Part C: Project Details

1. Background

Learning science process skills is crucial all over the world.

Learning science process skills has long been an important learning objective of the science curricula in many countries (American Association for the Advancement of Science, 1993; National Curriculum Board, 2009). Similarly, learning science process skills is also a curriculum emphasis in both junior secondary curriculum (CDC, 1998) and NSS curriculum (CDC & HKEAA, 2007a-e) in Hong Kong. For instance, in F.1 to F.3 science syllabus, it clearly states:

- *It is important that students progressing through the junior secondary level should acquire and continually develop the skills which will enable them to solve problems in a logical way and to make sense of the environment. These skills include:*
  - *a. the ability to observe closely and carefully*
  - *b. the ability to classify*
  - *c. the ability to measure accurately*
  - *d. the ability to handle equipment and apparatus properly and safely*
  - *e. the ability to communicate*
  - *f. the ability to infer from observations and experimental data*
  - *g. the ability to predict*
  - *h. the ability to propose hypotheses*
  - *i. the ability to interpret data*
  - *j. the ability to control variables"*

(Science syllabuses for secondary schools, CDC, 1998, p.16)

Although learning science process skills has been stated as an important objective in both local and overseas curricula, teachers seldom plan to teach science process skills systematically in schools.

International studies point to the need of improving students' process skills.

International comparative studies (e.g. PISA and TIMSS) have consistently shown that Hong Kong students, as compared to students of other regions, generally perform better in science subjects. As indicated in TIMSS 2007 report, the ranking of grade 8 (S2) students in Hong Kong is 9 out of 48 countries/ regions (Martin, Mullis and Foy, 2008). Students performed better in questions related to recognizing basic scientific knowledge, extracting information from figures and applying knowledge to practical situations. However, students were found to perform less favourably in questions regarding science process skills such as distinguishing purpose, observing, hypothesizing and drawing conclusion. This implies more works are expected to enhance students' science process skills.

Good science process skills are essential in the NSS context.

Between September 2009 and March 2010, Hong Kong Association for Science and Mathematics Education (HKASME) conducted a survey regarding the challenges encountered by science and mathematics teachers in the NSS context. A total of 441 questionnaires were received and two major challenges were identified. They were: (1) widening of the students' learning diversity; and (2) the implementation of School-based Assessment (SBA) at the NSS level. Teachers opined that these two challenges are closely linked to the decline in students' science and mathematics performance at the junior secondary level. Similar findings were also reported in another QEF project conducted by the

Association in 2011-2012[1]. The participating teachers reported that after completing the junior secondary level, students ***do not*** acquire science process skills (e.g. interpreting data, report writing) which are required in NSS science subjects, particularly in SBA. The finding further suggests that due attention has to be paid in developing students' science process skills at the junior level in order to better prepare students for the NSS curriculum.

Nurturing students' interest in science through developing students' science process skills

Another finding from the aforementioned QEF project is the significant drop in the number of students studying science in recent years. As reported by the teachers, fewer students opt for science at the NSS level. Students seem to be less interested in science than before. One of the reasons is that they do not find science interesting anymore. Most emphasis in science lessons is now put on teaching science content knowledge, rather than developing essential process skills and nurturing students' interest in science. As reported in many international studies (e.g. Gibson and Chase, 2002; Roth and Roychoudhury, 1993), engaging students in the development of process skills in the context of inquiry-based learning may improve students' science process skills as well as maintain students' positive attitude towards learning science.

2. Goals and objectives

Goals:

In view of the above curriculum goal and the challenges associated with the implementation of the NSS curriculum. The proposed project aims to:

2.1 develop framework to teach and assess science process skills;

2.2 develop AfL (Assessment for Learning) strategies with school-based curriculum planning;

2.3 nurture student interest in learning science so as to bridge the gap between junior science level and the NSS level.

Objectives:

The objectives of this project are:

1.) to develop curriculum frameworks and materials for teaching and assessing science process skills in the context of Hong Kong science curriculum (Secondary1-3);
2.) to develop a range of school-based curriculum plans with AfL strategies for developing students' science process skills; and
3.) to provide teacher training courses on how to teach and assess science process skills and teaching science as inquiry.

[1] The title of the project is "Developing Curriculum Leadership with Holistic Curriculum Planning in Science KLA under the New Senior Secondary Context".

3. Targets and expected number of beneficiaries

The direct targets and expected number of beneficiaries:

- Collaborating schools: 5 secondary schools developing school-based curriculum plans
- Students: around 1,500 students from the collaborating schools
- School teachers: about 300 science teachers participating in the training courses

It is expected that indirectly all science teachers and students in secondary schools will be benefited from the curriculum materials, the school-based curriculum planning strategies, the experiences using AfL generated from this project.

4. Implementation plan with time-line

We plan to achieve the goal and objectives stipulated in this proposal through 3 phases over a period of 24 months.

Phase 1: Planning phase (3/2013 – 6/2013)

The main purpose of this phase is to develop a framework for learning and teaching of science process skills, as well as a framework for teaching science as inquiry. In designing the curriculum framework, both the junior and senior secondary science teachers will be involved to ensure proper bridging of curriculum. An advisory group will be formed consisting of at least 10 NSS Physics/Chemistry/Biology teachers. They will give suggestions and critical comments on the curriculum framework. Thus, science process skills to be attained by students will be elaborated to facilitate instructional and formative assessment. Below is an elaboration of the science process skills to be attained by students from junior to senior secondary levels. The list is not exhausted and will be further revised by teachers of the advisory group.

List of process skills to be attained by junior and senior secondary students

Science process skills to be learnt in junior secondary	progression	Science process skills to be learnt in senior secondary
Observation skill Classification skill Measuring skill Skill of handling equipment and apparatus Communication skill, including report writing Skill of inferring from observations and experimental data	→	Skill of making careful observations, Skill of asking relevant questions for investigations Skill of identifying problems and formulating hypotheses for investigations Skill of planning and conducting scientific investigations individually or collaboratively with appropriate instruments and methods Skills of collecting quantitative and

Skill of proposing hypotheses Skill of interpreting data Skill of control variables (adapted from Science syllabuses for secondary schools)	qualitative information with accuracy Skill of analysing data and draw conclusions for problem-solving; (adapted from C&A guide)

The frameworks together with the list of process skills will later guide the design of the curriculum materials, assessment tasks and the training workshops in the implementation phase. In addition, five schools will be invited to join the project (collaborating schools) to develop school-based curriculum plans with AfL strategies. Project staff will also be recruited in this phase to carry out administration work for the entire project.

Phase 2: Implementation phase (4/2013– 11/2014)

The implementation phase is further divided into 3 stages. They are: (a) development of curriculum materials, (b) planning school-based curriculum with AfL strategies with trial runs and (c) teacher training workshops.

(a) Development of curriculum materials

In total, 30 learning activities and/or assessment tasks will be developed which cover the junior Science Curriculum (Secondary 1-3). The design of the curriculum materials will make reference to current Hong Kong and overseas curriculum documents on what essential science process skills should be developed. The Project Consultants recruited for this project will be responsible for the development of curriculum materials that will include relevant examples related to the NSS science curriculum. By the end of August 2013, 30 learning activities and/or assessment tasks will be ready for school trial run.

(b) Planning school-based curriculum with AfL strategies

In order to assure the quality of the curriculum materials, science teachers in 5 collaborating schools will try out the materials in schools. In addition, the Project Consultants will facilitate the schools to develop curriculum plans with AfL strategies for enhancing students' science process skills.

At least 4 meetings will be held between the Project Consultants and school science teachers in each collaborating school to discuss the details of the curriculum plan and to adapt the curriculum materials for school use.

To understand the impact of the curriculum materials and school plans on student learning, evaluation will be conducted during this stage.

(c) Teacher training workshops

We propose a series of training workshops at various stages of implementation to equip teachers with understanding of science process skills, AfL strategies, school-based curriculum planning and inquiry teaching. The workshops can be classified into three types. The first type of workshops (fundamental) will deal with the skills/ strategies for teaching science process skills and inquiry teaching. The second type will focus on curriculum planning with AfL strategies. The third type will be on strategies for assessing students' science process skills. As far as possible, relevant examples related to NSS curriculum will be introduced in the workshops.

Total number of workshops will not less than 20. The table below presents the proposed dates and expected number of workshops. Thus teacher participants can have equal exposure on the three types of workshops. In case of overwhelming responses, more workshops will be provided to cater for more participants.

Type of workshops	Period	No. of workshops
Teaching science process skills	7/2013 – 6/2014	6-9
Curriculum planning strategies	8/2013 – 8/2014	6-9
Assessment for learning science process skills	10/2013 – 11/2014	6-9

All teachers joining the workshop 'Teaching science process skills" will be invited to join **"Curriculum Resources Design Award Scheme"**. The purpose of this Award Scheme is to encourage teachers to develop curriculum materials (e.g. teaching plan, teaching activities and/or assessment tasks) for teaching science process skills. It is hoped that with the collective input and engagement of frontline teachers, they are more willing to incorporate science process skills and inquiry teaching in their daily lessons. The winning teams will also be invited to share their teaching ideas in the workshops.

At the end of each workshop, teachers' feedbacks will be collected by completing evaluation questionnaires.

Phase 3: Evaluation and dissemination phase (8/2014- 2/2015)

In this phase, all the curriculum materials developed for this project will be finalized and translated into both English and Chinese. Collaborating schools will submit their finalized curriculum plans. Selected teachers and students participating in the project will be interviewed to collect feedbacks on the project as

a whole. A **Dissemination Seminar** will also be held to disseminate the experience of this project to all Hong Kong Science teachers.

The table below summarizes the implementation plan of this project

Implementation Plan with Time-line

Phase	Description of work	Proposed Schedule
Planning	• Developing a framework for teaching and assessing science process skills • Publicizing project and inviting schools to collaborate • Recruiting project staff and setting up project office	3/2013 – 5/2013
Implementation	• Developing curriculum materials	4/2013 – 10/2013
	• 6-9 workshops on skills/ strategies for teaching science process skills and inquiry teaching • Inviting teachers to the Curriculum Resources Design Award Scheme	7/2013 – 6/2014
	• Developing school curriculum plans on teaching science process skills and trying out curriculum materials in schools	11/2013 – 6/2014
	• 6-9 workshops on curriculum planning with AfL strategies regarding science process skills • Sharing by teachers on their designed curriculum resources	8/2013 – 8/2014
	• 6-9 workshops on strategies for assessing students' science process skills • Sharing by teachers on their designed curriculum resources	10/2013 – 11/2014
Evaluation and Dissemination	• Translating and finalizing the curriculum materials	8/2014 – 11/2014
	• Seminar to disseminate the outcomes of the project	8/2014 – 11/2014
	• Writing up reports and presentation of evaluation results	11/2014 – 2/2015

5. Conceptual framework of what science process skills students should learn

As mentioned in the background of this proposal, learning science process skills has been a curriculum objective in Hong Kong and international contexts. In this present project, we make reference to local and international curriculum documents and suggest a framework with six essential science process skills which science students should learn in junior secondary level.

The six essential process skills are:

1. Observing, measuring & recording data;
2. Interpreting data/ inferring;
3. Predicting/ proposing hypothesis;
4. Investigating (includes choosing appropriate apparatus, correct handling of apparatus, taking precautions, identifying and controlling variables);
5. Communicating (includes making use of multiple representations, e.g. read, write, speak, listen,

graphics, to present their ideas).
6. Classifying

A table showing the inclusion of the six process skills in the 3-year junior science curriculum in Hong Kong is presented in *Appendix*. In sum, we propose that the six process skills are the foci of each unit of learning and school curriculum plans should emphasize the teaching of these skills. Thus, the table will serve as an initial framework to inform the design of the training workshops and the curriculum resources of this present project.

6. Expected deliverables and outcomes

The project is expected to have impact on the development of junior science curriculum in Hong Kong. The expected outcomes and deliverables are as follows:

- 30 sets of curriculum resources for the learning and teaching of science process skills in science curriculum (Secondary 1-3);
- 5 school-based curriculum plans for enhancing students' process skills with AfL strategies;
- At least 20 teacher workshops on how to teach and implement science process skills in schools; and
- 1 seminar to disseminate the knowledge and materials generated from this project.

7. Readiness of the applicant organization for undertaking the project

The Association

HKASME was founded in 1964 to promote science and mathematics education. We are a charitable institution and a professional organization for the promotion of science and mathematics education in Hong Kong. Membership comprises mainly physics, chemistry, biology, mathematics, integrated science and liberal studies teachers from secondary schools and also local science educators. The Association is affiliated to the Association for Science Education (ASE) of UK and is a founding member of the International Council of Associations for Science Education (ICASE). In the past two decades, the Association has forwarded to the government and Education Bureau her views on a wide range of educational issues in Hong Kong, including the development of science and mathematics education, the diversification of curriculum, teacher induction and in-service education, and the need to establish an independent and well-resourced curriculum development institute. The association is glad to see that many of her proposals have been accepted and implemented by the government. The Association has good experiences in developing science curriculum resources and has an expert pool consisting of experienced teachers and professionals. Apart from this, the Association is a good platform to disseminate good practices in science and mathematics education.

In the NSS context, the Association feels the need to undertake this project under QEF and in the long-run to provide schools in Hong Kong with good exemplars of curriculum plans as well as quality curriculum resources.

Building on the fruitful experience of earlier project

In fact, this proposed project is built on the fruitful and successful experience of a previous QEF project organized by the Association in 2011-2012. We initially identified 4 facilitating factors (School Administration, External Agents, School Colleagues and Tools) which are pivotal to the school-based curriculum planning. We have also developed some preliminary curriculum materials for the teaching of science process skills in S1 and S2 levels.

Invitation to interested schools

Two secondary schools who expressed interest in developing junior science curriculum has already been invited to participate in this proposed project. These two schools have good experience in promoting scientific literacy and are keen on the development of science education.

Steering Committee Meetings

In addition, Steering Committee Meetings will be held every six months to monitor the proper running of the project. The Project Leader will be the chairman of the committee. The Project Advisors, Project Consultants and the Principals/ representatives of the 5 collaborating schools will be the members of the committee. Representatives from the CDI will also be invited to join the Steering Committee after the approval of this project. The duties of the Committee include:

- Overseeing, supervising and monitoring the progress, finance and personnel affairs of this project;
- Giving advice and comments on the strategies and implementation of the project in schools;
- Giving suggestions on the content of training workshops; and
- Developing relevant strategies for disseminating the experiences and knowledge generated in this project.

8. Tentative Budget with detailed breakdown

Item	**(HKD)**
Staff Cost: - 1 full time Research Assistant (net salary + MPF)	($16,000 x 24 months) x 1.05 = $ 403,200
Subtotal	**$403,200**
General expenses such as: • Cost for renting venue • Audit report • Reward for the Curriculum Design Award Scheme • Others: travelling expenses of project staff, computer accessories (e.g. portable hard disc, USB drive), printing & photocopying, reference books, administrative fees (e.g. bank charges for opening account), staff insurance, stationery & office equipment, minor consumables, others etc.	 $80,000 $15,000 $20,000 $30,000

Subtotal	**$145,000**
Services: (a) Teacher Training • Payment for conducting training workshops • Payment for developing training materials	 $900/hr x 20 workshops x 3hrs = $54,000 $900/hr x 3 sets of materials x 40 hrs = $108,000
(b) Development of curriculum materials regarding science process skills • Payment for developing curriculum materials	$900/hr x 30 sets x 20 hrs = $540,000
(c) Consultancy service fee for school support • Payment to Project Consultants for developing curriculum framework and school-based curriculum plans with collaborating schools	$900/hr x 5 schools x 60 hrs = $270,000
(d) Webpage Hosting and Management • Storage of materials and maintained by external agents for teachers to login	$50,000
Subtotal	**$1,022,000**
Contingency: About 3% is reserved for an adjustment of inflation	$35,100
Subtotal	**$35,100**
Total	**$1,605,300**

9. Report Submission Schedule

The grantee 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
Progress Report 1/3/2013 - 31/8/2013	30/9/2013	Interim Financial Report 1/3/2013 - 31/8/2013	30/9/2013
Progress Report 1/9/2013 - 28/02/2014	31/3/2014	Interim Financial Report 1/9/2013 - 28/02/2014	31/3/2014
Progress Report 1/3/2014 - 31/8/2014	30/9/2014	Interim Financial Report 1/3/2014 - 31/8/2014	30/9/2014
Final Report 1/3/2013 - 28/2/2015	31/5/2015	Final Financial Report 1/9/2014 - 28/2/2015	31/5/2015

10. Evaluation of Project Impact

(a) Evaluation parameters and method

A comprehensive, systematic and evidence-based evaluation from various perspectives will be employed. The five components which will be evaluated are:

Curriculum Plans: Five school-based curriculum plans of junior science curriculum will be generated in this project. Curriculum experts will be invited to give comments on the quality of the plans.

Curriculum Resources: 30 sets of learning activities/ assessment tasks will be developed in this project. The quality of the curriculum resources will be assessed by the Project Leader, Project Advisors and the teachers of the collaborating schools.

Training workshops: Evaluation questionnaires will be distributed in each workshop to collect objective data for analysis.

School implementation: Selected teachers will be interviewed to give comments and suggestions on the implementation of the project in the 5 collaborating schools. Students' data of the collaborating schools will also be collected to evaluate the impact of the curriculum resources and the school curriculum plan. Those students' data collected include:

- pre-tests and post-tests (distributed before and after the school implementation of the project to assess students' improvement in science process skills);
- students' school tests and examination results (assess students' overall science performance after joining the project);
- interview data.

(b) How the project would benefit the education sector as a whole

This project will help the education sector reconsider the role of teaching science process skills in junior science curriculum and think of the effective way to bridge the gap between junior secondary and NSS levels. The **curriculum resources** generated will support teachers teaching science process skills in classrooms, while the **curriculum plans** generated will be exemplars for schools aiming to incorporate science process skills and inquiry-based teaching in junior secondary level. The **training workshops** will equip teachers with the necessary knowledge and skills for teaching science process skills and implementing inquiry-based teaching in schools. As the project will end at 2015, we envisage the knowledge generated from this project will provide useful information for the curriculum review of junior science curriculum.

11. Sustainability of the outcomes of the project

Our Association is a professional organization for all science and mathematics teachers in Hong Kong with about 700 members. We have a wide range of teacher activities held regularly to promote science education and teaching professional. The experiences and knowledge generated from this project will be further developed beyond the funding period. To achieve this, teachers joining the training workshops and dissemination seminar will be invited to join the Association to further polish the curriculum plans and

curriculum resources for the use at schools. Thus the momentum of this curriculum initiatives will be grown up and have long-term impact on the education sectors, especially at junior science level.

12. Dissemination/ Publicity

The dissemination methods recruited in this project are:

- Disseminating the project outcome in dissemination seminar and conference;
- Posting the curriculum plans and curriculum resources in our Association's website;
- Sharing the experience and knowledge generated from this project in the Journal of our Association named 'Hong Kong Science Teachers' Journal' which is published annually.

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Appendix:

The six essential process skills proposed in this project:

1. Observing, measuring & recording data;
2. Interpreting data/ inferring;
3. Predicting/ proposing hypothesis;
4. Investigating (includes choosing appropriate apparatus, correct handling of apparatus, taking precautions, identifying and controlling variables);
5. Communicating (includes making use of multiple representations, e.g. read, write, speak, listen, graphics, to present their ideas).
6. Classifying

The inclusion of the six process skills in the 3-year junior science curriculum in Hong Kong:

Unit[2] / Process Skills	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Observing, measuring & recording data	√	√	√	√	√	√		√	√		√	√	√	√	√
Interpreting data/ inferring	√	√		√	√	√	√	√	√	√	√	√	√	√	√
Predicting/ proposing hypothesis				√		√	√	√	√		√				√
Investigating	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Communicating	√	√	√	√	√		√	√	√	√	√	√	√	√	√
Classifying		√				√				√		√		√	

[2]The 15 units in the 3-year junior science curriculum are: Unit 1- Introducing Science, Unit 2- Looking at Living Things, Unit 3- Cells and Human Reproduction, Unit 4- Energy, Unit 5- The Wonderful Solvent- Water, Unit 6- Matter as Particles, Unit 7- Living Things and Air, Unit 8- Making Use of Electricity, Unit 9- Space Travel, Unit 10- Common Acids and Alkalis, Unit 11- Sensing the Environment, Unit 12- A Healthy Body, Unit 13- Metals.