Quality Education Fund

The Dedicated Funding Programme for Publicly-funded Schools

Part B: Project Proposal

Project Title: **STEM Room Enhancement for school-based learning project** 增強 **STEM** 特別室以支援校本學習計劃	**Project Number:** *(2019/0184) (Revised)*

Name of School: Jockey Club Ti-I College

Direct Beneficiaries

(a) Sector: ☐Kindergarten ☐Primary ☑Secondary ☐Special School *(Please put a tick in the appropriate box(es).)*

(b) Beneficiaries: (1) Students: Around 480 students, 15 classes, 3 year levels; (2) Teachers: 15 ;
(3) Parents: 60; (4) Others: 0

Project Period: 12/2020 to 01/2023

1 Project Needs

1.1 Project Aims

The ultimate goal of STEM education is to strengthen students' ability to integrate and apply knowledge and skills across different STEM disciplines, and to nurture their creativity, collaboration and problem-solving skills, as well as to foster their innovation and entrepreneurial spirit as required in the 21st century. Nurture a versatile pool of talents with different sets and levels of skills to enhance the competitiveness of Hong Kong.

We believe there are 5 key areas of knowledge that must be learnt to bridge between the skills and ultimate goal mentioned, including: Robotics and Electronics, Coding, Computer Aided Manufacturing Methods, Computer Aided Design Methods, and Product Design Methods. Hence, the aim of this project is to develop knowledge and experience in the 5 key areas of knowledge. Since higher forms students must focus on preparing themselves for the public examinations ahead, the target population of this project is Secondary 1 to Secondary 3 Students.

Another aim of the project is to train the teaching staff to be able to teach STEM education sustainably and develop knowledge, skills and teaching experience in the 5 key areas of knowledge mentioned above.

1.2 Innovative Elements

The project encourages hands on participation of students in various learning activities. Referencing theories of experiential learning, students are expected to have higher motivation of learning and longer knowledge retention rate than rote learning from lecturing. A new learning environment of the STEM room would surely benefit this project by providing space for collaboration and hands on learning.

A key innovative element is the use of a project-based product design approach to tackle STEM. Project based learning help to develop teamwork, application of inter-subject knowledge, project management skills and presentation language skills. Electronic building blocks is utilized to implement project-base product design learning of STEM knowledge. Electronic building blocks replaces conventional circuit models and apparatus and are much simpler to use and encourage students to use it to develop functional prototypes for designs to tackle real life cases. Electronic building blocks consists of coding block and logic gates block. We noticed that using coding to tackle STEM may be a hasty generalization. Electronic building blocks offer a much more analog approach to electronics and circuit building that is closer to real-life scenario. Coding can also be implemented if the case requires higher level of logic behind it.

1.3 Alignment with school-based / students' needs

The core disciplines of STEM: Integrated Sciences, Technology Education and Mathematics are now part of the school's eight Key Learning Area, in which all students are entitled to study. We recognise the importance of STEM. We reckon that STEM would be a perfect opportunity for us to regain progress in this subject matter. In the future, we would like to initiate cross-disciplinary collaboration among the following subjects:
Information and Communication Technology (ICT)
Design and Technology (DT)
Geography (Geo)
Visual Arts (VA)
Physical Education (PE)
Integrated Science (IS)
Mathematics (Maths)

The school recognises the importance of STEM KSA. Science and Engineering is a popular choice of disciplines among students for further studies. It is important for us to build a strong and firm base for them to go further in their career, let alone to keep them from being hindered. To explore opportunities of innovative technology development in the big bay area, we bear great responsibility to equip them with knowledge, skills and experience.

2 Project Feasibility

2.1 Key concept (s) / rationale(s) of the project

This project stands on the shoulders of giants that proposed the Maker movement for education. Despite being popular among western countries, the majority of Hong Kong's educators does not seem to bat an eye upon this culture of "Maker movement". Lee (2015) believed that bringing Making into K-12 education can enhance opportunities for students to engage in design and engineering practices, specifically STEM/STEAM practices (2015). We embrace the effectiveness of Making on STEM education as it engages students to participate and learn by experiential learning. Ironic it may be, we believe experiential learning would be more effective for Hong Kong learners than rote learning.

There is no set definition of making, from integration of the definitions of Honey and Kanter (2013), Sheridan et al (2014), Kuznetsov and Palos (2010) et cetra, we would like to adopt the definition of Making by Lee (2015), as "The process of creation that involves traditional craft techniques, digital technology that is incorporated within the design and for manufacturing". We hope to motivate our students to learn STEM related knowledge to achieve Maslow's self actualization through stimulation by Making activities. Kalil (2013) suggest that "people who design and make things on their own time because they find it rewarding to make, tinker, problem-solve, discover and share what they have learned." Lee described there are three elements of Making and the Maker Movement that are critical for understanding its promise for education: Digital Tools, Community Infrastructure and the Maker Mindset. These three elements correspond to the government's ultimate goal of STEM education. Digital tools prepare the young people of Hong Kong with different sets and levels of skills to enhance the competitiveness of Hong Kong; Community Infrastructure foster the entrepreneur spirit and collaboration with institutes of the bay area; and the maker mindset develops student's innovation, creativity and problem-solving skills.

Rather than challenging students with straight forward, simplified problems, students would be given complex and realistic problems that are simulations of real-life experiences in our STEM curriculum. To be discussed in 2.7, the curriculum we propose is a thematic, interdisciplinary unit centered on an engineering design challenge. Not only does these themes interconnect with the existing Integrated Science curriculum, it also stimulates the students to make a personal connection to the experience, hence elongates knowledge retention. As Lesh et al stated (2000), it is important for students to try to make sense of the situation based on extensions of their personal knowledge and experiences.

Dare, Pettis and Moore created the Wind Turbines unit (2013) and provided the basis for hands on STEM education. The unit involved students investigating the shape and number of blades, and where to place the wind turbines at the school campus. The process of Making allowed students to collaborate and work as a group, which is another essential component of STEM learning. This is what we want to recreate in our school, embodied knowledge, where knowledge and abilities are organized around experience, as Sriraman and Lesh suggested (2007).

The discussion can be illustrated by two education models: Figure 1: The Lesh Translation Model, and Figure 2: The STEM Translation Model.

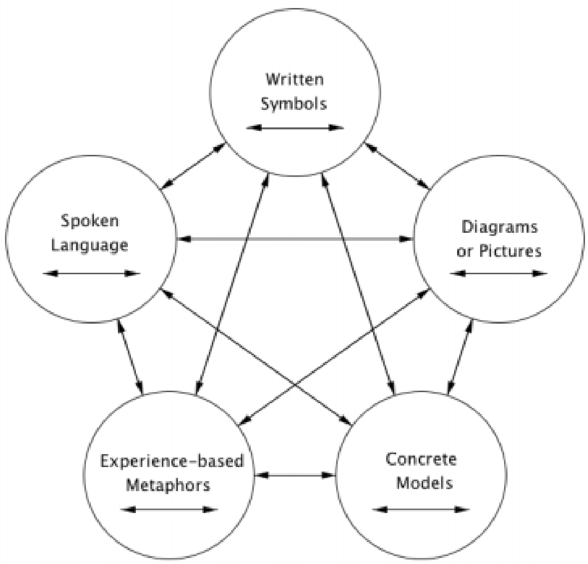

Fig. 1

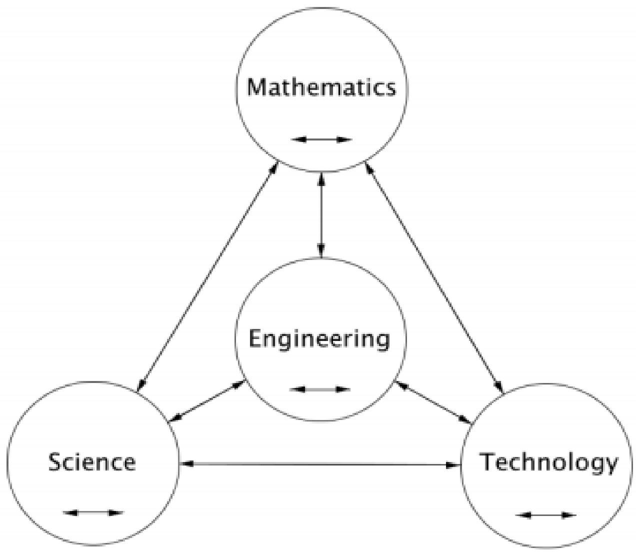

Fig. 2

The Lesh transition model illustrate the importance of each ways of knowing to maximize students' conceptual understanding. The process of making allow student to be engaged with learning experience. Ordinary lecture based rote learning can only satisfy the 'Spoken Language', 'Diagrams of Pictures' and in some cases 'Written Symbols'. Whereas a project-based STEM learning that integrates Making should be able to satisfy all five components.

Our product design approach to STEM asks students to apply the ideas, skills and techniques from one discipline of the STEM Translation Model to tackle problems in another (Glancy and Moore, 2013). This would help students to perceive relationships, similarities and differences between each discipline of STEM. In traditional class room learning where each subject has its own lesson, students see the concept in its two different manifestation and are unable to make connections between them. On the contrary, the product design approach allow students to undergo a process of convergent cognition, as suggested by Rich, Letham and Wright (2012). Where a synergistic relationship combining two or more subject reveals a more complex object.

In summary, bringing Making and Product Design to our school as an approach to STEM education has the potential to bring creative, playful, engineering and design-relevant learning.

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2.2 Applicant's readiness or ability/ experience/ conditions/ facilities for project implementation

We plan to change the usage of existing Language Room as the new STEM Room. The existing Language Room will be relocated to a special room inside the new school library. Therefore, the setup of new STEM Room will not affect the existing lessons or curriculums of other subjects. On the other hand, the school is planning to assign certain amount of lessons to be taken place at this new STEM Room. Please kindly refer to 2.7(d) for the detailed "STEM Room" recommended usage timetable.

Currently, the School implements STEM@Ti-I education in two main directions, Gifted Education and Cocurricular Activities.

In Gifted Education, a STEM@Ti-I Team is formed under the Gifted Education Committee. The main responsibilities of the Team include planning, implementation, and evaluation of the STEM@Ti-I education in the School such as the administration/coordination of EDB's One-off STEM Grant and the establishment of the School STEM Room.; and the regular carrying out of various after-class/afterschool STEM activities. The Gifted Education Committee in itself also actively selects suitable talented students to enroll in different pullout, offsite STEM activities and competitions.

In Cocurricular Activities, student bodies like the Student IT/AV Team and the Science Society regularly organize/co-organize various activities like the STEM Week and fun STEM workshops for the students. The Parent Teacher Association is also very supportive and actively involved in many of these activities, such as the Organic Tie-Dye (with Visual Art),the Preserved Flowers (with Chemistry and Alumni),and the Fun Bakery (with Biology and Technology & Living) workshops, etc.

Lately, propelled by the EDB's STEM initiatives as given in their "Task Force on Review of School Curriculum: Consultation Document" (see under Section 3.6), many Subject Panels have also started to strengthen STEM education not only in their individual formal curriculum but in cross-curricular/cross-discipline collaboration as well. For instance, the Integrated Science, the Design & Technology, and the Information & Communication Technology subjects collaboratively organize a Model Rocket Car Race project assignment in this Academic Year (2019~2020). The Visual Art Panel has organized a Chair-making Project and a BCSW × JCTIC - Upcycling Design Project in current School Years.

2.3 Principal's and teachers' involvement and their roles

The concerted effort of the whole school community will ensure the delivery of the goals stipulated in this project. To be specific, besides the Principal and one of the Assistant Principals, teachers and technicians of various subject departments; including the Science, ICT, Design & Technology, Visual Arts, Physical Education, Mathematics and Geography Department have already worked and will continue to work closely for the project.

With the very unique mission of providing a balanced curriculum of Academics, Sports & Visual Arts in our school, the Principal has specified the direction of our STEM initiative to be "STEM@Ti-I"; meaning the infusion of the two important aspects of Sports & Visual Arts into the philosophy of STEM. The Principal will continue to guide, inspire and direct the school community to develop within this visionary perspective.

While the Assistant Principal is directly involved in the very front line of delivering the STEM education, he will monitor and coordinate the efforts of the various parties.

The ICT Department would take the lead of the project; piloting and working side-by-side with teachers of the above said departments in the execution of the project, including the designs of a number of diversified STEM activities to the procurement of various equipment. Teachers of the above said department are highly aware of the needs for constant review, discussions, and sharing of experiences. Representatives of different parties will regularly report the development and progress of the project to the principal, teaching staff and IMC.

Technical Support Staff will actively participate in all related activities by providing necessary support.

Rank	**Duties and roles in the project**
The Principal	Guide, inspire and direct the school community in the development of the "STEM @Ti-I"; Review the development of the project & utilization of resources; and, Build networks with other schools.
Assistant Principal	Evaluate and monitor the progress of the project; and, Coordinate the efforts of various parties.
Coordinator of the ICT Department	Lead the project; Help with lesson designs & development; and, Monitor progress and quality.
Teachers (10)	Design lessons; Deliver educational targets; Manage teaching resources; Sharing experience; and, Execute project goals.

Supporting Staff - TSS (2)	Provide support for teaching activities; Help prepare experiments; and, Manage equipment & teaching materials.

2.4 Parents' involvement / participation (if applicable)

Through the "Parents'-Teachers' Association" (PTA) activity, the school strengthens home-school cooperation and enhances understanding and communication between parents and teachers. Our PTA has always been highly committed to the educational opportunities for our students. Parents, as stake-holders, can contribute to the goals of our STEM education in the following ways.

First, the Parent-Teacher Association (PTA) can continue as what it has done in the previous years, to co-organize extra-curricular STEM activities for both students and parents. In the year 2018-2019, the school and the PTA co-organized a LED Cap Workshop in which participants worked on several Saturday afternoons and learnt how to use the soldering irons to put together LEDs controlled by Arduino Nano. The PTA helped promote the activity and handled some of the administrative work. Our school plans to start an additional STEM workshop at the "Parents'-Teachers' Association" activities each semester starting from the 2020-21 school year, so that parents of the school can access the latest STEM technology knowledge. The number of participants in each workshop is expected to be 30. The topics of the workshop will include 3D printer demonstration, electronic building blocks and programming, and the principles and applications of the Internet of Things.

Second, some parents actually took part in the above-mentioned workshop last year as participants, working together with their children. It demonstrated clearly that STEM education in our school is not solely for the students. Hence, the tradition for parents to be actively involved will go on.

Third, our parents from different walks of life can actually be assistants or even trainers for some of our extra-curricular STEM activities targeting our students. There are parents who are highly skilled in computer programming while others have experience in engineering and manufacturing. They can demonstrate their expertise to our students by holding workshops or even visits.

Lastly, not only our students, but our parents, can also be benefitted from the new STEM Room because like their children, the parents can also make the best use of the facilities in the STEM Room to satisfy their imagination to make their own STEM creations.

2.5 Roles of collaborator(s) (if applicable)

NIL

2.6 Implementation timeline

Implementation period *(MM/YYYY)*	Project activities
12/2020	Tendering for the STEM Room and procure required hardware and equipment for the project
02/2021	Staff professional development on teaching with electronic building blocks, 3D CAD CAM methods and safety.
03/2021	Commence Year 1 of the project. Establish STEM@Ti-I sub-section under Science Society.
06/2021	1st phrase of staff professional development on the use of different equipment in lessons.
07/2021	Mid-year evaluation of project progress.
11/2021	In-school roadshow of students' STEM@Ti-I projects.
12/2021	Dissemination of Project Results
01/2022	1st workshop for the "Parents'-Teachers' Association" activity
01/2022	End of year evaluation of project progress.
02/2022	Staff professional development on teaching with electronic building blocks, 3D CAD CAM methods and safety.
03/2022	Commence Year 2 of the project.
06/2022	2nd phrase of staff professional development on the use of different equipment in lessons.
07/2022	Mid-year evaluation of project progress.
11/2022	In-school roadshow of students' STEM@Ti-I projects.
12/2022	Dissemination of Project Results
01/2023	2nd workshop for the "Parents'-Teachers' Association" activity
01/2023	End of year evaluation of project progress.

2.7 Details of project activities (Item (a)-(f) not applicable to this application can be deleted.)

a. ***Student activity***

All three year level will begin implementing the changes in the 2020-2021 academic year simultaneously. The project should last for 2 years until the end of the 2021-2022 school year before the end of the project evaluation.

Student Activity for Secondary 1 Students

Activity Number	Activity name	Content	Number of sessions, duration (mins)	Subject in relation	Expected learning outcomes
1.1	Building a windmill with electronic building blocks	Energy changes Energy sources System Integration Control and Automation Production Process Application of Systems	2, 70	Integrated Science	• Recognise that energy exists in different forms (chemical energy, electrical energy, kinetic energy, light energy, potential energy, sound energy and thermal energy) • Recognise that different forms of energy can be converted from one form to another • Mechanical, electrical, electronic and pneumatic control systems • Identification and application of building blocks/modules of the electronic systems including the input, processing and output devices • Functions of common components in a pneumatic system and recognise the related symbols • Model control systems • Construction kits for model and simulate technological solutions • Design of simple systems to meet specified problems • Proper use of a range of appropriate machines to implement solutions to design problems • Basic concepts of CAD and 3D modeling • Application of IT tools such as CAD software to present design ideas
1.2	Building a solar powered car with electronic building blocks		2, 70	Design and Technology	
1.3	Building a robotic arm with electronic building blocks		2, 70	Design and Technology	
1.4	Building a traffic light with electronic building blocks		2, 70	Design and Technology	

1.5	Introduction to 2D and 3D Computer Aided Design and Manufacturing	Production Process	2, 70	Information and Communication Technology	• Basic elements of Design,
					   ○ Design consideration,
					   ○ Production process in various fields.

1.6	Checking water turbidity and Total Dissolved Solid with electronic building blocks sensors. Compare turbidity and Total Dissolved Solid with of sea water, muddy water, pond water, tap water and distilled water	Water Purification	3, 105	Integrated Science	• State some of the impurities found in natural water • State the needs for purifying water • Understand the processes involved in different methods of water purification (sedimentation, filtration)

1.7	Design and produce a water purification setup with 3D CAD CAM and manufacture with a 3D Printer		3, 105	Integrated Science	
1.8	Introduction to Micro:bit compatible environment monitoring sensors	Control and Automation Programming Concepts	2, 70	Information and Communication Technology	• Understand the various forms of systems: mechanical, electrical, electronic, pneumatic, and computing as well as their principles of operation • Analysis and identification of control systems as input, process and output elements and feedback • Understand the importance of the stored program in an automated processing task and using programs to control the computer • Input simple programs into the computer, execute and modify the programs, observe results of the programs, and save the programs for retrieval at a later stage
1.9	Design and produce a Micro:bit environment monitoring station	Production Process	2, 70	Design and Technology	• Construction kits for model and simulate technological solutions • Design of simple systems to meet specified problems • Proper use of a range of appropriate machines to implement solutions to design problems • Basic concepts of CAD and 3D modeling • Application of IT tools such as CAD software to present design ideas

Student Activity for Secondary 2 Students

Activity Number	Activity name	Content	Number of sessions, duration (mins)	Subject in relation	Expected learning outcomes
2.1	Measuring air CO2 Concentration Calibrating a digital device	Air Information Processing and Presentation	1, 35	Integrated Science	• Recognise that air is a mixture of gases • State the percentage of main gases in air
2.2	Comparing CO2 concentration of exhaled air before and after exercise	Respiration Gas Exchange in Plants and animals; Information Processing and Presentation"	1, 35	Physical Education	• Recognise that the chemical energy stored in food can be changed by our body into other useful forms of energy to support body activities. • Describe respiration as a process in which food is broken down in cells to release energy

2.3	Comparing CO2 concentration of air around leaves under different conditions	Photosynthesis Gas exchange in plants and animals; Information Processing and Presentation	1, 35	Integrated Science	• Recognise that photosynthesis is the process that plants make their own food. • State that light energy is converted to chemical energy in food during photosynthesis in plants. • Write the word equation of photosynthesis. • Write the chemical equation of photosynthesis. • Understand that the net gas exchange in plants depends on the relative rate of photosynthesis and respiration taken place

2.4	Process data collected from an experiment.	Photosynthesis Gas exchange in plants and animals; Information Processing and Presentation	1, 35	Integrated Science, Information and Communication Technology	• Use of office automation software to prepare daily routine
					• Understand Spreadsheet features including:
					  ○ cell references, simple functions, basic mathematical operators, formatting features, multiple worksheets
					  ○ error values associated with the use of formulae
					  ○ data manipulation: simple filtering and sorting
					  ○ charts with two or more sets of data
					• Error detection by verification and validation

2.5	Testing the Micro:bit environment monitoring station AR sandbox graphical simulations	Changing Climate, Changing Environments	2, 70	Geography	• Use data-logging equipment to record local weather data over a period. • Use a spreadsheet to calculate the changing employment figures in the manufacturing sector before and after industrial relocation. • Use AR sandbox to teach of geographic concepts through a variety of graphics effects and simulations
2.6	Intermediate 2D and 3D Computer Aided Design and Manufacturing	Structure and Mechanisms, Production Process	2, 70	Information and Communication Technology	• Simple properties of structures and movement, • Use of mechanisms for transmission and control of movements
2.7	STEM@Ti-I Project: Plan an investigation about coordination, metabolism or physical fitness. Set hypothesis and methodology. Consult with teachers		2, 70	Integrated Science	This should enable students to: • make careful observations, ask relevant questions, identify problems and formulate hypotheses for investigations; • plan, conduct and write reports on scientific investigations; • select and design appropriate methods of investigations for specific purposes; • use appropriate instruments and apply proper techniques for carrying out practical work; • identify and explain the importance of control variables in scientific investigations; • explain why sample size, random sampling, replicates and repeat procedures are important in scientific investigations;
2.8	STEM@Ti-I Project: Build sensors with electronic building blocks, 3D CADCAM and rapid prototyping,		4, 140	Design and Technology	
2.9	STEM@Ti-I Project: Calibrate sensors with out		2, 70	Integrated Science	

	of the box sensors, conduct pilot testing				• classify, collate and display both first and second hand data; • use diagrams, graphs, flow charts and physical models as visual representations of phenomena and relationships arising from the data; • analyses and draw conclusions from data; • understand that the process of scientific investigations includes analyzing evidence and providing explanations based upon scientific theories and concepts; and • formulate and revise scientific explanations and models using logic and evidence. • Be able to use sport sciences equipment to conduct investigations
2.10	STEM@Ti-I Project: Conduct Experiment, data collection and processing		2, 70	Information and Communication Technology	
2.11	STEM@Ti-I Project: Make conclusion and evaluation		2, 70	Integrated Science	
2.12	STEM@Ti-I Project: Presentation, in school roadshow of project results.		2, 70	Integrated Science	

Student Activity for Secondary 3 Students

Activity Number	Activity name	Content	Number of sessions, duration (mins)	Subject in relation	Expected learning outcomes
3.1	Drawing with an electronic drawing board in a virtual 3D environment.	Visual Arts Making: Presentation and production	3, 105	Visual Arts	• Explore alternative ways of expression by re-composing or by various combinations; and evaluate alternative ways of expression based on aims, purposes, aesthetic logic and principles of organization, etc with computer aided art tools. • Use sketching, drawing, information technology, or other appropriate tools and resources to stimulate and develop ideas. • Explore and apply skills and knowledge of traditional and emerging technology in visual communication.
3.2	Sculpturing with an electronic drawing board in a virtual 3D environment.		3, 105	Visual Arts	
3.3	Creating a virtual reality art gallery with the digital artwork from 3.1 and 3.2.	Programming Concepts Production Process	3, 105	Information and Communication Technology	• Proper use of a range of appropriate machines to implement solutions to design problems • Basic concepts of CAD and 3D modeling • Application of IT tools such as CAD software to present design ideas • Simple commands to manipulate text strings, display text with interesting effects and generate sound in the programming environment • Relational operators (>, >=, <, <=, = and <>) and logical operators (AND, OR and NOT) • Programming a VR tour
3.4	Using 2D and 3D softwares to recreate artwork produced in 3.1 and 3.2 in real life with laser cutter and 3D printer.		3, 105	Information and Communication Technology	

Justification: How does these student activities associate to STEM related subjects in terms of lesson design, teaching methods and learning outcomes.

Activity Number	Activity name	Associated STEM Subjects	How does these student activities associate to STEM related subjects in terms of lesson design, teaching methods and learning outcomes.
1.1-1.4	Building a windmill with electronic building blocks; Building a solar powered car with electronic building blocks; Building a robotic arm with electronic building blocks; Building a torch with electronic building blocks	Integrated Science	The lessons are designed to be a part of the integrated science curriculum and technology education curriculum for S.1 Students. In association with the IS topic: Energy and conversion and circuits. The teaching method used in this class is a combination of lecture and small group activity. After students finish taking notes they are engaged in a small group making activity to build a windmill, a solar car, a torch and robot arm with electronic building block. The battery is electrical energy and as it turns the DC motor or servo motor, it is converted into kinetic energy. The solar panel converts light energy into electrical energy. The small group activity is a use of experiential learning that is supposed to elongate knowledge retention. After the activity, students will make notes on their notebook/practical booklet. The learning outcome is the ability to identify different kinds of energy, understand that energy is interconvertible, and that solar energy is green, sustainable but solar panels are expensive hence has low efficiency. Identify types of electronic building blocks for future activities and their function.
1.5	Introduction to 2D and 3D Computer Aided Design and Manufacturing	Information and Communication Technology	The lessons are designed to be part of the ICT curriculum which also covers area of knowledge of mathematics and design technology. The lesson structure will be a lecture-based structure in a computer room. Students will learn to use a 3D Design software to draw simple objects. They will then learn to export a file in STL (or other common 3D object) and DXF (or other common vector graphics) file type. And then import it into the 3D printer's driver software so that they can print it out, and into a laser cutter software so they can cut it out. The teacher will also elaborate on the various types of computer aided manufacturing hardware including 3D printer and Laser Cutter, their mechanisms and safety precautions.
1.6	Checking water turbidity and Total Dissolved Solid with electronic building blocks sensors. Compare turbidity and Total Dissolved Solid with of sea water, muddy water, pond water, tap water and distilled water	Integrated Science	The lessons are designed to be part of the IS curriculum, in association with the IS topic: water. The teaching method used in this class will be a combination of lecture and experiment. After students finish taking notes they are engaged in experiments. In the experiment, students will learn to use an electronic TDS sensor, collect data. Students are engaged in to lab report writing. They'll have to identify variables, learn the importance of a control experiment, make a proper hypothesis, draw graphs and charts to represent data, draw conclusions and evaluate the experiment. The learning outcomes of the activity is to understand the impurities of water, different methods of water purifications, how to write a lab report and how to use apparatus in a laboratory.
1.7	Design and produce a water purification setup with 3D CAD CAM and manufacture with a 3D Printer	Information and Communication Technology	The lessons are designed to be part of the ICT curriculum which also covers are of knowledge of IS in activity 1.6. Students will learn to use a 3D Design software to draw simple objects. They will then learn to export a file in STL (or other common 3D object). And then import it into the 3D printer's driver software so that they can print it out. They are engaged in design thinking to design and produce a device that filters water.
1.8	Introduction to Micro:bit compatible environment monitoring sensors	Information and Communication Technology	These lessons are designed to be part of the ICT curriculum. Students will learn to program a micro controller to perform various functions. The teaching method will be a lecture styled. Students will receive a micro:bit and input simple programs into it, execute and modify the programs, observe results of the programs, and save the programs for retrieval at a later stage. The students' learning outcome will be

			understanding the various forms of systems: mechanical, electrical, electronic, pneumatic, and computing as well as their principles of operation. Analysis and identification of control systems as input, process and output elements and feedback. Understand the importance of the stored program in an automated processing task and using programs to control the computer.
1.9	Design and produce a Micro:bit environment monitoring station	Design and Technology	These lessons are designed to be part of the DT curriculum. Student will construct kits for model and simulate technological solutions. Design of simple systems to measure the weather and environment. The students will implement solutions to design problems with the help of CAD and CAM machineries in the campus. The will also be engaged in using IT tools such as CAD software to present design ideas.
2.1	Measuring air CO_2 Concentration Calibrating a digital device	Integrated Science	This lesson is designed to be part of the IS curriculum, specifically for the Air chapter. The teaching style of the lessons will be a lecture with an investigation. Students will learn that air is a mixture of gases and be able to state the percentage of main gases in the air. Then students will learn to use an electronic device that measure the CO_2 concentration.
2.2	Comparing CO_2 concentration of expired air before and after exercise	Physical Education	This lesson is designed to be part of the PE curriculum which is part of sport science, it also involves knowledge from IS's respiration and gas exchange topics. The structure of the lesson will be part lecture and experiment. The students will learn to use the CO_2 meter to collect data before and after exercise to investigate if one's CO_2 exhaled will increase after exercise.
2.3-2.4	Comparing CO_2 concentration outside leaves under different conditions; Process data collected from an experiment.	Integrated Science	These lessons are designed to be part of the IS curriculum, specifically for the photosynthesis and gas exchange topics. The structure of the lesson will be part lecture and part experiment. The students will use a CO_2 meter to collect data of air around leaves in different condition to determine whether the plant is undergoing photosynthesis or respiration.
2.5	Testing the Micro:bit environment monitoring station	Geography	These lessons are designed to be part of the geography curriculum. Specifically, for the weather and climate chapter. Students will use data-logging equipment to record local weather data over a period, use a spreadsheet log the data present them in a graphical way. The teaching method used in this class will be a combination of lecture and practical. After students finish taking notes, they are engaged in the practical work. In the practical, they will be deploying the micro:bit environment monitoring station to log the weather of the campus.
2.6	Intermediate 2D and 3D Computer Aided Design and Manufacturing	Information and Communication Technology	The lessons are designed to be part of the ICT curriculum which also covers area of knowledge of mathematics and design technology. The lesson structure will be a lecture-based structure in a computer room. Students will learn to use a 3D Design software to draw simple objects. They will then learn to export a file in STL (or other common 3D object) and DXF (or other common vector graphics) file type. And then import it into the 3D printer's driver software so that they can print it out, and into a laser cutter software so they can cut it out. The teacher will also elaborate on the various types of computer aided manufacturing hardware including 3D printer and Laser Cutter, their mechanisms and safety precautions.
2.7-12	STEM@Ti-I Project:	IS, ICT, DT, PE	These lessons are designed to be a pan-subject investigation. Students form small groups and choose a topic related to coordination, metabolism or physical fitness. The lesson structure will be tutorial styled. Students will consult with their subject teachers respectively on their viability and design of their investigation, and teacher will provide guidance and support. The process of designing and making their

			apparatus helps the student to practice their knowledge from DT and ICT. The data collection and processing involve ICT knowledge. And the conclusion and evaluation writing involve IS and PE knowledge.
3.1-3.4	Drawing with an electronic drawing board in a virtual 3D environment; Sculpturing with an electronic drawing board in a virtual 3D environment; Creating a virtual reality art gallery with the digital artwork from 3.1 and 3.2; Using 2D and 3D softwares to recreate artwork produced in 3.1 and 3.2 in real life with laser cutter and 3D printer.	Visual Arts	These lessons are designed to be a part of the VA curriculum which also involves knowledge and skills in technology education. The structure of these lessons will be a part lecture part tutorial style. Students will explore and apply skills and knowledge of traditional and emerging technology in visual communication. Then, students use of a range of appropriate machines to recreate their work, including 3D printer and laser cutter. Students will also learn to export their work into a virtual environment in which they will use coding to programme the tour. This activity engages students in Technology Education.

The STEM@Ti-I after school activities

Activity Number	Name of activities	Content	No. of sessions and duration	Teachers/Supporting personnel	Expected learning outcome
A.1	Interior design for an ideal home	Designing an ideal home with 3D design software	2 sessions (3 hours)	Teachers/Supporting personnel ICT Teachers, DT teachers and TSS	Able to use 3D design software, including drawing geometric figures, use 3D tools such as push-pull to make stereoscopic graphics, recognize the 3D warehouse, and download the furniture model into the design.
A.2	Interior design for an ideal home	Making an ideal home with 3D printer and laser cutter	2 sessions (3 hours)		Understanding the operation principle of 3D printers and laser cutting machines, and import the reduced size of ideal home models for 3D printing and laser cutting.
A.3	Interior design for an ideal home	Import 3D models into VR software	2 sessions (3 hours)	ICT teachers and TSS	Import the ideal home 3D model into VR software and using coding skills to design and create a mini VR game.

A.4	Shooting live video to create a VR movie	Use 360-degree panoramic VR camera to capture street and regional images in different parts of Hong Kong. Create VR short films to learn about the streets, facilities and infrastructure of the CBD, inner city, suburban and suburban areas.	2 sessions (3 hours)	ICT teachers and TSS	Multimedia production, including: creating or capturing images, sounds and/or videos with simple tools or devices (e.g. digital cameras, microphones, digital camcorders) Editing multimedia elements with basic skills such as resizing and rotating images, adjusting audio volume and editing [video] movies. Integrating multimedia elements into the product.
A.5	Shooting live video to create a VR movie	Post-production of VR movies after-school activity.	4 sessions (6 hours)	ICT teachers, TSS	
A.6	Shooting live video to create a VR movie	Visit the Hong Kong Geopark and take VR images to master geological knowledge and the formation of hexagonal stones	3 sessions (4.5 hours)	ICT teachers and TSS	The formation of rock (volcanic, sedimentary, metamorphic) Hong Kong's topography and distribution of geological overall topography Types and distribution of major rocks in Hong Kong Major geological features of Hong Kong (folds and faults)
A.7	Shooting live video to create a VR movie	Display student works and geography learning materials in the STEM Room VR creative space	Half day activity (4.5 hours)	ICT teachers, geography teachers and TSS	Promote the fun of VR, Geography, and Computer Science and its content to students
A.8	Shooting live video to create a VR movie	Use the VR mature textbook to learn urban planning topics in the STEM Room VR creative space	2 sessions (3 hours)	ICT teachers, geography teachers and TSS	Map reading with different types and scales. Identify different types of shapes in the aerial photos.
A.9	Micro:bit, Arduino and IOT training	Introduction to coding and programming in a blocky environment	3 sessions (4.5 hours)	ICT teachers, TSS	Understand the various forms of systems: mechanical, electrical, electronic, pneumatic, and computing as well as their principles of operation Analysis and identification of control systems as input, process and output elements and feedback Understand the importance of the stored program in an automated processing task and using programs to control the computer Input simple programs into the computer, execute and modify
A.10	Robot arm and robot car programming	Programming robot arm to pick up objects and robot car to follow a path and avoid obstacles	3 sessions (4.5 hours)	ICT teachers, TSS	

					the programs, observe results of the programs, and save the programs for retrieval at a later stage

b. *Teacher training, if applicable*

Training should take place out of lesson hours.

Activity Number	Activity name	Content	Duration (Hours)	Hired personnel	Expected learning outcomes
T.1	3D CAD and teaching methods	Learning how to use a 3D CAD software. Integration of 3D CAD with mathematics and geometry. Joining methods of CAM materials	2	To ensure the sustainability of the project, teaching staff must undergo professional training in order to properly teach and run the programme. Training should be taught by professional 3rd party training providers who have experience on running such programmes in other schools. Hardware training should ideally be taught by the vendor of such machines as they should be most familiar with them. Recruited trainer must have relevant university degree, education diploma or equivalent, and have more than 3 years experience in teaching local STEM courses.	Be able to use CAD softwares to design 3D and 2D objects. Provide guidance in projects.
T.2	3D CAD with 3D Scanner		1.5		
T.3	CAM: Operating a laser cutter	Operating a laser cutter, calibration, materials knowledge, laser safety, software operation, integration with CAD and maintenance.	1.5		Be able to operate a laser cutter and aware of safety hazards.
T.4	CAM: Operating a 3D printer	Operating a 3D printer, calibration, materials knowledge, software operation, integration with CAD and maintenance.	1.5		Be able to operate a 3D printer and aware of safety hazards.
T.5	How to teach with electronic building blocks	Basics of electronic building blocks, usage of IO, project-based learning with electronic building blocks, scenario training, coding with electronic building blocks.	2		Be able to teach STEM projects with electronic building blocks. Manage projects and provide guidance.
T.6	How to teach coding with block programming and Arduino	Basics of block programming, integrating block programming into robots. Arduino C coding language. Operating a microcontroller with Arduino code.	2		Be able to teach block and C programming and provide guidance in projects.
T7	Product Design and Project based teaching	Product design life cycle. Integrate curriculum knowledge into product design and project-based learning. Project based teaching management.	1.5		Be able to lead students to undergo the product design life cycle and manage projects.
T8	360 degree VR camcorder operation training	360-degree panoramic VR camera operation training Shooting skills and teaching skills training	1.5		Responsible teachers and technical colleagues can master all software and hardware operations and teaching skills
T9	VR image editing software operation training	How to use VR video editing software and teaching techniques	1.5		
T10	VR headset,	Training for VR headset setup and operation.	1.5		

	operating software and computer usage training and customized VR content preparation training	Customized VR content and related teaching techniques.			
T11	2D/3D drawing pen usage training	Learning how to use and operate 2D/3D drawing pen and related software for painting and digital sculpturing	1.5	Recruited trainer must have relevant university degree, education diploma or equivalent, and have more than 3 years experience in teaching local STEM courses.	Responsible teachers and technical colleagues can master all 2D/3D drawing pen software and hardware operations and teaching skills

c. Example of STEM Lesson Plan:

Jockey Club Ti-I College

Teacher:	Year Level: S1
Lesson Duration: 70 minutes	Activity: Building a solar powered car with electronic building blocks (1.2)
Date:	

Lesson Summary：

Infusing STEM knowledge, arrange the following activities for S1 students. Introduce the function and application of the DC motor electronic building block Improve students' understanding on the concept of energy conversion Enhance students' ability to work with and STEM teaching tools and modules

Expected Learning Outcome：

After this lesson, students should be able to: 1.Design a Mars Rover incorporating a DC motor 2.Understand the concept of energy conversion, that the Mars Rover receive energy from the sun and converted it to kinetic energy 3. Develop interest in scientific exploration and technology, actively participate in learning activities and to learn in a self-actualized manner 4. Develop a good ICT learner profile, so that they can use ICT effectively and ethically

Key learning area

Science and technologies around us, understand the world in the informative generation

Teaching objectives:

1. Students can master programming, electronic circuit principles and design, and can apply the knowledge to complete related learning tasks.
2. Use the Block Code Editor for Micro:bit to create a tram remote control program.

After completing this lesson, students can

1. Write a simple program and apply the programming structure—sequences, branches, and loops
2. Application programming to solve problems and develop computational thinking
3. Name the source of energy and its use in everyday life (e.g. light and electricity)
4. Speak energy examples and energy conversion (e.g.: light, sound, electricity)
5. Learn about simple machines: rollers
6. Apply design cycles to design and build products
7. Explain the application of science and technology in daily life and its impact on daily life.

Teaching apparatus：

Power Bit*1 Wire Bit*1 DC Motor Bit*1 Electric Cables*1 Solar Panel*1 3D Printed Rover Parts*1 Cardboard
Scissors Masking Tape Stopwatch Strings Coloured Paper Drinking Straws Skewer sticks Glue gun 3D printed/ Laser cut wheels Wooden Rover Body Other Crafting tools

Venue: Playground with plenty of direct sunlight

Time (mins)	Procedure	Activity	Questions/ Lecture/ Instructions	Arrangement	Resources	Knowledge and Skills
5	Initiate	Ask guiding questions	What are the types of energy What is energy conversion What are sustainable sources of energy, what are green energy?	Slideshow		Make a hypothesis, Communication skills
5	Development		Introduce the basics of solar power, solar panels, its materials and limitation. Elaborate that all energy on Earth came from the sun	Slideshow		Think, discuss and share.
5	Development	Demonstrate, distribute materials, elaborate	Teacher showcase the solar rover. Asks the students about the function of each part. Elaborate on mechanics of wheels and rollers.		Teacher's model	Think, discuss and share.
15	Development	Small group activity	Students uses electronic building blocks to construct a circuit. Measure the dimensions of the blocks. Design and produce the rover.		Teacher instruct students to test the 3 modes of a DC motor.	Communication skills, critical thinking, creativity, problem solving skills, collaborative skills.
5	Transit		Finalize product, packup and clean materials. Transit to playground for test run.			Scientific investigation, basic workflow of science and technology activities.
25	Development	Test	Test each group's rover, instruct students to record experiment results.		Worksheets, stopwatch, strings	

5	Transit		Pack up material, return to STEM Room			
5	Summary		Teacher concludes lesson	Slideshow		
	Extension		Open the Micro:bit makecode page and write a program that controls the movement of the rover. And assemble the Micro:bit to the Rover and connect the relevant circuit accessories.			Apply coding knowledge and skills.
	Extension		Complete the worksheet. Use appropriate graphs and charts to demonstrate the experiment results.			Make a logical hypothesis. Using a spreadsheet to compute and generate graphs and charts.

d. "STEM Room" recommended usage timetable (starting from the 2019-20 school year):

In addition to arranging the STEM Innovation Learning Activities mentioned above, the school is also planning to arrange some of the following subjects in the creative space for classroom activities. It is expected that resources will be used to support interdisciplinary learning and STEM education is integrated into the regular classroom, and the details are as follows:

Subject	Grade	Time
ICT	S1-S3	On average 1 lesson per class per month
Integrated Science	S1-S3	On average 1 lesson per class per month

VA	S1-S3	4 lessons per semester
Geography	S1-S3	4 lessons per semester
STEM@Ti-I After-school activities	Students who participate in Science Society (STEM@Ti-I sub-section) and the "STEM Design and Application Competition"	In the after-school hours (about 45 minutes to 1 hour) under the supervision of teachers.

In addition, the school plans to hold community STEM workshops and seminars for teachers in the same district in the "STEM Room" every year.

e. Equipment (including installation of new fixtures or facilities), if applicable

	Details of equipment to be procured	Contribution to fulfilment of the project aim(s) and if applicable, the expected utilization rate
1	Electronic modules (Inventor Kit) - 12 sets	• Essential for the completion of student activity 1.1, 1.2, 1.3, 1.4 1.6, 2.1, 2.2, 2.3, 2.7, 2.8, 2.9, 2.10 and STEM@Ti-I After-school activities mentioned in student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
2	Micro:Bit and expansion modules - 70 sets	• Essential for the completion of student activity 1.8, 1.9, 2.5, and STEM@Ti-I After-school activities A.10 and A.11 mentioned in student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
3	Advanced Arduino and sensor kits - 12 sets	• Essential for the completion of student activity 1.1, 1.2, 1.3, 1.4 1.6, 2.1, 2.2, 2.3, 2.7, 2.8, 2.9, 2.10, and STEM@Ti-I After-school activities A.10 and A.11 mentioned in student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
4	IoT and related sensor kits - 50 sets	• Essential for the completion of student activity 2.7, 2.8, 2.9, 2.10 and STEM@Ti-I After-school activities A.10 and A.11 mentioned in student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
5	STEM Sensors kit for projects (CO2, TDS, Turbidity, PM2.5, Light/Sound/Temperature/Motion, Waterproof Temperature) - 12 sets	• Essential for the completion of student activity 1.6, 1.7, 2.1, 2.2, 2.3, 2.4, and STEM@Ti-I After-school activities mentioned in student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
6	High-precision 3D Scanner - 1 set	• Essential for the completion of student activity STEM@Ti-I After-school activities mentioned in student activity.

		• STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Support the “STEM Design and Application Competition” held on campus to provide basic STEM equipment for students • Providing basic STEM equipment for the selected students in the school to participate in off-campus open competitions • Provide basic equipment for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
7	Interactive panel - 1 set	• Plan to be deployed in the teaching area of the “STEM Room” to enhance the interactive learning elements of teachers and classmates in STEM teaching. • Provide basic infrastructure for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
8	Notebook PC（20 sets）	• Support product design team project and design 3D printing and laser cutting models • Support the “STEM Design and Application Competition” held on campus to provide basic STEM equipment for students • Providing basic STEM equipment for the selected students in the school to participate in off-campus open competitions • Provide basic infrastructure for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
9	High-end gaming desktop PC (1 set) with multimedia editing software (1 set)	• Essential for the student activity 3.3 VR activity learning projects mentioned and STEM@Ti-I After-school activities mentioned in student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic equipment for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
10	High-end gaming desktop PC （1 set） — for VR device kit and related applications	
11	VR Headset and Control Device Kit（4 sets） — support spatial positioning and motion tracking functions	
12	Supporting equipment for the VR Experience Zone, including: - 360-degree camera for VR image and video shooting - Selfie stick (1 meter long)	
13	3D printers - 4 sets	• Essential in making activities mentioned in 1.1, 1.2, 1.3, 1.4, 1,5, 2.5, 2.7, 2.8, 2.9, 2.10, 2.11 and 3.4 under student activity and STEM@Ti-I After-school activities. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Support the “STEM Design and Application Competition” held on campus to provide basic STEM equipment for students • Providing basic STEM equipment for the selected students in the school to participate in off-campus open competitions • Provide basic equipment for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education

14	Laser cutter including peripheral coolers and fume extractor (1 set)	• Essential in making activities mentioned in 1.1, 1.2, 1.3, 1.4, 1,5, 2.5, 2.7, 2.8, 2.9, 2.10, 2.11 and 3.4 under student activity and STEM@Ti-I After-school activities. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Support the "STEM Design and Application Competition" held on campus to provide basic STEM equipment for students • Providing basic STEM equipment for the selected students in the school to participate in off-campus open competitions • Provide basic equipment for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
15	Moisture Resistant Box (2 sets)	• Complimentary to store materials for 3D printers and laser cutter. • Support the "STEM Design and Application Competition" held on campus to provide basic STEM equipment for students • Providing basic STEM equipment for the selected students in the school to participate in off-campus open competitions • Provide basic equipment for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
16	Robots with LED lighting and greyscale sensors (30 sets)	• Essential for the completion of A.11 STEM@Ti-I After-school activities student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
17	Robotic arm kit (10 sets)	• Essential for the completion of A.11 STEM@Ti-I After-school activities student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
18	CNC Machine (1 set)	• Essential for the making activity learning projects mentioned and STEM@Ti-I After-school activities mentioned in student activity. • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Support the "STEM Design and Application Competition" held on campus to provide basic STEM equipment for students • Providing basic STEM equipment for the selected students in the school to participate in off-campus open competitions • Provide basic equipment for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to

		develop STEM education
19	2D/3D computer graphics drawing pen with design software (20 sets)	• Essential for the completion of student activity 3.1-3.2 and STEM@Ti-I After-school activities student activity • STEM learning activities (as mentioned above) in the 2020-21 school year and 2021-22 school year, for use by students in S1-S3 of the school. • Support the “STEM Design and Application Competition” held in the school to provide basic STEM equipment for students • Providing basic STEM equipment for the selected students in the school to participate in off-campus open competitions • Provide basic teaching materials for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • Our school will continue to use it after the plan is completed to develop STEM education
20	3D sculpture drawing software (20 sets)	
21	Augmented Reality Sandbox	Essential for the teaching of geographic concepts through a variety of graphics effects and simulations in student activity 2.5

f. ***Construction works, if applicable***

Item	Details of the construction works proposed	Contribution to fulfilment of the project aim(s) and if applicable, the expected utilization rate
1	Wall and ceiling painting refurbishment of STEM Room (930 sq ft)	• STEM interdisciplinary classroom activities in S1-S3 (a total of 15 classes) (school-based), and use in the Science Society (STEM@Ti-I sub-section) activities • For some sections of other subjects, please refer to 2.7(d) “STEM Room” recommended timetable for details. • Support the “STEM Design and Application Competition” held on campus to provide infrastructure for students • Providing infrastructure for the selected students in the school to participate in off-campus open competitions • Providing facility for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • The school will continue to use the STEM Room after the completion of the program to develop STEM education.
2	Handling all debris, mud, flooring, furniture and fittings, etc.	• Eliminate old facilities and avoid potential hazards • STEM interdisciplinary classroom activities in S1-S3 (a total of 15 classes) (school-based), and use in the Science Society (STEM@Ti-I sub-section) activities • For some sections of other subjects, please refer to 2.7(d) “STEM Room” recommended timetable for details. • Support the “STEM Design and Application Competition” held on campus to provide infrastructure for students • Providing infrastructure for the selected students in the school to participate in off-campus open competitions • Providing facility for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations • The school will continue to use the STEM Room after the completion of the program to develop STEM education.
3	STEM Room Air Vent Window Refurbishment	• Modify the existing infrastructure of STEM Room • Enhance the atmosphere and provide space for students to discuss and collaborate to develop their creativity • STEM interdisciplinary classroom activities in S1-S3 (a total of 15 classes) (school-based), and use in the Science Society (STEM@Ti-I sub-section) activities • For some sections of other subjects, please refer to 2.7(d) “STEM Room” recommended timetable for details. • Support the “STEM Design and Application Competition” held
4	Graffitti wall x 2 sets	
5	STEM themed wall decoration outside the STEM Room x 1 set	
6	New Fire-proof Glass Entrance Door x 1 set	

<table>
<tr><td>7</td><td>Furniture for STEM Room（Movable table x 13 sets and Student Chairs x 36 sets)</td><td rowspan="3">on campus to provide infrastructure for students
• Providing infrastructure for the selected students in the school to participate in off-campus open competitions
• Providing facility for the "Parents'-Teachers' Association" activities and workshops organized in collaboration with community organizations
• The school will continue to use the STEM Room after the completion of the program to develop STEM education.</td></tr>
<tr><td>8</td><td>Heavy Duty Workbench (8 sets)</td></tr>
<tr><td>9</td><td>Furniture - Full-height display cupboard/cabinet with tempered glass door</td></tr>
</table>

g. Features of the school-based curriculum to be developed, if applicable

Once all equipment of the STEM Room is employed and teachers are well trained to utilize the resources, students from secondary 1 to secondary 3 will have some of their ICT lessons in the STEM Room as mentioned in 2.7a. STEM content would be integrated into the ICT lessons of junior secondary students.

Four lessons of each semester from Geography and Visual Arts would take place in the STEM Room for students to participate in experience learning sessions with Virtual Reality activities. The VR experiential learning would help students to visualize territorial landforms such as tropical rainforests, plate boundaries, coastal transportation of materials, rivers et cetra, to deepen their impression of said topics. As for Visual Arts, the school hopes to implement VR to give students an opportunity to facilitate diverse identity and provides teachers and students with new ideas about using VR in art education. Also, art teachers can use VR as a tool to help students better understand art and develop creative ideas. It would help students to visualize interact with their personal imagination.

h. Other activities, if applicable (Please specify how they contribute to fulfilment of the project aim(s).)

The school plans to establish a Science Society (STEM@Ti-I sub-section) as a weekly after-school student activities club for active pupils who are interested to extend their learning and experiences on STEM related topics. The Science Society (STEM@Ti-I sub-section) would focus on teaching students advanced knowledge in 3D CAD CAM, Robotics, Coding, Rapid Prototyping and Circuitries. Utilizing VR technologies and equipment, club members would be able to produce VR movies and

Students with outstanding abilities would be selected to participate in interschool STEM competitions for them to practice their knowledge and skills. It would also be a great opportunity to share the school’s progress on STEM learning with other participating entities.

2.8 Budget

Total Grant Sought: HK$ 1,184,200

<table>
<tr><th rowspan="2">Budget Categories*</th><th colspan="2">Breakdown for the budget items</th><th rowspan="2">Justifications
(Please provide justification for each budget item, including the qualifications and experiences required of the hired personnel.)</th></tr>
<tr><th>Item</th><th>Amount (HK$)</th></tr>
<tr><td>a. Staff</td><td colspan="3">Not Applicable</td></tr>
<tr><td rowspan="2">b. Service</td><td>1. Workshop for teachers as described in 2.7b.
$880 x 18 hours</td><td>15,840</td><td>Essential for teaching staff to be able to learn the technologies and ways of teaching with the new STEM materials.</td></tr>
<tr><td>2. Onsite support and consultation services throughout the project period ($780 x 35 hours)</td><td>27,300</td><td>Supporting staff regularly visit the school to provide the following services, including:
• Making teaching aids and providing technical support, including: All subject related teaching aids in STEM after-school activities in S1 to S3.
• Assist teachers to prepare learning</td></tr>
</table>

			and teaching resources, including: Worksheets and PPT materials related to all topics in STEM after-school activities in S1 to S3. • In addition, support staff will meet with teachers on a regular basis (twice each semester) to review the teaching content of the STEM curriculum and provide technical support for the new STEM textbook content. Supporting staff must have a relevant university degree, education diploma or equivalent, and have more than 3 years experience in teaching local STEM courses
c. Equipment	1. Electronic Building Blocks (Inventor Kit) - 12 sets	30,000	Basic electronics and sensors to support all STEM courses covered in this project.
	2. Micro:Bit and expansion modules - 70 sets	13,440	Can support block programming and related teaching activities. Students can realize STEM products/inventions based on these materials.
	3. Advanced Arduino and sensor kits - 12 sets	26,280	Advanced electronics and sensors to support all STEM courses covered in this project.
	4. IoT and related sensor kits - 50 sets	34,000	Can support Internet of Things (IoT) application platform and related programming teaching, allowing students to realize smart home products with Internet of Things functions through programming.
	5. STEM Sensors kit for projects (CO_2, TDS, Turbidity, PM2.5, Light/Sound/Temperature/Motion, Waterproof Temperature) - 12 sets	30,500	Advanced electronics and sensors to support all STEM courses covered in this project.
	6. High-precision 3D Scanner - 1 set	8,500	Support product design team project study and production of STEM teaching tools and student works.
	7. Interactive panel - 1 set	50,000	Strengthen the interactive learning elements of teachers and students in STEM teaching.
	8. Notebook PC（20 sets）	100,000	Support product design team project study and design of 3D printed works.
	9. High-end gaming desktop PC (1 set) with multimedia editing software (1 set)	12,052	Requires a gaming computer with an independent graphics card to assist in the production of various teaching content and student work video content and cutting
	10. High-end gaming desktop PC（1 set）－ for VR device kit and related applications	15,000	Requires a gaming computer with a separate graphics card to assist in the production of VR content and cutting

	11. VR Headset and Control Device Kit（4 sets） － support spatial positioning and motion tracking functions	12,800	Operate VR glasses and somatosensory instruments, operate virtual reality equipment sets to assist training, and cooperate with customized teaching content.
	12. Supporting equipment for the VR Experience Zone, including: - 360-degree camera for VR image and video shooting - Selfie stick (1 meter long)	4,500	For producing customized VR teaching content.
	13. 3D printers - 4 sets	80,000	Support product design team project study and production of STEM teaching tools and student works. *We reckon the potential operation and safety issue of 3D printers and will implement appropriate safety measures for the usage of 3D printers at the “STEM Room”.
	14. Laser cutter including peripheral coolers and fume extractor (1 set)	65,000	Support product design team project study and production of STEM teaching tools and student works. *We reckon the potential operation and safety issue of laser cutter and will implement appropriate safety measures for the usage of laser cutter at the “STEM Room”.
	15. Moisture Resistant Box (2 sets)	8,000	Used to store 3D printing supplies, and STEM works that require special storage.
	16. Robots with LED lighting and greyscale sensors (30 sets)	25,500	Support learning activities of control systems as input, process and output elements and feedback.
	17. Robotic arm kit (10 sets)	22,000	Support learning activities of control systems as input, process and output elements and feedback.
	18. CNC Machine (1 set)	60,000	Support product design team project study and production of STEM teaching tools and student works. *We reckon the potential operation and safety issue of CNC machine and will implement appropriate safety measures for the usage of CNC machine at the “STEM Room”.
	19. 2D/3D computer graphics drawing pen with design software (20 sets)	25,000	Support product design team project study and production of STEM teaching tools and student works.
	20. 3D sculpture drawing software (20 sets)	20,000	Support product design team project study and production of STEM teaching tools and student works.
	21. Augmented Reality Sandbox	60,000	Generate various graphics effects and simulations

d. Works	1. Wall and ceiling painting refurbishment (930 sq ft)	60,000	In accordance with the theme of the "STEM Room", reorganize part of the wall of the room to facilitate students' group discussions, design sketches, and planning progress.
	2. Handling all debris, mud, flooring, furniture and fittings, etc.	35,000	Includes costs related to clearing existing room facilities.
	3. STEM Room Air Vent Window Refurbishment	5,000	In accordance with the theme of the "STEM Room", reorganize the part of the wall adjacent to the computer room and add glass wall partitions. To enhance the atmosphere of STEM learning and facilitate students and teachers to make good use of two special room resources.
	4. Graffiti wall x 2 sets	15,000	Install a graffiti wall to facilitate students' group discussions, design sketches, and planning progress.
	5. New Fire-proof Glass Entrance x 1 set	30,000	In accordance with the theme of the "STEM Room", the fire glass doors at the entrance of the room were reorganized to facilitate students' group discussions, design sketches, and planning of work progress. You can also let other teachers and students see the internal activities and enhance the atmosphere of STEM learning.
	6. Furniture for STEM Room （Movable table x 13 sets and Student Chairs x 36 sets)	60,000	Assign student tables and chairs, which can be flexibly allocated so that students can group for STEM activities and group discussions.
	7. Workbench (8 sets)	48,000	Assign 8 sets of multifunctional woodworking tables to place heavy equipment, such as 3D printers. And reserve space for students to use STEM tools to make works.
	8. Furniture - Full-height display cupboard with tempered glass door	100,000	Assign a new 10x1.85m cabinets for storage of student exhibits and scientific equipment.
e. General expenses	1. Plastic Filaments for 3D Printing Projects	5,000	To produce students' work in class, club time and exhibitions.
	2. Acrylic Boards and plywood boards for Laser Cutting Projects	5,000	To produce students' work in class, club time and exhibitions.
	3. Crafts materials	2,007	To produce students' work in class, club time and exhibitions.
	4. Auditing expenses	15,000	
f. Contingency	Contingency fee for Works (d*10%)	35,300	
	General contingency fee (b+c+e)*0.03	23,181	
	Total Grant Sought (HK$):	**$1,184,200**	

(i) Applicants should refer to the QEF Pricing Standards in completing the above table. All staff recruitment and procurement of goods and services should be carried out on an open, fair and competitive basis. Budget categories not applicable to this application can be deleted.
(ii) For applications involving school improvement works, a contingency provision of not more than 10% for carrying out works is considered acceptable.
(iii) For projects lasting for more than one year, a contingency provision of not more than 3% of the total budget exclusive of staff cost and works expenditure (including the related contingency provision), if any, is considered acceptable.

3 Expected Project Outcomes

3.1 Deliverables / outcomes

☑Learning and teaching materials ☐Resource package

☐~~e-deliverables*~~*~~(please specify)~~* ___________________________________

☑Others *(please specify)* ____

- Arrange seminars at the school's "STEM Room" every academic year to invite other school teachers to participate in and share learning and teaching resources such as teaching schedule, teaching plan and worksheets. The topics include: STEM+IS after-school activities and VR after-school activities.
- Students' work

3.2 Positive impact on quality education/ the school's development

By employing new equipment, developing the curriculum and training teachers, the school should be able to develop STEM education in a sustainable and systematic way with hopes of nurturing students into learners of the 21st century.

3.3 Evaluation

Please state the methodologies of evaluating project effectiveness and provide the success criteria.
(Examples: lesson observation, questionnaire survey, focus group interview, pre-test/post-test)
A proper evaluation would be done to review the progress and performance of students' learning and of our staff teaching. It would be done by in class observation, surveys, focus groups and review of students' work and performance in STEM related subjects. The investigation should follow the basic principles of research methods and design. Questions should not be biased nor leading, and each interviewed party should be truthful and honest during the process of investigation. The successful criteria will be based on the satisfaction (positive feedback) from students, teachers and parents through questionnaires and/or interviews. The school would also assess the following criteria to measure the success of the programme:

1. At least 70% teachers agreed that the effectiveness of promoting STEM teaching and learning was enhanced.
2. At least 70% students agreed that their motivation to learn STEM related subjects and knowledge was enhanced.
3. At least 70% students agreed that their creativity, collaboration and problem-solving skills were improved.
4. At least 70% teachers agreed that their professional abilities were further developed.

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For applications with grant sought exceeding $200,000, please complete Parts 3.4 and 3.5.

3.4 Sustainability of the project

The school shall organize a proper evaluation and appraisal meeting to review the scheme with the organizing committee and participating teachers. From the discussion, the programme would be improved and extended into new topics of STEM teaching.
After completion, the school would set budget for the maintenance of all STEM equipment employed in this programme so that these fixed assets could be used to aid the teaching and learning processes and improve such experiences.

3.5 Dissemination

This project would co-organize workshops and seminars with local community organizations to promote STEM teaching and learning, and to share our experience from the projects. These workshops shall invite primary schools students to experience the fruits of STEM education. Besides, the school will arrange two "Parents'-Teachers' Association" STEM workshops throughout this project.
At the end of each academic year, the school would organize a STEM fair to display projects and work completed by our students with the local community.
Teachers trained and equipped with new STEM skills set shall share their experience with other schools to help the academia to develop STEM teaching and learning.

4 Declaration

4.1 Our school understands that the expenditure items funded by the QEF is one-off. Our school will bear the recurrent expenditure incurred, including maintenance costs, daily operating costs, etc. and the possible consequences that may arise.

4.2 Our school will bear all possible consequences resulted from the related school premises alteration/ improvement works, including but not limited to the provision of relevant grants, repair works, etc.

4.3 The applicant school will observe all the rules and regulations on alteration to school premises (including structural alteration and conversion, change of room, etc.) and seek approval from the respective Regional Education Office before project commencement.

4.4 Our school will ensure that all procurement of goods and services is conducted on an open, fair and competitive basis with measures taken to avoid conflict of interests in the procurement process.

4.5 Our school will observe all related regulations and safety precautions stated at www.edb.gov.hk/en/te/dt-safety when setting up a special room involving machine tools and equipment. We will also take proper care of the safety concerns of operating laser cutters, 3D printers and CNC machines.

4.6 Our school will ensure sufficient space for installing the proposed equipment and students to carry out practical work safely.

4.7 Our school will make sure that the proposed school-based STEM curriculum would not affect or hinder the implementation of existing STEM related KLA/subjects, including Design and Technology (D&T).

5 Assets Usage Plan

Category (in alphabetical order)	**Item / Description**	**No. of Units**	**Total Cost**	**Proposed Plan for Deployment** *(Note)*
computer hardware	Electronic Building Blocks (Inventor Kit)	12	30,000	Maintained and utilized by STEM-related KLA subjects
	Micro:Bit and expansion modules	70	13,440	Maintained and utilized by STEM-related KLA subjects
	Advanced Arduino and sensor kits	12	26,280	Maintained and utilized by STEM-related KLA subjects
	IoT and related sensor kits	50	34,000	Maintained and utilized by STEM-related KLA subjects
	STEM Sensors kit for projects (CO_2, TDS, Turbidity, PM2.5, Light/Sound/Temperature/Motion, Waterproof Temperature)	12	30,500	Maintained and utilized by STEM-related KLA subjects
	High-precision 3D Scanner	1	8,500	Maintained and utilized by STEM-related KLA subjects
	Interactive panel	1	50,000	Maintained and utilized by STEM-related KLA subjects

	Notebook PC	20	100,000	Maintained and utilized by STEM-related KLA subjects
	High-end gaming desktop PC with multimedia editing software	1	12,052	Maintained and utilized by STEM-related KLA subjects
	High-end gaming desktop PC－for VR device kit and related applications	1	15,000	Maintained and utilized by STEM-related KLA subjects
	VR Headset and Control Device Kit	4	12,800	Maintained and utilized by STEM-related KLA subjects
	Supporting equipment for the VR Experience Zone, including: - 360-degree camera for VR image and video shooting - Selfie stick (1 meter long)	1	4,500	Maintained and utilized by STEM-related KLA subjects
	3D printers	4	80,000	Maintained and utilized by STEM-related KLA subjects
	Laser cutter including peripheral coolers and fume extractor	1	65,000	Maintained and utilized by STEM-related KLA subjects
	Moisture Resistant Box	2	8,000	Maintained and utilized by STEM-related KLA subjects
	Robots with LED lighting and greyscale sensors	30	25,500	Maintained and utilized by STEM-related KLA subjects
	Robotic arm kit	10	22,000	Maintained and utilized by STEM-related KLA subjects
	CNC Machine	1	60,000	Maintained and utilized by STEM-related KLA subjects
	2D/3D computer graphics drawing pen with design software	20	25,000	Maintained and utilized by STEM-related KLA subjects
	Augmented Reality Sandbox	1	60,000	Maintained and utilized by STEM-related KLA subjects
computer software	3D sculpture drawing software	20	20,000	Maintained and utilized by STEM-related KLA subjects

6 Report Submission Schedule

The school commits to submit proper reports in strict accordance with the following schedule:

Project Management (Should be submitted via the "Electronic Project Management System" (EPMS))		**Financial Management** (Hard copy together with supporting documents should be submitted to the QEF Secretariat by mail or in person)	
Type of report and reporting period	**Report due on**	**Type of report and reporting period**	**Report due on**
Progress Report 01/12/2020 - 31/05/2021	30/06/2021	Interim Financial Report 01/12/2020 - 31/05/2021	30/06/2021
Progress Report 01/06/2021 - 30/11/2021	31/12/2021	Interim Financial Report 01/06/2021 - 30/11/2021	31/12/2021
Progress Report 01/12/2021 - 31/05/2022	30/06/2022	Interim Financial Report 01/12/2021 - 31/05/2022	30/06/2022
Progress Report 01/06/2022 - 30/11/2022	31/12/2022	Interim Financial Report 01/06/2022 - 30/11/2022	31/12/2022
Final Report 01/12/2020 - 31/01/2023	30/04/2023	Final Financial Report 01/12/2022 - 31/01/2023	30/04/2023