Project Summary

Title: Problem-Based Learning in the Field Environment

Goals: 1) To prepare students to become progressive problem solvers and authentic knowledge constructors with a mind of inquiry through a self-directed study on contextualized problem sets in the field setting. 2) To promote Problem-Based Learning methodology among secondary schools as an effective learning method.

Objectives: 1) Participating students will be able to demonstrate independently the application of Scientific Inquiry to solve problems. 2) Participating teachers will be able to establish and coordinate a small-scale and highly self-directed learning community for thematic study with the techniques in facilitating, guiding and mentoring the student PBL group.

Expected number of beneficiaries: 32 participating teachers and 640 participating students, 16 participating schools and education sector.

Duration: Sept 2003 – Dec 2005 **Total Requested Budget**: 846,800

Implementation method: the project will be run for 4 rounds. Each round comprises of Phase 1 (for teachers) and Phase 2 (for students and teachers). In Phase 1, teachers act as co-learners to undertake action research. In Phase 2, teachers act as facilitators while students will undertake action research. Experts-in-the-fields or local officials will be invited to offer interactive discussion with PBL groups with respect to the nature of the problem sets.

Expected deliverables will be produced at student, teacher and community levels such as student portfolio, teaching portfolio, compiled CD-ROM of groups' outputs, student whole-school presentation, poster exhibition, parents meetings, staff sharing session, PBL methodology teaching material and PBL workshop material.

Product: The above expected deliverables will be presented in the form of a report.

Expected outcomes will be reflected at student, teacher and community levels. 1) Students are tuned 'learn-to-learn' with a learning-passionate mind. 2) Students perform as well as their counterparts from traditional classrooms on exams and perform better on tackling unfamiliar problems. 3) Teacher-student relationship will be promoted. 4) Successful experience of the present project lays a strong groundwork for the education sector in light of education reform.

Evaluation will consist of four mechanisms:

1. Quantifiable measures of the deliverables.
2. Independent assessor evaluates the progress and outcome of the whole project.
3. Evaluation by participating teachers through questionnaire and interview.
4. Evaluation from students through questionnaire, peer-evaluation, interview and assessment on presentation.

Needs and Applicant's Capability

1. Background

1.1 Introduction

An ultimate goal of education in the Information Literacy Age is commonly agreed by most educators as transforming students into progressive problem solvers and authentic knowledge builders. Most reports, such as the SCANS (Survey of Necessary and Comprehensive Skills and Goals 2000) documents in the US, recommend such instruction. Most school goal statements allude to the need for critical thinking and problem solving skills. Nevertheless very often such instruction in problem solving takes the approach of teaching models to students to apply to neat case studies rather than the messy problems of a real world. A methodology which authentically addresses the core of problem-solving dominated learning mechanism is imperative.

The need to establish such student-centered problem-solving skills as the primary education goal is also well recognized for the Hong Kong students. The recent education reform (Curriculum Development Council, 2001) consultancy report has correctly identified 'Learning to Learn' as the key to the success of our future students. However, this initiative is not as well appreciated by some school teachers in Hong Kong due to the lack of demonstrative cases and training programmes on problem-solving learning mechanism for them. We believe the procurement for such a pedagogical change cannot rely solely on the self-initiation of the school teachers, and must require participation of the tertiary institutions in Hong Kong. A sizeable fraction of courses in the tertiary institutions in Hong Kong are now taught with a problem-solving learning approach. The Faculty of Medicine at HKU, for instance, now uses Problem-Based Learning (PBL) as the primary mode of instruction of its programme. Endeavour to adopt a similar teaching pedagogy in secondary school, even experimental in nature for the time being, should be condoned. Successful experience with PBL in the tertiary institute should be shared with secondary school sectors through training workshops for school teachers and organized activities for students on problem-solving dominated learning.

The ideal setting for conducting problem-based learning is in the field, where students are required to cope with real problems often with no definitive solutions. The field mapping programme in the Department of Earth Sciences, for example, demands students to identify geological units which are often messy and ambiguous, and make

judgment on enigmatic situations which cannot be answered in a definitive manner. Such field study, with emphasis on the problem-solving processes rather than the answers to the problems, is cognate with problem-based learning and represents a best means of introducing PBL to school education. In this proposal, we request support from the Quality Education Fund to undertake training workshops for teachers on problem-based learning in the field setting. We have selected the Earth Science as the theme of the project because of its nature as a field-based science. In addition, Earth Science has been reported to be the weakest area for Hong Kong students in a recent international study (TIMSS-R, 1999). This current project can also enhance the Earth Science component in the school curriculum.

It is necessary to describe the plan of the current proposed project in the context of the development of PBL and in particular, the feasibility to incorporate PBL into the school curriculum in Hong Kong. We should point out that the proposed project will serve as an exercise to learn about potential problems and difficulties arising from the adoption of the new learning pedagogy. Given the nature of this proposal, it is necessary to accurately assess the performance and success of the project.

1.2. A brief overview of PBL methodology

Underlying principles of PBL

Problem-Based Learning is a pedagogical strategy for posing significant, contextualized, real world situations and providing resources, guidance, and instruction to learners (Mayo, Donnelly, Nash, & Schwartz, 1993). What significantly distinguishes PBL from other traditional learning mechanisms lies on a coherent component in PBL that participants construct knowledge progressively through neutralizing contextualized problem sets and situations, with neither conventionally-practiced classroom-format lecture nor 'end-of-chapter' questions. PBL is a radically different approach to the current mode of teaching-and-learning which constantly needs encouragement and support (White, 1996).

Brief History of PBL development

The concept of PBL was originally shaped by Dr. Howard Barrows and Ann Kelson of Southern Illinois University School of Medicine in early 1970s as both a curriculum and a process. McMaster University Medical School in Canada was the first to bring PBL to the forefront of education. Of all teaching methods, PBL is the best studied in a scientific sense. The medical schools at

Harvard, the University of Limburg at Maastricht (Netherlands), the University of Newcastle (Australia) and the University of New Mexico (U.S.) and even the University of Hong Kong have already developed such a program. Today over 80% of medical schools and many other professional schools utilize PBL to teach professional cases (Bridges and Hallinger, 1991; Vernon and Blake, 1993). PBL is now used globally in higher education in areas such as health sciences, nursing, dentistry, pharmacy, veterinary medicine, public health, architecture, computing, business, law, engineering, forestry, police science, social work, education and many other professional fields including the earth sciences. Many K-12 schools in the U.S. are also using the PBL methodology.

1.3. The prevailing need for education reform in Hong Kong

Recent findings by the Third International Mathematics and Science Study Report (TIMSS-R) in 1999, which was funded with a grant from the Quality Education Fund and is the only large-scale survey in the fields of mathematics and science education in Hong Kong, have revealed that an entire education reform in Hong Kong is urgently in need. The following points summarized by Dr Frederick K. S. Leung of the Faculty of Education at the University of Hong Kong, a researcher in the TIMSS-R project, are particularly notable (extracted from Wen Wei Po 10th Jun 2001):

1. While Hong Kong students performed well in mathematics (4th), the performance in science was just marginally above the international average (15th).

2. Earth Science was the weakest area for Hong Kong students which showed a below-international-average performance while the strongest was Life Science

3. From 1995 to 1999, Hong Kong student have been spending increasingly less time on mathematics, science or related subjects.

4. Hong Kong students showed a marked performance gap compared with the international average performance in Science Performance Expectations in terms of Scientific Inquiry and the Nature of Science.

5. Hong Kong students were weak at Formulating Conclusions from Investigational Data.

6. Hong Kong students were far behind in Designing Investigations compared with the international performance.

The afore-mentioned conclusions bear important implications on our science curriculum and the conventional mode of teaching science. The findings also revealed a significant deficiency in teaching of earth sciences. Dr Leung also emphasized that the entire education system in Hong Kong needs a striking reform so as to meet upcoming society demands and that the prevailing instruction mode of science curriculum needs to be metamorphosed from a fact-teaching mode to a self-exploring mode (Wen Wei Po 10th Jun 2001).

One of the remedies to the situation is obviously the need for promoting student-centered problem-based learning. We should admit, however, the undertaking of PBL is not itself problem-free. For an instance, Prof. Dan Sherman of the University of Delaware encountered some of the following problems in his Anthropology course that engaged the PBL mode:

- How could the class be fairly assessed?
- How should the students be grouped, and what to do with uncooperative students?
- How to deal with students' charges for the shift of the responsibility of education from teachers to students?
- How to deal with colleagues' challenges on grading policy and justification for better course achievements etc?

Some of these concerns are not unfounded. Because the use of problem-based learning is relatively new, it is not known whether it achieves the desired long-term objectives. In some cases, there is a lack of support from teachers who don't understand the PBL method. [www.udel.edu/pbl/dancase3.html]. It was pointed out, in particular, that **most classrooms do not lend themselves to a problem-based learning format**.

More specifically, a number of local secondary schools has successfully adopted a project-based approach which resembles PBL as their co-development curriculum. Some of the notable projects funded by the Quality Education Fund are

1. Life-wide Learning: A New Learning Experience through Project Learning (2001/0136) conducted by YCH Lan Chi Pat Memorial Secondary School
2. A New Approach of Social and Humanities Education through Project-based

Learning (2001/0582) conducted by HKTA The Yuen Yuen Institute No.1 Secondary School

3. Teaching Integrated Science with a Question-oriented Approach (1999/2040) conducted by Department of Physics, The Hong Kong University of Science & Technology
4. Collaborative Learning Through Projects (1998/3038) conducted by South Tuen Mun Government Secondary School
5. Learning Skills Acquisition for Junior Secondary Students - Project Work (1998/1347) conducted by Lok Sin Tong Ku Chiu Man Secondary School

The success of these projects forms the basis for a more extensive practice of PBL in Hong Kong secondary schools. A common caveat for PBL in the classroom, however, is the lack of hands-on activity and the tendency for the PBL session to resolve into a hypothesizing exercise. We believe that the best venue for undertaking PBL is the field. Most of the proposed projects were essentially confined to the classroom or indoor setting. The **"Problem-Based Learning in the field environment"** we propose here will act as a pioneering project which authentically combines the key features of PBL with remarkable fieldwork techniques and the sophisticated knowledge on natural sciences, with special reference to the issues on student's performance on Scientific Inquiry (both in the field and in laboratory) and transformation of traditional learning process into one pro-active directed by students.

1.4. The need for new approach of "field studies"

We are aware that most schools in Hong Kong organize occasional field trips for students. In addition, there are three field study centers in Hong Kong, namely, Sai Kung Field Study Center, Caritas Chan Chun Ha Field Study Center and Ho Koon NEAC Field Study Center, which are made accessible to teachers as teaching resources. The current situation regarding the field study in schools, however, suffer the following limitations:

1. Contents of provided field studies are curriculum-based, fundamentally restricted to the topics listed in the HKCE or HKAL examination syllabuses.

2. The field studies are essentially a notes-taking exercise for the students. Even in cases that require students to do some investigations, the exercises are conducted with standard procedures and worksheets.

3. In most schools, students go on only a few fieldtrips during the whole school curriculum. In fact, we know of many schools whose students are actually never taken onto field trips even for biology or geography courses.

4. Teachers themselves are deficient in terms of field experience or support.

The current proposed project intends to redress these deficiencies by experimenting with a new style of field study. The designed activities in the project are designed to highlight the following objectives.

I. Field studies will be conducted with an **interdisciplinary approach** in which discipline-specific knowledge such as Physics, Chemistry, Statistics and Mathematics can be well mingled throughout the group work.

II. Field studies will be tailored in such a way that student's **curiosity, learning motivation** and **interest** can be well engaged.

III. The understanding of **Science Inquiry** can be reinforced through conducting fieldwork in the approach of self-exploring such that the development of problem-solving and self-studying skills can be sufficiently reflected.

IV. The design of field programmes can be **extended** to those students who do not enroll in the disciplines of Biology or Geography as well as those at junior level.

V. Participants of the proposed project should be allowed to **establish field study sites** such that they can acquire a deeper and more comprehensive understanding of the nature of Scientific Inquiry through the process of reflection, evaluation and decision-making.

VI. Field studies can **address those complex and ambiguous problems** in place of case studies such that the whole PBL group will be benefited via repeated reflecting, debriefing and presentation.

2. Applicant organization's capabilities for the project

2.1. Project Leader's capability

1. Dr LS Chan is Associate Dean (Outreach) of the Faculty of Science

2.2. Expertise in the relevant field of study and extensive experience in educational activities

1. The Department of Earth Sciences is the only of its kind in Hong Kong, accredited by the Geological Society of the United Kingdom.
2. By nature, the Earth Sciences programme is a field-based one that strongly emphasizes on the training of observational and problem-solving skills, particularly in a field setting. The Department is extraordinarily competent in the coordination of field-based PBL.
3. The teachers in the Department of Earth Sciences are well acquainted with the concept of PBL and experienced with conducting workshops for school teachers.
4. The Department of Earth Sciences is also well recognized for its commitment to teaching and development of innovative teaching pedagogies. Recently, it has been awarded the **Excellent in Education Quality Award** by The University of Hong Kong.
5. The Faculty of Medicine at HKU is one of the most experienced practitioners of PBL in Hong Kong. Its successful experience with PBL will be shared with secondary school sectors through training workshops for school teachers.

Such organizational background lays a strong ground for facilitating project implementation. The renowned organization reputation also facilitates recruitment of potential schools and teachers to participate in the project.

2.3. Professional supports for the project implementation

1. Geological Society of Hong Kong agrees to provide assistance in field studies.
2. Experts in different fields such as construction engineering companies, engineering consulting companies will be consulted and will give interactive, professional discussions with teacher and student PBL groups.
3. An independent consultant from Faculty of Education at The University of Hong Kong will offer professional consultancy advice and report for the project.

2.4. Provision of extensive resources

1. The Department of Earth Sciences is readily able to provide necessary field gears such as geological compass, topographic and geological maps, hammers and geochemical laboratory for detailed analysis.
2. Sufficient resources are available from HKU include the provision of project staff to work collaboratively with participating schools in the implementation and evaluation of the project and provision of reference books and materials.
3. Good facilities are available at HKU for to organize seminars, workshops and meetings, favoring the developmental processes.

2.5. Extensive networks for public dissemination

The in-situ extensive networks between The University of Hong Kong, the Faculty of Science and the Department of Earth Sciences with the secondary school sectors effectively facilitate the dissemination of the project's ideas and practices. In addition, the excellent partner-relationship between the University and some of the secondary schools will, together with the extensive networks, will greatly enhance an effective implementation of the proposed project.

Project Description

1. Goals and Objectives

1.1 Goals

The project goals are aimed to further engage students' curiosity and improve their quality in a sustainable learning environment and ultimately prepare them to succeed in the 21st century. The goals of the current project are formulated around the following major goals to exert positive impact on teaching quality and quality learning atmosphere:

Student Level

1. To prepare students to become progressive problem-solvers, passionate learners and authentic knowledge constructors with a realization that learning is an on-going process throughout their lifetime.
2. To engage students in authentic practice of empirical scientific inquiry and foster their development on minds of inquiry for the complexity of scientific problems.
3. To develop students with essential communication skills in the fields of listening and speaking in addition to reading and writing via continuous peer-interaction, cooperative learning and peer-collaboration.
4. To prepare students to think critically and analytically, and develop an ability to find appropriate learning resources in order to solve complex real world problems.
5. To widen students' horizon in the earth and natural sciences through a series of fieldwork-based interdisciplinary investigations.
6. To sharpen students' personalities, enhance their personal growth and develop effective written and verbal communication abilities through continuous collaboration in small heterogeneous study groups.
7. To promote teacher-student relationships through constant mentoring, communication, support and encouragement, and collaborative effort to solve problems and thus enhancing quality learning atmosphere.

Teacher Level

1. To prepare teachers to acquire first-hand experience of a fieldwork-based PBL methodology through participating as co-learners in teacher PBL group.
2. To engage teachers in authentic practice of empirical scientific inquiry and

enhance their appreciation for the complexity of scientific problems.

3. To enhance teachers' perspective in the earth and natural sciences through a series of fieldwork-based interdisciplinary investigations.
4. To broaden teachers learning areas by providing heterogeneous teacher PBL groups and joint-school presentation delivered by student PBL group.
5. To foster teachers' professionalism by encouraging them to act as facilitator for student PBL groups and by directly participating in interdisciplinary PBL.
6. To promote teacher-student relationships through constant mentoring, communication, support and encouragement, and collaborative effort to solve problems and thus enhancing teaching quality.

Education Community Level

1. To establish a partnership between university and secondary schools, and to provide students with an early on interaction with university staffs and thus widen their horizon on various disciplines of studies.
2. To establish a cooperative working relationship between private sector, learned society and the education sector via intervening group discussions with experts-in-the-field.

1.2 Objectives

The following objectives in the domains of cognitive, psychomotor and affective are the specific illustration of the project goals.

Student Level

1. Participating students will be able to demonstrate independently the operational procedure of Scientific Inquiry (detailed observation, full description, sampling of data, processing and analysis of data, experimental verification, presentation of findings, formulation of hypotheses, evaluation of inferred results and collaboration with peers).
2. Participating students will be able to identify the geosphere, atmosphere, hydrosphere and biosphere as the essential components of the Earth System and realize that the Earth System operates as a function of these parameters which are all complexly inter-related.
3. Participating students will be able to demonstrate independently the operational procedure of fieldwork and laboratory research techniques.
4. Participating students will be able to utilize a variety of 2-Dimensional graphic techniques such as statistical diagrams, tables, concept maps, flow charts, tree diagrams, labeled photographs and sketches for a systematical

organization of information and for a well-constructed presentation of an idea or an event.

5. Participating students will be able to utilize their scientific knowledge acquired in PBL to account satisfactorily for some of field problems with a demonstration of interdisciplinary knowledge, such as the impact of seawater salinity on weathering features, the control of soil nutrition and lithology on vegetation.
6. Participating students will be able to create learning portfolios (encountered difficulties, ways to seek resources, plan for group work and individual work) to record the progress of their group work, individual work and achievement.
7. Participating students will be able to demonstrate a willingness to acquire new knowledge and will actively ask questions when they have difficulties.
8. Participating students will be able to show the sense of responsibilities to other constituent members in group work such as satisfactory completion of assigned individual task on time, attendance of fieldwork and group discussion.
9. Participating students will be able to illustrate their commitment to the group work and individual work such as sacrifice of personal spare time for quality group work and individual work.
10. Participating students will be able to demonstrate consideration and politeness to other constituent members during collaborative work such as an understanding of varying individual member's background and ability.

Teacher Level

1. Participating teachers will be able to establish and coordinate a small-scale and highly self-directed learning community for thematic study within their secondary schools, illustrating the techniques in facilitating, guiding and mentoring the student PBL group.
2. Participating teachers will be able to identify the geosphere, atmosphere, hydrosphere and biosphere as the essential components of the Earth System and realize that the Earth System operates as a function of these parameters which are all complexly inter-related.
3. Participating teachers will be able to create teaching portfolios (encountered difficulties of conducting self-directed learning community, appropriate ways to give participating students guidelines, ways to engage students' learning motivation, effective teaching strategies and assessment of learning and teaching effectiveness) to record the progress of their group work, individual work and achievement.

Education Community Level

1. Participating teachers will be able to demonstrate a change in their conceptions and approaches to teaching.
2. Participating teachers will be able to incorporate learned strategies into their own school-based curriculum.
3. Participating teachers share ideas and the good practices of the current project with other non-participating teachers from participating or non-participating schools, enabling a wider public dissemination.

2. Targets and Expected Number of Beneficiaries

2.1. Targets

2. The targets are secondary school students ranging from Form 1 to Form 7 students and teachers.
3. The project adopts a voluntary-basis for all participating students. Participating students will be selected by their teachers based on their interview performance, interest and record of past teaching development programmes in school.

Targets	Expected number
Participating secondary schools	16
Participating teachers	32
Participating students	640

2.2. Expected Number of Beneficiaries

Expected beneficiaries can be subdivided into two types: the first one are those participating students and teachers who directly take part in the proposed project (1st level) while the other are those students and teachers who learn fruitful experiences of the proposed project from participating students and teachers via whole-school presentation and exhibition (2nd level). The expected numbers of beneficiaries are tabulated as below:

	Number of beneficiary teachers	Number of beneficiary students
1st level *(Direct beneficiaries)*	2 from each participating school (Total: 32 teachers for 4 rounds)	20 students/teacher (Total: 640 students for 4 rounds)
2nd level *(Indirect beneficiaries)*	All teachers from participating school	All students (both Arts and Science) from participating school

In addition, the entire education sector will be benefited from the successful experience of the present project which serves as a reference of pioneering learning methodology mingling field studies, science curriculum and PBL.

4. Extent of teachers and principals' involvement

In general, teachers' involvement is a more direct way through direct participation in Phase 1 PBL. Teachers offer a more direct interaction with students through acting as group facilitator while principals offer an essential backup for both teachers and students.

3.1. Teachers' involvement

Since the project will be run in two phases, roles played by teachers in each phase are different.

Phase 1

1. Participating teachers attend the PBL workshop organized by experts on the subject joined by staff members from the Department of Earth Sciences at HKU.
2. Teachers will undertake the action research. Detailed description of tasks will be given in next section.
3. Teachers will assist with dissemination of their experience and present a plan of practicing PBL for their own education sector or to the public.

4. Teachers have to work closely with the project team to evaluate the effectiveness of Phase 1 PBL.

Phase 2

1. Teachers will actively engage in the design of problems assigned to their own student groups by identifying students' needs, strengths and weakness.
2. Teachers will assist with the dissemination of the ideas and practices of the present project school among students.
3. Teachers will share their experience with other participating teachers from different schools.
4. Teachers will act as facilitator/mentor for Phase 2 program.
5. Teachers have to evaluate the effectiveness of Phase 2 by collecting student performance data.

3.2. Principals' involvement

The roles played by principals during the implementation process are less direct than those of teachers. However, principals' involvement is essential to the success of the entire PBL project because:

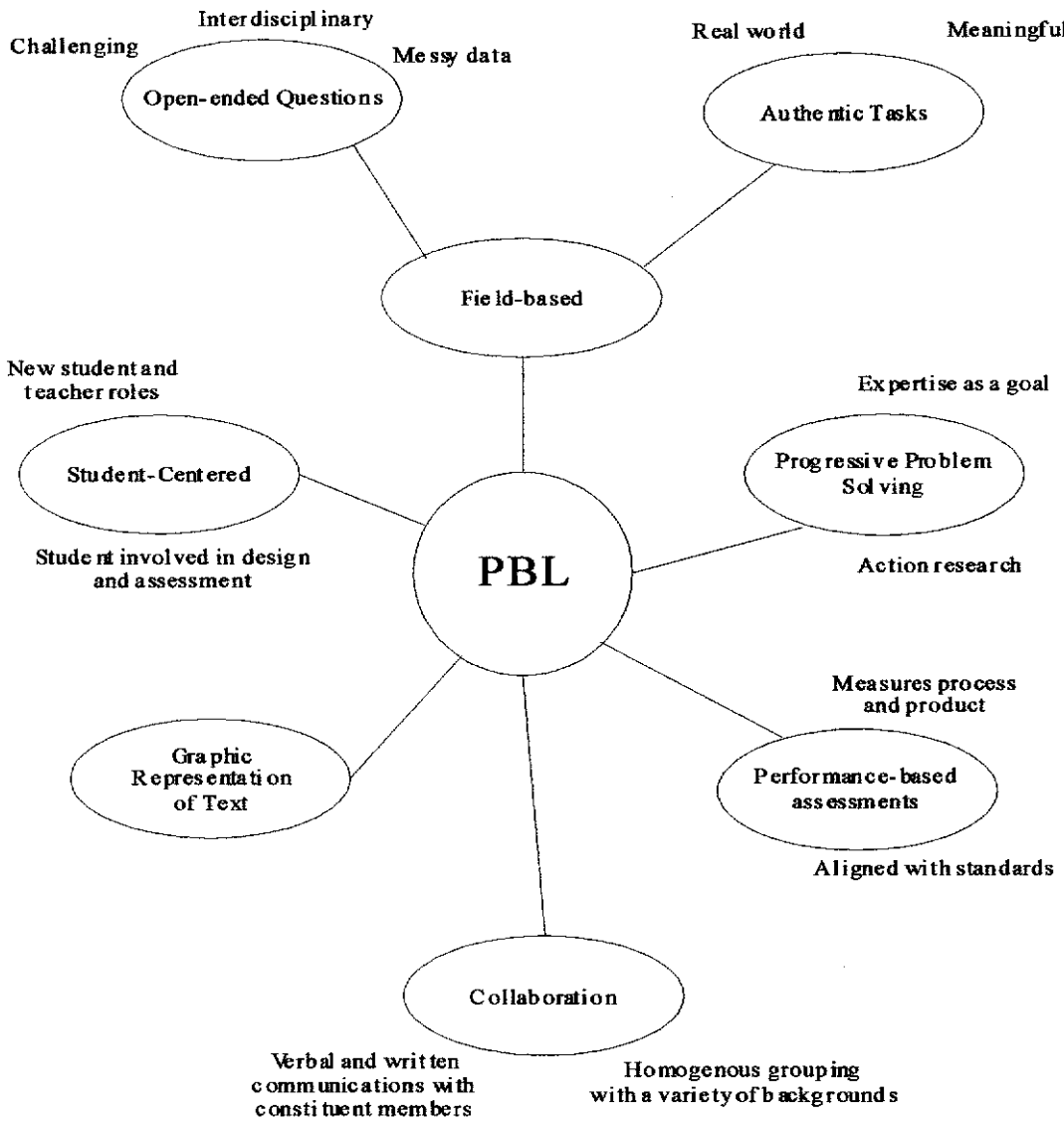
1. Principals will empower participating teachers in taking up the responsibilities.
2. Principals will have to give full support to both participating teachers and students by allowing a flexible timetable for their group work.
3. Principals may have to adjust participating teachers' workload.
4. Principals will coordinate with parents via students' parents meetings to introduce the ideas of the project.
5. Principals will assist in the dissemination on the ideas and practices of the current project in among non-participating students and teachers through various forums or participants sharing session.

4. Action plan with time-line

4.1. Proposed model of 'PBL in the field'

The PBL methodology in our model is largely founded on the key features outlined by Rasmussen and Moffitt in 1995. Since a key to successful PBL is the design of contextual problem sets, we believe that a field-based PBL will sufficiently reflect the importance of authentic tasks in PBL. Our model therefore significantly addresses not

only the core of PBL methodology but also the nature of authentic tasks. The following diagram illustrates eight key features of our model.



Key features of our model

Note: Adapted from Jones, Rasmussen & Moffitt, (1995).

4.2. The roles for teacher and student in the project

In our model, traditional teacher and student roles change dramatically as the whole teaching-and-learning mechanism remarkably shifts from a teacher-centered system to a student-centered one. With great reduction on the amount of direct instruction, students assume increasing responsibility for their own learning (Bridges & Hallinger, 1991), giving them more motivation and a sense of accomplishment, leading them to become successful life-long learners and progressive problem-solvers. The teaching organizations and individual teachers in turn become facilitator, tutors, evaluators and task group consultants rather than information-provider or expert. Table 1 below summarizes the roles played by teachers and students in the proposed PBL.

	Teachers	**Students**
Act as	1. Facilitator 2. Mentor 3. Guide	1. Problem solver 2. Collaborator 3. Explorer 4. Teacher
Tasks	1. Stimulate students' learning motivation. 2. Engaged in negotiation, stimulates and monitors discussion and project work but does not control. 3. Redirect focus and guide students to consider multiple perspectives. 4. Help to maintain quality collaborative and learning atmosphere.	1. Cultivate passion for life-long learning and view learning as a pro-active process. 2. Explore advancing knowledge and the state-of-the-art technique. 3. Teach others in formal and informal contexts. 4. Develop outputs for real use. 5. Maintain quality collaborative atmosphere.

Table 1: Summary of teacher roles and student roles in PBL.

4.3. Implementation plan

Programs and activities

The proposed project will run 4 rounds over a 28-month-period. Each round is intentionally subdivided into two main phases. Phase 1 is targeted at teachers and Phase 2 at students. The two phases are designed slightly differently due to the different capability and attitude of teachers and students, as shown in Tables 2.

Main components of Phase 1 and Phase 2

Phase 1 and Phase 2 will be conducted in a similar fashion, comprising of three major components: **PBL workshop**, **Action research** and **Interaction with experts-in-the-field**. They are tabulated as shown in Table 3.

A) PBL workshop

A weekend field camp will be organized for teachers in the first Phase of the programme. The field camp will start off with a workshop on PBL. An expert on the subject will be invited to give an overview of the concept and principles behind the learning pedagogy. The participants will be divided into groups and undertake an action research on a specific problem using the PBL approach.

B) Action Research

"Action research" basically consists of five main stages: cognition (identifying), planning (strategies formulation), process and analysis (verification of collected raw data), presentation of findings (verbal presentation and exhibition) and final assessment of the project impact. The groups will also be advised that in the process of PBL, they may sometimes have to revisit a particular stage, make modifications and repeat the second stage in an iterative manner. A representative evolution history of "action research" is tabulated in Table 4.

Towards the end of the fieldcamp, participating teachers will spend 2 hours come together in a discussion session. The discussion will focus on the following three aspects:

1. the potential problem and difficulty encountered in PBL for school students.

2. how to overcome the problems and difficulties.
3. how to implement a PBL field camp for their students.

Each of the teachers will be required to formulate a plan, as part of the outcome of the discussion, on a PBL camps for students, which is the primary objective of Phase 2.

C) Interaction with experts-in-the-field

The fieldcamp will culminate in a summary session to discuss problems how to overcome problems encountered in PBL and how to conduct PBL in the field for students. Experts in relevant fields will interact with PBL group members, for example, engineering constructor companies, engineering consultant companies, Agriculture, Fisheries and Conservation Department and so forth. These interactions will be introduced during Action Research such that participating students can acquire a general picture of what they plan to research. During these discussions with experts, all participating students are encouraged to utilize the opportunity to explore how the classroom-teaching materials are applied in the real world.

Table 2: Similarities and distinctions between Phase 1 and Phase 2 programmes

	Phase 1	Phase 2
Targets (direct beneficiaries)	Teachers only	Teachers and students from the same participating school
Aims	a. To provide teachers with first-hand experience of field-based PBL. b. To provide teachers with opportunities to foresee technical difficulties arising during Phase 2.	a. To introduce field-based PBL for school students. b. To provide students a collaborative work in field setting.
Duration	9 weeks	10 to 12 weeks
Grouping	a. 4 to 6 constituent members. b. Heterogeneous style for a conglomeration of ideas, backgrounds and abilities. c. 2 teacher PBL groups in each round.	a. 5 to 7 constituent members. b. Heterogeneous style for a conglomeration of ideas, backgrounds and abilities. c. 4 to 5 student PBL groups in each round.
Meeting	Regular meeting with a chartered tutor (facilitator) assigned by the project.	Regular meeting with a chartered tutor assigned by the project and with corresponding teacher (who participated in Phase 1).
Assigned problems (Tentative)	a. Control of seawater salinity on weathering pattern for different lithologies. b. Lithological control on vegetation type. c. A geomorphological analysis on wave effect.	a. Control of seawater salinity on weathering pattern for different lithologies. b. Lithological control on vegetation type. c. Wave action on landform.

Table 3: Main components of Phase 1 and Phase 2 programmes

	Participants	Content descriptions
PBL workshop	a. HKU staffs b. School teachers and principals	1. Conducted in prior to PBL group collaboration. 2. Organized by the Faculty of Medicine jointed with the Department of Earth Sciences at HKU. 3. Provide an overview on field-based PBL program, practical meaning and key features of PBL.
Action research	a. Chartered tutors b. School teachers c. School students	1. Main body of the Phase 1 and Phase 2. 2. Teachers act as PBL facilitators in Phase 2. 3. Participants work collaboratively with others to solve assigned problems in small group.
Interaction with experts-in-the-field	a. Experts-in-the-field b. School teachers c. School students	1. Experts in relevant fields will interact with PBL group members. 2. Intervened into the process of action research. 3. A n invaluable process towards the progress of knowledge construction because: ▪ Participants acquire an insight into the real practices of what they have researched or what they will plan to research. ▪ Participants promote their acquired knowledge to a superior and practical level.

Stage	Teacher roles	Strategies/goals	Student roles	Strategies/tasks
Cognition	Facilitator Mentor Guide	1. Establish PBL group. 2. Explain broad tasks and open-ended problems. 3. Guide students to consider multiple perspectives. 4. Ensure students reflection against broad tasks, problems and goals	Problem Solver Collaborator	1. Be self-directed and cultivate passion for learning. 2. Initiate and organize PBL group. 3. Develop and reflect on open-ended problems and inquiry. 4. Establish broad goals. 5. Maintain quality collaborative atmosphere.
Planning	Facilitator Mentor Guide	1. Guide students to generate ideas for appropriate actions. 2. Encourage student assessment of collaborative environment.	Problem Solver Collaborator	1. Formulate different perspectives, theories and hypotheses. 2. Consider alternative solutions 3. Refine according to feedback from teachers and peers 4. Interact with peers, teachers, local officials and experts-in-the-field
Process and analysis	Facilitator Mentor Guide	1. Monitor progress of group work. 2. Help students develop hypotheses. 3. Verify goals set out previously. 4. Assist fieldwork and coordinate logistics. 5. Anticipate new needs for group.	Problem Solver Collaborator Evaluator	1. Formulate hypotheses as sketches, notes and drafts. 2. Undertake fieldwork actively. 3. Maintain quality collaborative environment 4. Modify, evaluate and refine previous reflection if necessary. **5. Interact with peers, teachers, local officials and experts-in-the-field.**
Presentation on findings	Facilitator Mentor	1. Monitor presentation rehearsals. 2. Monitor outputs for quality.	Problem Solver Collaborator Evaluator Teacher	1. Synthesize and finalize findings 2. Undertake extra data collection if necessary. 3. Review critically outputs. 4. Construct outputs and presentation.
Final assessment	Facilitator Mentor	1. Act as observer. 2. Encourage students to teach others in informal and formal contexts. 3. Gather feedback from the floor.	Evaluator Teacher	1. Teach others in informal and formal contexts. 2. Gather and reflect feedback from the floor. 3. Peer conference with peer-evaluation. 4. Discuss how to improve.

Table 4: Action research plan (Phase 2) - tasks tackled by teachers and students during different stages *(Note: Participating teachers in Phase 1 will undertake the roles played by participating students in Phase 2 as shown above.)*

Schedule with Time-Line

Each round will be run for 21 weeks in accordance with the following schedule.

	Week	Programmes
Phase 1 (Teachers participation)	Week 1 to Week 3	1. Public Dissemination 2. PBL workshop 3. Identification of teachers' and schools' needs 4. Finalization of assigned problem
	Week 4 to Week 5	1. Action Research A. Cognition B. Planning C. Process and analysis D. Presentation of findings E. Final assessment 2. Interactions with experts-in-the-field
	Weak 6 to week 8	1. Evaluation 2. Interviews for assessment 3. Undertake Qualitative measures on outputs
Transition stage	Week 9 to Week 10	1. Data collection and analysis 2. Dissemination
Phase 2 (Teachers and students participation)	Week 11 to Week 12	1. Identification of students' needs 2. Finalization of assigned problem
	Week 13 to Week 19	1. Action Research A. Cognition B. Planning C. Process and analysis D. Presentation of findings E. Final assessment 2. Interactions with experts-in-the-field
	Weak 20 to week 21	1. Evaluation 2. Interviews for assessment 3. Undertake Qualitative measures on outputs

Since 4 rounds will be run, a year-plan will proceed as follows:

	1st round	2nd round	3rd round	4th round
Phase 1 (for teachers)	*Sept 2003 to Oct 2003*	*Mar 2004 to Apr 2004*	*Sept 2004 to Oct 2005*	*Mar 2005 to Apr 2005*
Phase 2 (for students and teachers)	*Nov 2003 to Feb 2004*	*May 2004 to Aug 2004*	*Nov 2004 to Feb 2005*	*May 2005 to Aug 2005*

From Sept 2005 to Dec 2005, a series of joint-school exhibition, poster exhibition and field trips will be held in accordance with the topics defined by student PBL group. Data collection and analysis and effectiveness-study report will be also produced.

5. Expected Deliverables and Outcomes

5.1. Expected Deliverables

Student Level

1. Each student PBL group will complete a full report and deliver a verbal whole-school presentation on their findings with a set of well-prepared visual aids.
2. Each student PBL group will deliver a verbal whole-school presentation on their findings to one other participating school.
3. All student PBL groups will jointly produce a presentation after each round.
4. All participating students will produce a student portfolio on their experience during different stages of PBL and the progress of group work.

Teacher Level

1. Each teacher PBL group will complete a full report and deliver a verbal presentation on their findings with a set of well-prepared visual aids.
2. All participating teachers will produce a teaching portfolio on their participation experience during different stages of PBL and the progress of group work.

3. PBL workshop materials, records will be produced.

Community Level

1. Parents meetings will be held for parents to understand the project goals, development and outcomes.
2. School staff sharing session will be encouraged to disseminate the project's ideas and practices.
3. All group deliverables will be compiled in an interactive CD-ROM.
4. A package of teaching materials on PBL methodology will be produced.
5. An effectiveness-study report of the entire project will be produced.

5.2. Expected Outcomes

Student Level

1. Participating students are tuned to 'learn-to-learn' with a realization that learning is an on-going process throughout their lifetime.
2. Participating students will acquire interdisciplinary knowledge and become proficient in problem solving, self-directed learning and team participation.
3. Participating students perform as well as their counterparts from traditional classrooms on traditional exams, perform better on tackling unfamiliar problems and are better practitioners of their professions.
4. Participating students can apply their acquired knowledge on daily life and on serving the community.
5. Participating students will acquire a reinforced understanding on Scientific Inquiry and the nature of science.
6. Teacher-student relationship will be further promoted through constant mentoring, encouragement and communication.
7. Students will show a sophisticated group cooperation.
8. Students will demonstrate a positive attitude towards themselves and others.

Teacher Level

1. Participating teachers can establish and coordinate small-scale learning community in schools.
2. Teacher-teacher relationship will be further enhanced through interdisciplinary PBL and hence reinforce professionalism development.
3. Teacher-student relationship will be further promoted through constant

mentoring, encouragement and communication.

Community Level

The successful experience of the present project lays a strong groundwork for the incorporation of PBL into the current science curriculum.

6. Budget Details

6.1. Salary (Total: 472,000)

A **senior research assistant** will be employed as the primary programme organizer. The position will be in charge of publicizing and organizing the activities, coordinating with the external assessor and preparing project reports. This is a full-time position.

Salary: 13,000/month * 28 months = 364,000

An **external consultant** will be invited to observe and assess the progression and efficacy of the project. The consultant will serve in an independent role.

Consultant fee 120 hours * $700/hour = 84,000

University students employed as **field helpers** to organize student activities during the field camp.An estimated 60 man-day is required at $400/man-day 24,000

6.2. Field Expenses (total: 210,800)

A total of 32 teachers will be invited to participate in the Phase I of the programme. Each teachers will then conduct PBL learning for 20 students. The total number of participants estimated are 32 teachers and 640 students. The expenditure include meals, accommodation, and field transportation. Estimated expenses are:

Field camps for teachers
Accommodation and meals at 200/day *32 * 2 days = 12,800
Field transportation and other expenses: 20,000

Field camp for students
Accommodation and meals at 200/day*640* 2days
- (student participation fee at 100/day*640*2 days) = 128,000

Field transportation and other expenses: 50,000

6.3. General Expenses (Total: 164,000)

Promotion and Publicity 60,000
General Expenses: $3000/month * 28 month = 84,000
Production of report:
20,000

Total Requested: 846,800

Project Impact

1. Evaluation Parameters and Method

We will emphasize the need to accurately assess the success of the proposed project. Since the proposed project comprises of two phases, evaluation methods will be developed individually for these two phases. The first phase fosters the teacher development on the practice of PBL. Participants will be well-equipped with the skills of acting PBL facilitator, provided with the first-hand experience of fieldwork-based PBL. The second phase fosters student development through the fieldwork-based PBL

The evaluation will consist of four mechanisms.

1. Quantifiable measures of the deliverables. The efficacy of the project can be directly compared to the deliverables specified in the current proposal.

2. Independent assessor. An independent assessor will be employed to provide an independent assessment of the progress and outcome of the whole project. The assessor will conduct the evaluation and interviews, and furnish an independent report that will be submitted along with the final report of the proposal.

3. Evaluation by participating teachers. The evaluation will take the form on both a questionnaire for all participating teachers and in-depth interviews with individual teachers. The interview may take the form of a group discussion on the efficiency, merits and shortcomings of the whole process.

4. Evaluation from students. All participating students will submit an evaluation for the project and will undertake peer-evaluation. A selected group of students will also be invited to an assessment session and present verbal comments on the project.

2. Project Significances

Of all learning methods, PBL is best studied in a scientific sense. However, many

educational organizations are still reluctant to put it into their current practice, concerning if the adoption of PBL can expose students sufficiently to knowledge. Therefore, one of our major visions in the present project is to eliminate education sector's as well as parents' concern on the PBL significance, demonstrating a positive image that PBL's advantages outweigh its shortcomings and projecting the present project as a successful reference model for the education sector. Following are the project significances which can benefit the education sector as a whole.

Tackling potential problems faced by PBL

Since the roles for teacher and student change remarkably, potential problems are expected at students, parents and teachers levels.

A) Student level

1. Students familiar with the traditional "talk and chalk" classroom are likely to be uncomfortable with the PBL format for some time.
2. Students may ask for a clear direction on what they exactly have to do to get their grade.
3. Students will expect teachers to prescribe a number of tasks, events, concepts and a set "number of pages" for written products.
4. Students may express concerns on their grade being dependent on other group members' effort.

B) Parent level

1. Students' parents may express concerns when their children are not comfortable with this new environment.
2. Students' parent may ask for a clear syllabus in which their children concretely learn.
3. Students' parent may wonder what teachers are teaching during school time, feeling reluctant to the new learning method.

C) Teacher level

1. Moving into "untraditional" instructional modes may appear risky, scary, and uncertain to teachers who are new to PBL.
2. Interdisciplinary studies may subject them to risk of out-of-expertise.
3. Teacher may have to spend extra time and energy on stimulating and mentoring student PBL group.

We will use the PBL workshop to resolve and discuss the potential problems

listed above.

Enhancement of quality learning atmosphere

1. Participating students will "learn to learn" and become learning-passionate with a realization that learning is an on-going process throughout their lifetime.
2. Participating students become a progressive problem solver, being skillful in self-directed learning and team collaboration.
3. Participating students' performance can trigger peer-inspiration among other non-participating students in participating schools.
4. The field-based PBL will be beneficial to the all-round development of students with a variety of abilities and backgrounds such as able student and less able student.
5. Teacher-student relationship will be further promoted through constant mentoring, encouragement and communication and thus enable a quality learning environment.

Enhancement of teaching quality

1. Participating teachers will gain, in addition to their expertises, extra interdisciplinary knowledge and valuable first-hand experience of the field-based and interdisciplinary PBL via directly participation.
2. Participating teachers will gain additional experience on establishing and coordinating small-scale self-directed learning community in schools, which enables a new element of teaching in school and promotes teachers professional competence.
3. Schools' participation in the project enables an introduction of an effective teach-and-learn approach, enhancing present teaching quality.
4. Participation in the project enhances teachers' new insight into the trend and diagnostic features of education reform.
5. The adoption of the proposed field-based PBL in schools will facilitate an experimental integration of various disciplinary subjects in a student-centered setting, which self-evidently addresses the urgent need for education reform in society.
6. Interdisciplinary PBL will promote Teacher-Teacher relationship via consulting, support, encouragement and communication and hence will facilitate teaching quality and professionalism development.
7. The collaboration of secondary schools with The University of Hong Kong assists a further development of school-based curriculum, establishing a model for the education sector.

3. Sustainability of project outcomes

The sustainability of the current project is a high priority consideration. As illustrated in the section of "Goals and Objectives", one of the major goals of the proposed project is to prepare students to become progressive problem-solvers, passionate learners and authentic knowledge constructors with a realization that learning is an on-going process throughout their lifetime. As a consequence, the skills, knowledge and beliefs acquired via the project will be well-sustained with a passionate mind developed by all participants. Sustainability is thus achieved. In addition, a number of methods to sustain the project outcomes is outlined as follows:

1. All deliverables can serve as reference materials accessible for other students and teachers.
2. Developed teaching materials on field-based PBL will be made accessible to the public.
3. The Department of Earth Sciences is able to provide necessary field support.
4. Field expenses can be shared by participating students, teachers and schools in a well-balanced manner.

4. Public Dissemination

In order to project the developed models, strategies and professional practices of the proposed project ultimately on the entire education sector, methods are outlined for an effective dissemination:

1. Seminars, workshops and exhibitions will be delivered for promotion of the project.
2. The project will actively recruit potential schools teachers after workshop, increasing beneficiaries.
3. Resource materials, like teaching and learning exemplars CD-ROM will be distributed to public.
4. Throughout the project, participating teachers and students will be encouraged to disseminate the ideas and practices of the field-based PBL.

Appendix A: Uniqueness of the proposed project

1. Students learn via the effective PBL methodology

Research indicates that in the typical classroom, 85% of teacher questions are at the recall or simple comprehension level. Questions that elicit synthesis and evaluative skills of thinking are rarely asked. However, in PBL environments, students learn more effectively because of the following key features of PBL.

1.1. Meaning-emphasized

Memorization is an essential element in traditional learning programs (Vernon & Blake, 1993). Unfortunately, most students merely use little of what they memorize in classroom. PBL attempts to break this focus by engaging students actively in meaningful learning through replacing lectures with discussion forums, teachers mentoring and collaborative research. Students engaged in PBL will hence acquire a higher level of comprehension on real-world contexts.

1.2. Development of self-directed students

As PBL addresses student-centered approach, they tend to assume increased responsibility to pursue solutions. These students use self-selected resources, such as journals, on-line searches, and other library resources (Vernon & Blake, 1993), more often than traditional students. These processes and learning skills help students become more competent in information-seeking skills than traditional students.

1.3. Development of interpersonal skills

Social interaction is an important element of human life. PBL authentically incorporates student interaction and teamwork, thereby enhancing students' interpersonal skills (Bernstein et al., 1995; Pincus, 1995) such as working with group dynamic, peer evaluation, and how to present and defend their plans (Delafuente, Munyer, Angaran, & Doering, 1994).

1.4. Promotion of teacher-student relationship

The aspect which PBL operating organizations favour most is the teacher-student relationship (Vernon, 1995). These organizations also consider PBL a more nurturing and enjoyable curriculum and believe the increased student-teacher contact is beneficial to the cognitive growth of the student (Albanese & Mitchell, 1993).

2. PBL is conducted in its ideal setting

We believe the best ideal settings for conducting problem-based learning is in the field, where students have to cope with real and in-situ problems with no definitive solutions under a challenging working environment. There are five justifications behind this appeal.

2.1. Complexity of field problems

Field problems are essentially complicated to a variety of extent and in practice are not generally solvable with simple algorithms. It is due mainly to the fact that a field problem is effectively a function of massive parameter controls which are all well-linked via pronounced feedback mechanisms. Thereby natural environments readily provide in-situ complex problems, which requires a multi-disciplinary examination approach, as a crucial element for the adoption of PBL.

2.2. Contextualization of field problems

Since field problems which are constantly emerging in our real-world and which are prevailingly occurring in our daily life, they are self-evidently well-marked authentic tasks posted to PBL students.

2.3. The uncertainties of solution to problems

Field problems tend not to have just one "correct" answer: they tend to be unanticipated, ill-structured situations and filled with a variety of plausible solutions. Hence, PBL students will be enabled to learn to tackle open-ended questions and learn to pursue a relatively satisfactory solution from a variety of possible solutions.

2.4. Sharpening of students' characters

Tackling field problems requires additionally one's careful observation, self-directed and self-caring abilities. This will help to sharpen one's personal characters and thus improve participants' quality in an all-round way.

2.5. Students' learning motivation

Our preliminary survey result in 2002 (see Appendix B) and TIMSS-R (1999) data indicate that young school students are generally interested in problems which they will repeatedly encounter in their daily life and which the current education curriculum does not address significantly. The majority of surveyed students is inclined to the natural environments, in particular, the field of Earth Science and Life Science which seemingly engage our students' learning motivation.

Appendix B: Preliminary survey on student-favouring topics

The Department of Earth Sciences at the University of Hong Kong undertook a preliminary survey among primary (P5 and P6) and junior secondary school students (F1 to F3) in 2002. We distributed 700 questionnaire-sheets to 20 different schools. Each school was given 35 questionnaire-sheets for 35 individual students. The total number of received effective questionnaire-sheets was 374, occupying a 53.4% of total distributed questionnaire-sheets.

The questionnaire adopted an open-ended style. Each student was asked to write down ten 'Why' questions which he or she favours most. Only a very insignificant portion of questions fell out of the field of natural sciences. Thereby, the broad categorization of questions written by students could be largely based on TIMSS-R project with an addition of Technology category. The broad categories included Earth Science, Life Science, Physics, Chemistry and Technology. The breakdowns of broad categories are shown on chart 2 (Earth Science), chart 3 (Life Science), chart 4 (Physics) and chart 5 (Chemistry). There is no breakdown for the Technology category due to insignificant statistics result.

The survey result indicated that:

1. The field students were interested is the Earth Science (47%) followed by Life Science (35%).
2. The least number of students were interested in Chemistry (3%).
3. The favoured topics in the category of Earth Science and Life Science demonstrate a significant diversity.
4. The favoured topics in the category of Physics and Chemistry demonstrate a minor diversity.

The statistics can be attributed to that:

I. The majority of studied students are generally inclined to those events which they encounter in daily life and which the current curriculum does not address sufficiently.

II. Students in general show a wider range of interest in the topics of Earth Science and Life Science, which may be attributed to fact that students encounter these topics more frequently in daily life.

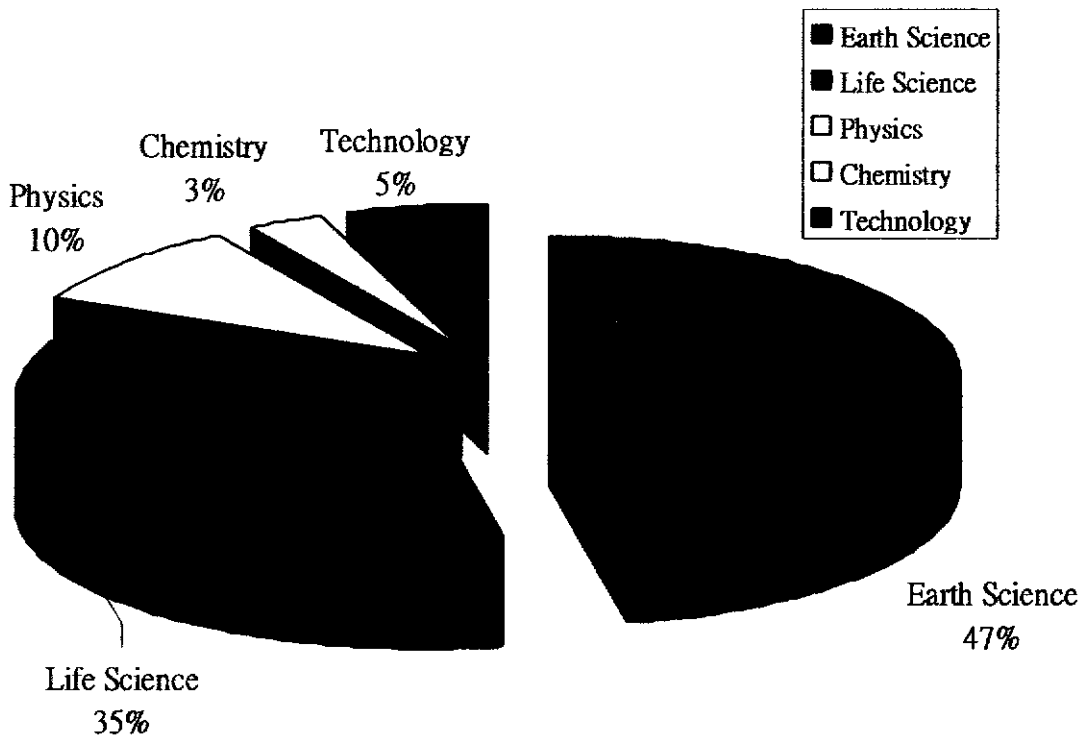


Chart 1: Broad categorization of student-favouring topics

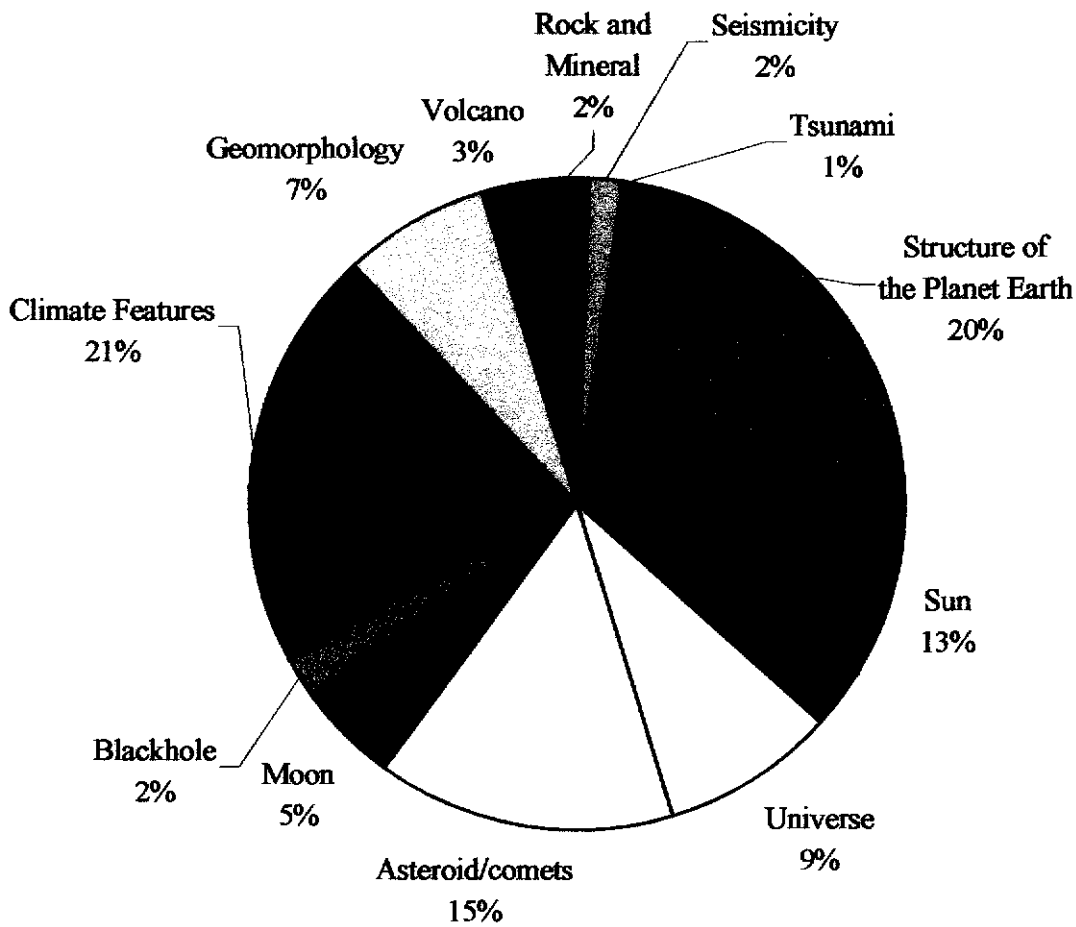


Chart 2: Breakdown of Earth Science category

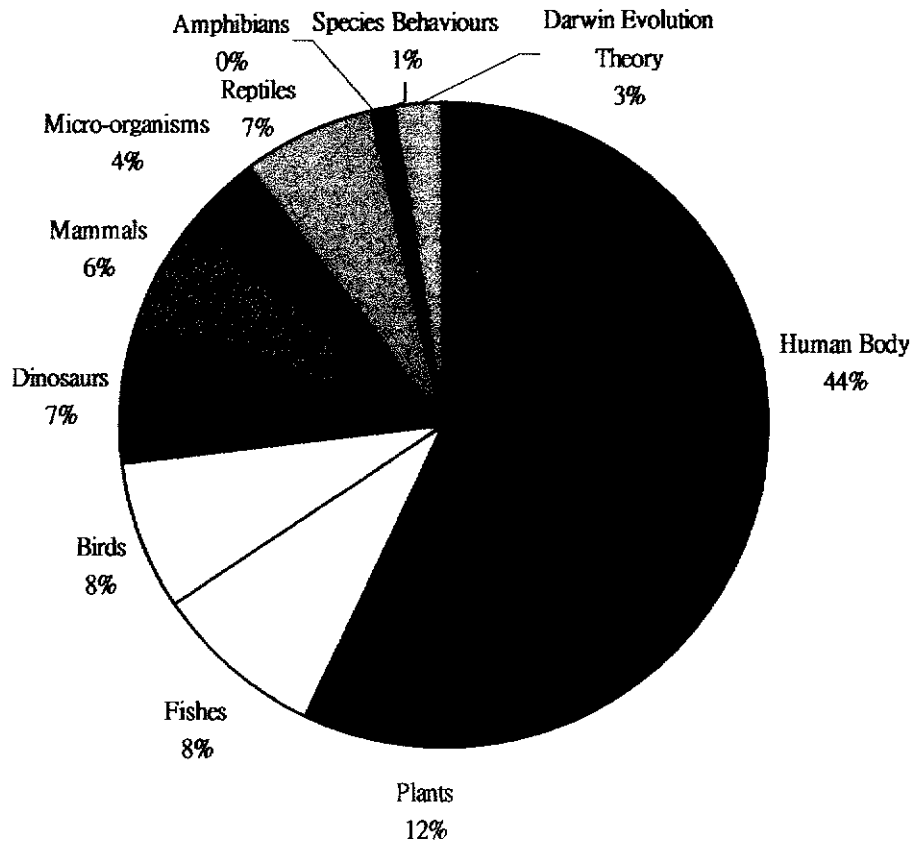


Chart 3: Breakdown of Life Science category

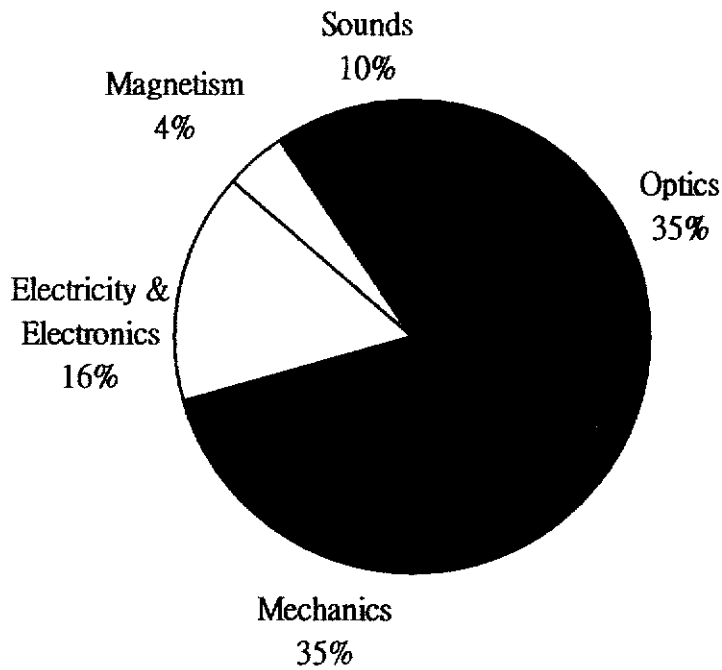


Chart 4: Breakdown of Physics category

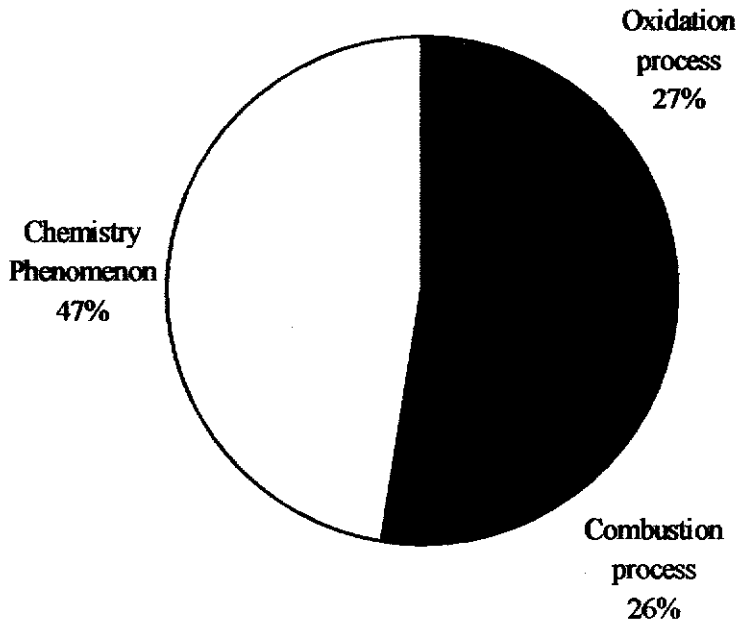


Chart 5: Breakdown of Chemistry category

Appendix C: Tentative list of participating schools

The Church of Christ in China Kei Long College

Principal: Ms Chan Kit Ching

St Stephen's College

Principal: Mr Chu Yip Ton

St Mary's Church College

Principal: Ms Cheng Ka Lee

Appendix E: Brief introduction to applicant's organization

The Department of Earth Sciences is the only of its kind in Hong Kong. The programme, requiring a total of at least 56 days in field study for its students, is accredited by the Geological Society of the UK. By nature, the earth sciences programme is a field-based one that emphasizes on the training of observational and problem-solving skills, particularly in a field setting. The teachers in the department are well acquainted with the concept of problem-based learning and experienced with conducting workshops for school teachers. The Department is also well recognized for its commitment to teaching and development of innovative teaching pedagogies. Recently, it has been awarded the **Excellent in Education Quality Award** by the University of Hong Kong.

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