remarks
	<p><u>Tryout learning & teaching pedagogies</u></p> <ul style="list-style-type: none"> • <i>Piloting learning & teaching: Science (S1-3); Primary General Studies</i> 	<p><u>Tryout learning & teaching pedagogies</u></p> <ul style="list-style-type: none"> • Continue piloting learning & teaching: <i>Science (S1-3); Primary General Studies</i> <p><u>Textbook vetting</u></p> <ul style="list-style-type: none"> • Science (S1-3) • Primary General Studies 	<p><u>Tryout learning & teaching pedagogies</u></p> <ul style="list-style-type: none"> • Mathematics (P1-6)/(S1-3)/(S4-6) <p><u>Textbook vetting</u></p> <ul style="list-style-type: none"> • Mathematics (P1-6)/(S1-3)/(4-6) 	
2. Learning activities for students	<p><u>Key events</u></p> <ul style="list-style-type: none"> • Student events in The InnoTech Expo 2016 • STEM-related projects under the Inter-school Cross-curricular Project Competition on Climate Change • WorldSkills Hong Kong Competition cum Carnival hosted by Vocational Training Council 	[On-going]	[On-going]	

Strategies	2016/17	2017/18	2018/19	Remarks
	<p><u>Other major activities/ competitions, including local, Mainland, regional and international ones</u> e.g.</p> <ul style="list-style-type: none"> <li>- Primary STEM Project Exhibition <li>- Hong Kong Student Science Project Competition <li>- Hong Kong Physics Olympiad <li>- Hong Kong Olympiad in Informatics <li>- Mathematics Project Competition <li>- Statistical Project Competition <li>- Statistics Creative-Writing Competition <li>- International Olympiad in Informatics <ul style="list-style-type: none"> <li>• Continue to partner with 			

Strategies	2016/17	2017/18	2018/19	Remarks
	relevant organisations for promotion/implementation of the events			
3. Learning and teaching resources	<p><u>One off grant</u></p> <p>Stage 1: for primary schools</p> <ul style="list-style-type: none"> Released to all government, aided and caput school, Direct Subsidy Scheme primary schools, including special schools with a primary section, in 2015/16 HK\$100,000 per school <p>Stage 2: for secondary schools</p> <p><u>Learning & teaching resources development</u></p> <ul style="list-style-type: none"> Primary General Studies: 4 sets of resources packages developed and disseminated; 3 	<p><u>Learning & teaching resources development</u></p> <p>[to sustain the development, including the launch of some new</p>	<p><u>Learning & teaching resources development</u></p> <p>[to sustain the development, including the launch of some new</p>	

Strategies	2016/17	2017/18	2018/19	Remarks
	<p>other sets being developed</p> <ul style="list-style-type: none"> • Science Education: Development project for updated Science (S1-3) curriculum - Mathematics Education: Seed Projects for primary and secondary levels; good practices to be disseminated • Technology Education: Unplugged Activities for learning and teaching of Programming at upper primary and junior secondary levels; Resource materials on "Principles of Food Processing and Technology" <p><u>STEM website</u></p>	<p>projects, as appropriate]</p> <ul style="list-style-type: none"> • Mathematics Education: Production of learning and teaching resources based on the good practices in the Seed projects 	<p>projects, as appropriate]</p>	

Strategies	2016/17	2017/18	2018/19	Remarks
	<ul style="list-style-type: none"> A STEM website was launched in September 2016 			
<p>4. Professional development of schools and teachers</p>	<p><u>PDP</u> <i>Primary & Secondary - for school leaders and teachers</i></p> <ul style="list-style-type: none"> Two events of Symposia held in mid Nov 2016 Seminar on coding education at upper primary level <p><i>Primary – for PSM(CD), General Studies/Mathematics Education panel heads/ teachers</i></p> <ul style="list-style-type: none"> On curriculum planning, pedagogies and assessment of STEM District workshops on STEM Workshop on enhancing Students' Computational Thinking through General 	<p><u>PDP</u></p> <p>[PDP continue to be strengthened]</p>	<p><u>PDP</u></p> <p>[PDP continue to be strengthened]</p>	

Strategies	2016/17	2017/18	2018/19	Remarks
	<p>Studies</p> <ul style="list-style-type: none"> • Sharing on the Good Practices <p><i>Secondary – for KLA coordinators/panel heads/ middle managers/ teachers</i></p> <ul style="list-style-type: none"> • Cross-KLA PDP and KLA-based/subject-based PDP • On curriculum planning, learning and teaching, assessment, knowledge enrichment and networking activities <p><u>Intensive training for school leaders and middle managers</u></p> <ul style="list-style-type: none"> • On enhancing curriculum leadership on implementation of STEM education <p>PDS: 4 secondary schools</p>	<p><u>Intensive training for school leaders and middle managers</u></p> <ul style="list-style-type: none"> • Tentative course implementation (from 2017 – 2019) <p>PDS: the school network among</p>	<p><u>Intensive training for school leaders and middle managers</u></p> <ul style="list-style-type: none"> • Tentative course implementation (from 2017 – 2019) <p>PDS: the school network among</p>	<p><u>Intensive training for school leaders and middle managers</u></p> <ul style="list-style-type: none"> • Cross-curricular training • Sufficient places for primary and

Strategies	2016/17	2017/18	2018/19	Remarks
	<p>designated; each to partner with a few other schools to try out learning and teaching initiatives</p> <p>QTN: potential schools are being invited</p> <p>STEM centres – being identified</p>	<p>PDS and partner schools to be sustained</p> <p>QTN: the scheme to be launched</p> <p>STEM centres – practices to be disseminated</p>	<p>PDS and partner schools to be sustained</p> <p>[Education Development Fund will last up to 2018/19]</p> <p>QTN: the scheme to be sustained; number of school involved in networking activities of the scheme to be increased</p> <p>STEM centres – practices continue to be shared and disseminated</p>	<p>secondary schools to be provided</p>
<p>5. Partnerships with community key players</p>	<ul style="list-style-type: none"> • Partnership with HK Jockey Club Charities Trust on “Computational Thinking and Coding Education Programme” • “Enriched IT Programme in Secondary School” by Office of the Government Chief Information Officer • Continue to partner with 	<p>[On-going]</p>	<p>[On-going]</p>	

Strategies	2016/17	2017/18	2018/19	Remarks
	various relevant government organisations/STEM-related bodies/professional bodies for teacher training, student activities and provision of resource materials			
6. Review and Dissemination	<ul style="list-style-type: none"> • Good practices disseminated via PDS • Regular meetings with curriculum advisory committees and focus groups • Monitoring the implementation of STEM education regularly 	[On-going]	[On-going]	