Quality Education Fund
Application with Grant Sought Not Exceeding $200,000
Part B: Project Proposal

Project Title	**Project Number**
Development of evaluation tools to measure the impact of STEM activities 開發評估工具來衡量 STEM 活動的影響	2017/0364 (Revised)

Basic Information

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Beneficiaries

(a) Sector: ☐ Kindergarten ☐ Primary ☒ Secondary ☐ Special
(Please tick the appropriate box(es))

(b) Students: 120 (in number)* and S4-S6 (class level/~~age~~)*

(c) Teachers: 4 (in number)*

(d) Parents: _____ (in number)*

(e) Participating Schools (excluding applicant school): 2 (in number and types)*

(f) Others (please specify): _____

** Please specify where appropriate*

Proposal

(I) Project Needs

(a) Please state the aims of the project in clear and concise terms and elaborate on how the proposed project could impact on school development.

1) To establish a set of questions for assessing students' scientific development, as a protocol for gauging the impact of STEM activities.
2) To deploy the protocol for a specific type of STEM activity, namely mobile-app-based physics activities, and assess its scientific learning imapact on students.

(b) (i) What are the areas of the needs and priorities of the school?
(*Please tick the appropriate box(es)*)

☒ Enhance learning and teaching to facilitate students' knowledge on subjects / learning areas / generic skills development
☐ Promote students' social and emotional development
☐ Enhance school management / leadership and teachers' professional development / wellness
☐ Others (please specify) _____

(ii) Please give background information to justify the demonstrated needs as mentioned in (b)(i).
(*Please tick the appropriate box(es)*)

☐ School development plan: _____
☐ Survey findings: _____
☒ Literature review summary: Previous studies have shown students could have better creativity and critical thinking by learning science (Sulisworo & Sutadi, 2017), and motivation towards science learning could be enhanced through informal learning and activities in the field of science, technology, engineering and mathematics (STEM). Students gain experimental experiences and inspired during fun exploration. Scientific knowledge would then be developed (Behrendt, 2017). As a result, STEM activities become more prevalent in the recent decade around the world.
In Hong Kong, the promotion of STEM education was first proposed in 2015 Policy Address in order to cultivate students' interest in STEM subjects, enhance their ability in integration and application of knowledge and nurture students' creativity, collaboration and problem solving skills (EDB, 2016). However, most assessments are focus on knowledge. Assessment of motivation towards science learning and scientific creativity will be developed as protocol to evaluate the impact of STEM activities in this project.
☐ Assessments on students' performance: _____
☒ Relevant experiences: The project team has conducted several workshops for secondary school students on mobile-apps based experiments (sound speed measurement and apparent weight experiment etc) during their visit in AP, PolyU.
☐ Others (please specify) _____

(c) Please elaborate on the innovative ideas or new practices to enhance, adapt, complement and/or supplement the existing practices that will facilitate the development of the school to address the needs specific to its own context.

As formal science learning in secondary schools focus on covering various scientific phenomena as prescribed in the syllabus, relatively little time is allocated for hands-on laboratory and application experiences. Such practical sessions act as supplementary learning experiences and assist students to have more thorough and high-level conceptual understanding. Students' interest and motivation to learn science will be fostered, when meaningful connections between science knowledge and students' daily lives are seamlessly connected.

In particular, STEM activities in various forms emphasize the integration and application of interdisciplinary subjects knowledge and techniques to solve real-life problems. Typically such activities are conducted outside classrooms and are not bounded by the syllabus, and students can be immersed in hands-on inquiry with open-ended exploration. They are inspired to plan, investigate, build and create multiple right answers, which is more comparable with the actual process of scientific explorations. In such student-centered settings, students are encouraged to express their own thoughts freely, and investigations through a trial-and-error method is built-in as part of the exploration proces. As a result, creative problem-solving, critical thinking and scientific process skills will be developed.

However, the extent in which these goals are achieved through such interventions are rarely assessed; in fact there is a lack of effective evaluation tools to measure the impact of STEM activities. According to the overview of STEM Education promotion (EDB, 2015), "this would not only enhance students' interest in STEM areas, but also enable them to prepare for their future studies and careers in the areas and other fields requiring relevant knowledge, skills and attitudes" as shown in figure 1.

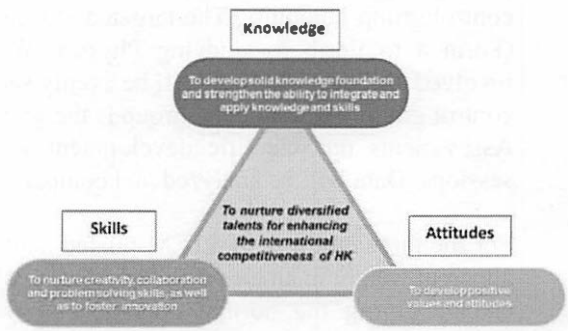

Figure 1 Framework of STEM Education in Hong Kong (EDB, 2015)

The existing assessments are mainly focus on the content and the ability of integration and application of interdisciplinary subjects knowledge (Guzey, Harwell, Moreno, Peralta & Moore, 2017; So, Zhan, Chow & Leung, 2017). The current project is to examine the impact on *learning motivation* and *skill* of STEM activities, creativity will be investigated as it becomes one of the important generic skills for students' development nowadays. Students' motivation towards science learning and scientific creativity will be constructed on the basis of study of Tuan, chin and Shieh (2005) and Hu and Adey (2002) respectively. These tests have been administered in China and Taiwan. Probably they could be adapted in Hong Kong.

Pilot study will be conducted to verify the relationship between STEM activities and their impact on science learning in the context of Hong Kong, by developing a set of assessment for schools' implementation. The assessment set include questions and scoring procedures will be prepared in both Chinese and English versions for local secondary schools to measure the impact of existing STEM activities, such as scientific creativity and students' motivation towards science learning. Science is being assessed in students' motivation test while creativity test examines a generic skill across STEM. In particular, we will test the effectiveness of the protocol by deploying it in the assessment of impact of mobile-app experiments on students' learning motivations and creativity. Such assessment tools could be used as a protocol for evaluating other STEM activities in schools.

(II) Project Feasibility

(a) Please describe the design of the project, including:

(i) Approach/Design/Activity (Applicants are advised to provide details on project activities as well as learning and teaching arrangements.)

A. Approach

In order to assist teachers in evaluating the impact of STEM activities, assessment with questions and scoring procedures will be developed in both English and Cantonese to facilitate studying with different media of instructions. Due to existing assessments focus on the understanding of STEM knowledge, the current project is going to investigate other aspects include:

- Students' motivation towards science learning (Tuan et. al, 2005)
- Scientific creativity (Hu & Adey, 2002)

B. Design

This project will first adapt some existing assessment questionnaires in literature which have been reported in literature for evaluating the two apsects listed in (A) for use in local shools. The questionaires will then be deployed to evaluate the impact of existing STEM activities offered by our department with the developed question sets. Once verified, the question sets will be used as a protocol for evaluating other STEM activities in the future. The questionnaire set will be developed between Dec 2018 to Jan 2019.

There will be three modules of STEM-related activities. In each module for participating students will be divided into two groups, (1) experimental and (2) control group randomly. The targeted students are senior high school students (Form 4 to Form 6) studying Physics. We expect the number of students involved around 120. They will be evenly separated as experimental group and control group. Experimental group is the group which attends STEM activities. Assessments on scientific development will be administered after activity sessions. Data will be analyzed and compared between groups.

For the three modules of STEM-related activities, the first one is based on the apparent weight in an elevator. Participants will experience the apparent weight change during the normal operation of the elevator. They can apply the knowledge of Newton's second law to account for the variation in the measured weight with the acceleration of the elevator.

The second modules can help to illustrate the vector nature of the gravitational acceleration. By observing the acceleration of a cart moving down a ramp with varying incline angles, participants can study the influence on the decomposition of the gravitational acceleration vector with different tilting angles.

The third modules is related to the Newton's third law. By investigating the collision of two carts with different mass configurations, participants can verify the action and reaction force pair according to the Newton's third law.

C. Activities

(1) *Demonstration of modules and assessment tools for the participating school teachers*. To familiarize participating school teachers with the procedures, a pilot run to demomstrate the modules will be conducted with the teachers. The participating school teachers will also try out the assessment set. This allows the team to anticipate the potential issues with the exercise and make relevant changes to the assessment. This is to be conducted in Feb 2019.

(2) *Full-scale launching of modules for students in participating schools*. After the modification of materials, a full-scale launching of the modules to the students will be conducted from Apr 2019 to Jul 2019. The teachers involved will co-teach the physics topics related to the activities and collaborate with the project team in running the STEM-related activities. The students will complete the developed question sets. The relationship between STEM activities and scientific development will be investigated. Moreover, opinions of teachers will be collected through survey forms.

(3) *Post-activity sharing session*. A sharing session will be organized to report the findings, and the potential future development of the practice arising from this

project.

(ii) Key Implementation Details
Project period: (12/2018) to (11/2019)

Month / Year	**Content / Activity / Event**	**Participants**
Dec 2018 – Jan 2019	• Development of assessment materials.	Project team members
Feb 2019 – Mar 2019	• Pilot run on demonstration of modules and assessment tools for the participating school teachers. • Collection of feedback from teachers	Physics Teachers of participating schools and project team members
Apr 2019 – Jul 2019	• Full-scale launching of modules for students in participating schools • Collection of feedback from teachers and students via online survey and focus group interview	
Aug 2019 – Nov 2019	• Analysis of student assessment • Sharing session with users • Evaluation of project	

(b) Please explain the extent of teachers' and/or principal's involvement and their roles in the project.

(i) Number of teachers involved and degree of input (time, types, etc.):
Four teachers involved. They will try out the modules and assessment set in the demonstration stage. Then they will co-teach the physics topics related to the activities and collaborate with the project team in running the STEM-related activities.

(ii) Roles of teachers in the project:
(Please tick the appropriate box(es))

☐ Leader ☒ Co-ordinator

☐ Developer ☒ Service recipient

☐ Others (please specify) _____

(c) Please provide the budget of the project and justify the major items involved.

Grant Sought: HK$ $197,800

Budget Item*	**Expenditure Detail (Including the breakdown for the budget items)**		**Justifications**
	Item	**Amount ($)**	
i) Staff	1 Project Assistant	$ 16,000 x 1.05 x 11 months = $ 184,800	The personnel involved will assist the project team members to develop the assessement materials, run for the STEM activities and assessment, collect feedback from the participants. The project assistant

			should possess a degree of related subjects, and at least one year of experience in conducting STEM activities in schools.
ii) Equipment	Experimental carts installed with magnets Balances Accessories to build experimental setup (e.g. ramp, mass, timer etc.)	20 x $200 = $4,000 5 x $100 = $500 10 x $350 = $3,500	
iii) General expenses	Printouts of teaching materials, Audit fee	$5000	
	Total Grant Sought ($):	$197,800	

** Please cross out as appropriate*

(III) Expected Project Outcomes

(i) Please describe how to evaluate the effectiveness of the project.
(*Please tick the appropriate box(es)*)

☐ Observation: _____

☒ Focused group interviews:
Interviews on randomly selected participating teachers and students will be conducted to gather their opinions on the project and impact on students' learning.

☒ Pre-and post-activity surveys:
Questionnaires will be used to collect both students and teachers' opinions on the project.

☒ Performance change of students in assessment: Assessments on students' scientific development, such as motivation and creativity will be administered.

☐ Others (please specify) _____

(ii) Please state the project deliverables or outcomes.
(*Please tick the appropriate box(es)*)

☐ Learning and teaching materials
☒ Resource package
☐ DVD
☐ Others (please specify) _____

Asset Usage Plan:

Category	Item/Description	No. of Units	Total Cost	Proposed Plan for Deployment
Equipment	Experimental carts installed with magnets	20	$4,000	PolyU
Equipment	Accessories to build experimental setup (e.g. ramps, timers, etc.)	10	$3500	PolyU

Report Submission Schedule

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

Project Management		Financial Management	
Type of Report and covering period	**Report due day**	**Type of Report and covering period**	**Report due day**
Final Report 01/12/2018 - 30/11/2019	29/02/2020	Final Financial Report 01/12/2018 - 30/11/2019	29/02/2020

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