A Case Study of School-Based Science Curriculum Development: Overview of Project Approach and Process of Implementation

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Abstract

Under the impetus of the Hong Kong education reform, curriculum development has brought a whole new range of perspectives with an emphasis on "Learning to Learn". Schools are encouraged to formulate their own curriculum development plan according to their individual situation and readiness. (Curriculum Development Council, 2001a). This School-Based Science Curriculum Development (SBSCD) project was established to echo the need for professional guidance and support in this area, with a focus in science education. The SBSCD project is one of the initiatives under the Hong Kong Schools Around the World (HKSAW) project funded by the Quality Education Fund. The benefits of mobilizing the resources from the Schools Around the World project in the SBSCD project is explained in the paper. This project, with a participation of seven schools, was designed for one academic term and has adopted an interactive approach embedded within three main phases: planning, implementation and evaluation. The aim of this short-term project is to reveal a naturalistic model of SBSCD that may lead the participating schools to realize their future science curriculum directions. Instruments were developed to obtain data on the school's existing situation as relevant to the SBSCD implementation, to investigate factors affecting the interaction between the schools and the HKSAW Curriculum Development Team, and to find out teachers' awareness of the strengths and weaknesses of their own teaching after the SBSCD. This paper serves as a preliminary report of this case study. Therefore, its main purpose is not to report on empirical findings, but rather to define the factors for the above study areas and to provide an initial reference on the process of implementation for school practitioners.

Background to the School-Based Science Curriculum Development Project

The Emerging Importance of the School-Based Curriculum Development (SBCD) in Hong Kong Education

Educators have always been under the pressure of assisting students to achieve satisfactory results in school and public examinations for class streaming and academic admission purpose. Therefore, they have generally voiced concerns about the lack of resource to improve upon curriculum design and to increase teaching/learning flexibility. It is also a common but mistaken belief that the curriculum is strictly "imposed" and delivered mainly through the coverage of a prescribed syllabus and text, as it has proven to be ineffective in students' learning both in Hong Kong and overseas (Curriculum Development Council, 2001a). Past study of SBCD in Hong Kong (Lo, 1995; Morris, 1996) has shown that the processes of curriculum planning were strongly influenced by teachers' desire to satisfy the complex bureaucratic requirements (such as requiring students to produce displayable outputs for open exhibitions), instead of based on a consideration of pupil's needs by an analysis of the context or situation in which the curriculum was used. After the abolishment of Primary Six Academic Aptitude Test (AAT) and the launching of the education reform in 2001, schools under the Hong Kong educational system, primary schools in particular, are given more opportunities in terms of time and resources innovations. According to the Government's recommendations, schools and teachers are encouraged to adapt the central curriculum, while develop their own school-based curriculum to help their students to achieve the learning targets (Curriculum Development Council, 2001a). At this present moment, the education reform is at its first stage of implementation. The Government official guidelines under the main theme "Learning to Learn" not only offer the curriculum framework, but also suggested development strategies and some exemplars from local schools (Curriculum Development Council, 2001b). The suggested developmental measures, such as varying the organization of contents, context and examples, learning and teaching strategies, pace of learning and teaching, homework, criteria and modes of assessment, are up to the schools and teachers to decide depending on their situations.

The Origin of the SBSCD Project

The present School-Based Science Curriculum Development (SBSCD) focuses on science education, providing school-based professional guidance and on-site curriculum development supports to teachers. SBSCD is one of the initiatives under the Hong Kong Schools Around the World (HKSAW)* Project. Schools Around the World (SAW) project is a multinational academic development model designed by the Council for Basic Education (CBE), an educational interest group based in Washington (U.S.) that advocates high academic performance for all students. Its nine participating nations/regions include the United States, the Czech Republic, France, Germany, Portugal, Australia, Japan, the United Kingdom and the Hong Kong SAR. As one of the implementing strategies of SBSCD, HKSAW Curriculum Development Team uses science student works from these nations/regions as references to stimulate teachers' professional exchange and discussions regarding the adaptability of these works to the local central curriculum.

Defining the scope of the project

Seven HKSAW member schools volunteered in the SBSCD project. The project was designed for one school-term. The Curriculum Development Team selected a set of

* The Schools Around the World project in Hong Kong is funded by the Quality Education Fund.

science subject units from the Hong Kong Primary 4-6 General Studies Syllabus and the Form 2 Integrated Science Syllabus for the schools to choose from for their project. These units were selected such that all nine SAW participating countries have student work resources of the same subject areas shared in the SAW online database.

Some schools adopt the same science subject units or choose similar objectives for their science curriculum development. With a pre-set range of topics and objectives, the HKSAW Curriculum Developer Team can easily facilitate the sharing of experiences among the schools.

The SBSCD Process

A SBSCD process model was designed for this project and its details are refined throughout the actual practice. The main phases for the SBSCD are planning, implementation and evaluation. The planning phase consists of three stages: 1. The school's pre-selection of SBSCD objectives; 2. A 'situational analysis' stage adapted from Sockett's (1976) and Skilbeck's (1984) curriculum development models for examining any factors relating to the formation of the school's existing science curriculum design; 3. Formation of a SBSCD action plan by teachers and the Curriculum Development Team. During the implementation phase, curriculum developers and the participating teachers are engaged in a series of collaborative process in which the curriculum developers provide both practical resources and logistic supports, as well as carefully observes all planned activities carried out according to the action plan. During the evaluation phase, individual interviews, meetings and an evaluation survey are conducted with teachers, in order to discover causes and effects from the interaction between the schools and the HKSAW Curriculum Development Team. This final phase also aims to find out teachers' awareness of the strengths and weaknesses of their own teaching after the SBSCD, and to adjust the schools' future SBSCD directions.

The Planning Phase

Stage 1-Pre-selecting Objectives

When inviting schools for joining the project, these prospective schools have revealed the following general concerns for their existing science curriculum: 1. There are little resources for measuring students' skill and attitude development within their learning in science. 2. Teachers often need special guidance on applying the science syllabus as the basis for constructing science investigation studies. 3. Many of the current primary schools' General Studies teachers are not trained in the science domain. Therefore, they need support for upgrading their professional knowledge and confidence in teaching science related topics. 4. Science teachers wish to develop science curriculum that can meet their school's overall aims while keeping themselves inline with the education reform directions. 5. The schools would like to improve upon the collaborative effort within their science departments. 6. Teachers have been heavily depending on the teachers' manuals accompanying the subscribed texts as their sole resource, and thus wish to expand upon the possible scope of educational resource.

To elicit schools' early thinking in shaping their own SBSCD project, each school is given the following suggested list of objectives, where they can choose up to three of them to implement:

- To develop students' and teachers' knowledge and skills in science investigation through experiments, and project learning.
- To enhance students' creative thinking through their own works.
- To enhance students' problem solving and collaborative abilities through group work activities.
- To build extension activities that increase students' exposure in science knowledge beyond the central curriculum.
- To enhance students' analytical thinking through hands-on activities.
- To arouse students' appreciation for learning by incorporating daily life examples and applications in teaching and learning activities.
- To discover and enhance students' various strengths and abilities through cross-curricular activities or student works.
- To use information technology to enhance the science teaching and learning

experience.

- To improve teaching and learning through the use of formative assessment and alternative assessment formats.

The above objectives list was compiled with consideration of the schools' general concerns and the appropriate settings for implementation within the timeframe of this project. Also, emphases were made based on the education reform incentives specific for school-based curriculum development in science (Curriculum Development Council, 2000a; 2000b).

For this project, schools may choose to participate in selected topics within a science unit of a single grade (e.g. P4 Electricity & Life Unit) or to participate in one single science event (e.g. School Science Day) for their curriculum development. The following subject units from the Hong Kong General Studies and Integrated Science syllabi were provided for the schools to choose as their content foci: Electricity & Daily Life (P4), Life Reproduction (P5), Forces & Simple Mechanics (P6), Forces (S2).

Stage 2 - Situational Analysis
Sockett (1976) suggested a 'situational analysis' process to understand the school's existing science curriculum design and any factors affecting its formation. Skilbeck's (1984) added upon the study by Sockett, listing a series of external and internal factors for the situational analysis process. External factors examine the context under which the curriculum development exercises are working, including the consideration of Hong Kong education reform incentives in school's existing science curriculum, the influence of the school's system and the degree of freedom given to teachers in relation to their choice of teaching approaches and shaping of the school's overall science curriculum. Internal factors examine the needs of the involved key groups (students, teachers, principal), including an understanding of teachers' normal teaching practices and their perception of students' abilities and an overall impression of the school ethos. Only those factors that are applicable to the extent of this project are described below, with relevant elaborations to the project setting.

External Factors:

1. *Educational system requirements and challenges*
   In Hong Kong, this factor is closely tied with the education reform, which suggests that the school's science curriculum should stress on the changing emphases for assessment, enhancing students' scientific reasoning and science process skills, encouraging students to engage actively in designing and conducting experiments, as well as exploring scientific concepts and their applications in daily life (Curriculum Development Council, 2001a). This factor analyzes the fulfillment of these emphases within the school's existing science curriculum, as well as how much the schools' science curriculum follow or adapt from the central curriculum. To examine this factor for a particular school, a copy of the school's existing curriculum design, including unit organization framework, lesson plans from individual teachers (if available), list of activities and project work outline, worksheets and resources list are obtained.

2. *The degree of autonomy given to the teachers in the school*
   This factor explores the teachers' freedom in their choices of approach in teaching/learning, in formulating decisions on the format and weighting of student evaluations, and in the organization of school events and any activities for the school's science education. These elements are examined through pre-consultation group interviews and communicating with the individual teachers during each occasion. From these rendezvous, a general impression of the school's collaborative spirit and the level of control from the school's supervising body on teachers' teaching can be obtained for the participating school.

3. *School's system requirements*
   Timetabling system, resources availability, class organization, and student assessment policies may all exert influences on the school's curriculum development. Specific information on timetabling system and student assessments are obtained directly from the school project coordinator. During the pre-consulting meeting, the curriculum developers would take a tour of the school property to understand the school's science classrooms arrangement and the science resources available.

Internal Factors:

1. *The student*
   Schools in Hong Kong are classified by different bandings according to the overall academic standard of the student body. Together with the social and cultural background of the particular school, a general impression of the overall student learning ability is formed among the teachers. Individual interviews with teachers are conducted to explore such perception and their past experience with the student body.

2. *The teacher*
   This factor explores teachers' individual characteristics such as their academic backgrounds and experience in science teaching, knowledge in the teaching topics, teaching methods used, attitude towards curriculum development, collaboration with colleagues, teaching preparation practices, major form of student work, and assessment methods. A well-formed survey is given to the teachers, and individual interviews are conducted with them to understand these aspects.

3. *School ethos*
   This factor involves an understanding of the school's organizational climate including the following:

   1. Principal supportiveness: an understanding of the principal's involvement in the school and his/her concern with the professional and personal welfare of the staff body.

   2. Operations emphasis: an understanding of the principal's concern with the operative aspects of the school and his/her close (sometimes burdensome) supervision of the staff body.

   3. Intimacy: a measure of social cohesiveness among teachers.

An overall understanding of the school ethos is formed through personal interviews with the principal, along with the opinions as revealed by the school project coordinator and through communicating with the participating teachers.

After a comprehensive analysis of these factors for a particular school is completed, it may serve to shape a school-based study focus, including forming the basis for revising the school's SBSCD objectives and their most appropriate action plan (to be explained in the next stage). For those factors identified to be the causes of potential hindrance for SBSCD, curriculum developers are responsible to address and alert them with the school project coordinator at this early stage of the project. Also, they will adjust their strategies accordingly while introducing and implementing the action plan.

Stage 3 - Action Plan Formation

Based on the information collected from the situational analysis, initial suggestions are made to address the organization and selection of teaching/learning activities and student assessment methods. A curriculum development proposal with activity outline is provided to the teachers, which is followed by a discussion session to address the appropriateness and feasibility of all the suggestions. Taken into considerations are the teachers' comfort level and previous experience in the introduced teaching methods, students' ability level and their existing knowledge, classroom physical conditions, as well as school facility resources available. All additional resources such as multimedia teaching aids, new experiment demonstrations, international study work samples from SAW, and any relevant supporting materials, are presented to the school along with the proposal. Any alternative teaching/learning suggestions are discussed and revised at this stage. During this process, the curriculum developers act as both consultants for teachers and facilitators who initiate the exchange of ideas and strategies from different schools and teachers. The outcome of such meetings is a revised and enhanced action plan with inputs from the participating teachers drawing from their previous experience and practices. For schools that implement an extended activity such as project learning or organizing a science day, relevant instruments for the activity (such as teachers' and students' guidelines, worksheets and assessment rubrics) and implementation logistics such as sequencing of the accompanying lessons, special class or classroom arrangements are addressed.

The Implementation Phase

During this phase of the project, the school project coordinator takes on a liaison role by working closely with the participating teachers, and constantly readjusting the action plan according to their feedbacks. The Curriculum Development Team and the participating teachers are engaged in the following collaborative process:

1. Curriculum developers observe and videotape the lesson/day of activity.

2. Observations are made regarding classroom arrangement, classroom environment, teacher-student interaction and the utilization of time, facilities and the designed activities.

3. To facilitate teachers' discussion on developing and assessing the student work specific for the project, and to enable them to share their results with other participating schools, teachers are asked to analyze the student work according to a standard template provided by the SAW project. Then, they are invited to share the student work, the completed template along with the accompanying teaching materials on the SAW online database.

4. Workshops with teachers and/or students are conducted upon request by specific schools to address issues related to schools' SBSCD foci.

The Evaluation Phase

As the whole SBSCD project was carried out within one school term, the outcomes derived from the objectives at the planning phase may not be verified to be sustainable results from the project. However, the following aspects are more readily measurable and the experiences can then be shared by the Curriculum Development Team:

- To find out the teachers' awareness of the strengths and weaknesses of their own teaching after implementing the SBSCD

- To identify factors aiding or hindering the processes of SBSCD

- To discover the causes and effects for the interaction between the curriculum developers and teachers (e.g. reasons for teachers' choice of suggested activities.)

- To explore the schools' cooperative climate relating to SBSCD

- To identify resources and organizational structures conducive to SBSCD

The following means are used to investigate the above aspects for each school:

1. *Immediate feedback after implementation:*
   Soon after the teacher carries out the implementing lesson, the curriculum developer conducts a brief meeting with the teacher to provide feedback on the lesson/activity implementation. The videotaped lesson is returned to the teacher, so he or she may refer to them to reflect upon teacher-student interaction, effectiveness of the planned activities, and to find out any areas for improvements.

2. *Questions for interview and questionnaire are formed to identify the following professional growth after participating in the SBSCD:*

   - Awareness of strength and weakness of teaching.
   - Increased exposure and understanding of lesson planning strategies and different teaching methods.
   - Deepened understanding of students' ability in learning after providing different learning settings and assessment instruments.
   - An increase in personal interest for participation in SBSCD.
   - Improvement in collaboration and communication with colleagues during the implementation phase
   - A growth of motivation for personal professional development.

To provide constructive feedback on the SBSCD project:

- Opinion on the workload and time commitment required for the SBSCD.
- Discovery of any hindering factors for the SBSCD and justifying them according to two categories: factors that were dealt with successfully during

the project, as well as factors that could not be addressed and their reasons.

- Comment on general effectiveness and overall value (for the school) of SBSCD.
- Comment on the quality and quantity of support by the Curriculum Development Team.

3. *An interview and a separate questionnaire are given to the School Project Coordinator.* （The role of the School Project Coordinator is usually taken by the science panel or the subject grade coordinator.） *Questions are asked to examine the following issues:*

    - Difficulties in communicating with various personnel such as principal, teachers, laboratory technicians (secondary school) and curriculum developers, and initiating communications among them.
    - Any logistic problems during the project.
    - Strategies attempted to address the above problems.
    - Perceived support from the school principal for the SBSCD.
    - Comment on sequencing, frequency and method of communication with respect to all the introduced activities.
    - Any personal gains from this management experience.

In addition to gaining these specific feedbacks, it is the ultimate goal of this evaluation process to provide a reflection opportunity for leading the schools in their realization of future science curriculum directions through the experiences gathered from this project. Throughout the execution of this three-phase SBSCD process, curriculum developers take into account teachers' existing believes of their own teaching approach and their attitudes towards introducing to new ideas. Teachers' collaboration in the planning, implementation and reflection are strongly encouraged.

Developing an Interactive Approach for SBSCD

The three-phase framework discussed above is constructed based on the planning and practical experiences thus far for the SBSCD project. It should be noted that although the project timeline is logically sequenced into phases (planning, implementation, and evaluation), it must not be presumed that the curriculum development elements are carried out in the prescribed sequence. Through conducting comparison studies among the various curriculum development models in history, Brady (1995) identified four key elements for the curriculum development process to be objective, content, method and evaluation. She stated from her extensive experiences in curriculum development that restricting a curriculum development to a fixed sequence could blunt its creativity. This point has special significant and practical implication in this project. For example, it is discovered that the exercise of some of the projects' objectives as fixed at the planning phase could create unnecessary constraints to the potential power of the curriculum development endeavour for a particular school. Even when a school has chosen its objectives and content when joining the project, a situational analysis process may reveal the school's hidden limitations on fulfilling these objectives, or even other issues within the school's science curriculum that require more immediate attention. Therefore, the school may need to change objectives and/or content. An interactive model is thus proven more appropriate for this project, as its' flexible nature allows it to respond quickly and reflect closer to the reality of curriculum development in a school; a change made to one curriculum element will initiate changes to the other elements. Therefore the model allows its elements to be progressively modifiable according to the changing conditions. For example, when a school wants to develop students' skills in project learning through the design of a class web-page, teachers may soon discover that students generally do not have adequate training and background knowledge in the IT field to proceed with this objective. The school may need to substitute with another objective that can be implemented within a school term, such as to develop science investigation through project learning. An interactive model allows the curriculum developer to react promptly to the learning situation in determining what sequence to follow among the curriculum elements. The dynamic and adaptable nature of this model encourages mutual understanding and increases comfort level for the teachers and students involved.

The method approach for the selection of teaching and learning activities in SBSCD is shaped in the following process: First, the curriculum objectives as stated in the planning stage; also the guidelines suggested in the education reform with regard to science education serve as the basis for searching for the appropriate teaching and learning strategies. The overall method approach is then formulated, using the following models of teaching and learning identified by Brady (1995) as the guiding theory principle.

Cognitive Developmental Model: Subjects embody not only their own unique content, but also particular ways of thinking. Cognitive developmental model stresses on engaging students in investigative activities to further develop upon their cognitive thinking and inquiry processes skills. In the scope of the SBSCD project, both P.O.E. (predict, observe, explain) model and science process skills reinforcement are applied alongside the thinking of the cognitive developmental model as they are relatively simple models suitable for primary and junior secondary school students. They are also easily adaptable for lesson demonstrations or applied in science investigation activities.

Interaction Model: The model emphasizes on learning occurred as a result of student's interaction with others. Numerous studies have proven that learning in groups is an effective process in enhancing students' problem solving and collaborative abilities (Johnson, D., Johnson, R. and Holubec, E., 1994; Kagan, S., 1994; Lazarowitz, R. and Karsenty, G., 1990). SBSCD suggested teaching/learning activities resulted of this model may include cooperative learning, peer and group evaluations.

Transaction Model: This model stresses on providing opportunities for teachers to take on different roles (such as advisor, observer, co-learner, facilitator) to form varying degrees of teaching directions in student discovery. This is implemented in three possible settings within the SBSCD: project learning, cross-curricular thematic week and School Science Day.

Behavioural Model: This model emphasizes tightly sequenced steps of learning and the use of reinforcement to elicit observable behaviours. In the SBSCD project, this is achieved through coupling diversified teaching activities with student work; training of students' different abilities through alternative assessment formats, with particular emphasis on daily life relevance. Through developing the action plan with schools, curriculum developers gradually guide teachers to shift their teaching-learning practices from mainly teacher exposition to more interactive and student-centered learning such as brainstorming and problem-solving in small groups.

As to the selection of evaluation approach, the emphasis is not on judging the outcomes of the particular schools with any pre-determined standard, but rather to reveal the contributing factors and their related issues as stated in the evaluation phase. In addition, the evaluation approach must consider the following characteristics of this SBSCD project:

- Allow a variety of information collected from a small sample to be evaluated and generate meaningful conclusions.
- Allow evaluation of valuable subjective data.
- Emphasize both the results and the transactions that take place.
- When any changes made to the elements within the SBSCD model or new ideas are to be implemented, evaluation can still take place without the fear of affecting the process.

With the above considerations, Parlett and Hamilton's illuminative model (1976) was adopted to form a framework for analyzing information and results in the project. The model incorporates an interactive approach which contains three key stages: observation, inquiry and explanation. Its aim is to 'illuminate' a curriculum through description and interpretation of all situational influences, the significant features and processes of the curriculum: After a curriculum developer obtains background information from the school, detailed observations are done based on the implementation (such as all teacher-student interactions), transactions (such as frequency of teachers' self-initiated contacts) and informal remarks (such as teachers' reactions to the suggested curriculum development plan). During the inquiry stage, the curriculum developer focuses on issues selected in the observation stage as the most worthy of attention, then refines areas for more sustained and intensive inquiry. This is achieved mainly within stage 2 and 3 of the planning phase as well as throughout the implementation phase. At the final stage of explanation, individual findings obtained from the planning and the implementation phases are placed in a broader explanatory context. Conclusions are formed by weighing alternative interpretations in the light of obtained data, spotting patterns of cause and effect and are presented to the school during the final report.

Curriculum developers constantly review each curriculum element with teachers and help them to plan, reflect and readjust teaching strategies and curriculum design. Although SBSCD uses the content, objective as the basis for the method and evaluation to build upon, an interactive approach emphasizing on immediate response to the schools and teachers' needs is reinforced throughout the process.

Conclusion

This paper reveals one overall approach for SBSCD and provides practical hints and ideas as reference for schools to attempt their own science curriculum development. These are generated from actual experiences by the Curriculum Development Team and through the collaborative effort of the participating schools and teachers. Together, the four curriculum elements are defined for each school and they are carried out under the three phases - planning, implementation and evaluation. Each school has displayed many different or unique characteristics; therefore a SBSCD plan is tailored-made for schools based on the needs of the students. The interactive project approach allows the curriculum developers to react quickly to every school's unique situation. Also, with a wide collection of student works from around the world being one of the key resources for curriculum development, teachers are exposed to worldwide exemplars in science teaching and learning. Through providing the sharing platforms created by the local and the Schools Around the World international websites, teachers may take active part in disseminating their curriculum development results from this valuable experience.

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