香港大學地球科學系主辦

Organized by Department of Earth Sciences, The University of Hong Kong

Department of Earth Sciences
The University of Hong Kong

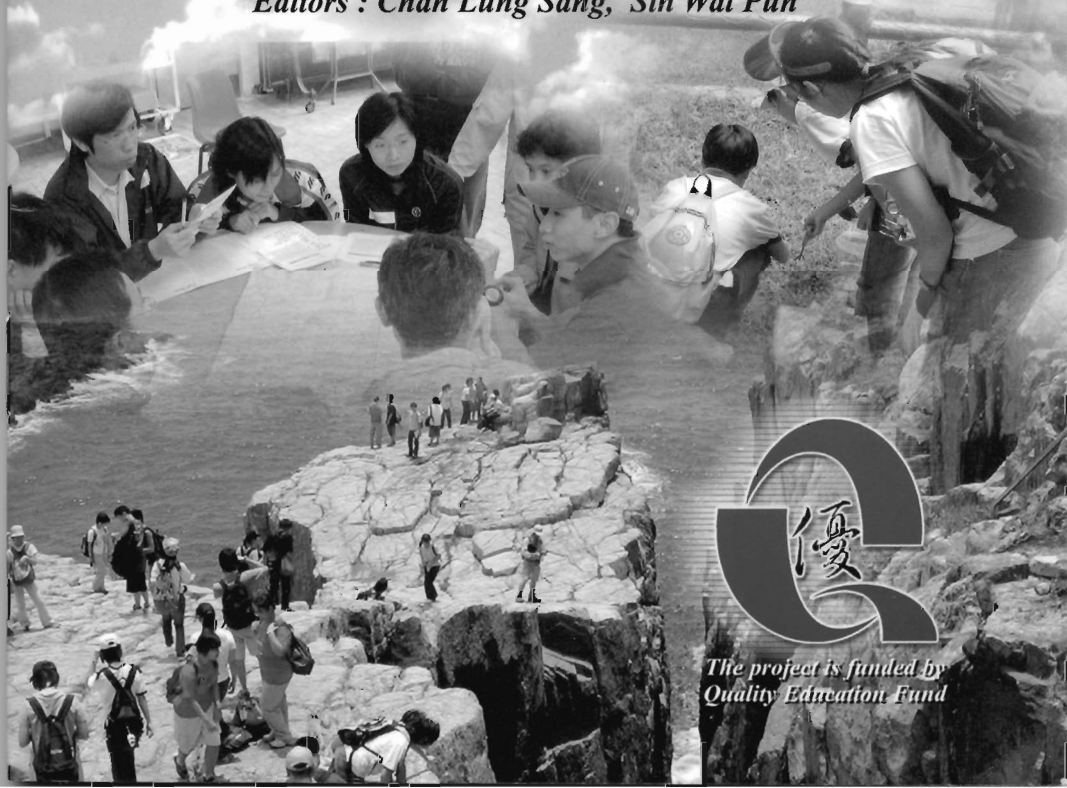
Problem-Based Learning

In The Field Environment

[REFERENCE TEMPLATE]

2005

Editors : Chan Lung Sang, Sin Wai Pun



The project is funded by Quality Education Fund

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Message from the Author

Once, a teacher asked me why I, as a geologist, would advocate the teaching mode of "Problem-Based Learning (PBL)". The reason is that in geological research, which involves a lot of field work, there are no standard answers like in examinations or textbooks. The cases that we deal with in the field are always complex and interdisciplinary. Not only we need to formulate our own questions to ask in the field, there are also no stipulations as to what approach should we take to solve the questions. The students in Department of Earth Sciences, The University of Hong Kong are essentially doing "Problem-Based Learning" in their field training, although they may not know the jargon used by education specialists. To us, however, this is a fundamental trade skill. I must say that we have more practical experience with this mode of learning compared with students in many other disciplines.

The Liberal Studies curriculum proposed by the Education and Manpower Bureau is based on several important notions, namely, inquiry-based learning and connecting knowledge from different subjects, with an aim to develop the student's self-motivation in learning and interdisciplinary thinking. I completely agree with these notions, but I also understand that it is not easy to apply them to the curriculum. Only by changing the roles of teachers and students in the learning process can we achieve the objective of "student-centred learning". In September 2003, we received funding from the Quality Education Fund to organize field sessions for teachers and students using the PBL approach. Judging from our observation and the feedback from the participants, PBL is a highly effective interdisciplinary learning mode truly transcending subject boundaries and is particularly suitable to be applied in the field environment. It encourages students of all levels to play a more active part in the learning process and provides every student with equal opportunity to express their opinions. I believe that the spirit of PBL is totally in line with that of the curriculum reform. It is a good learning mode which I hope can also serve as an exemplar for the Liberal Studies curriculum in future.

Dr. L.S. Chan
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February 2005

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Programme Overview

1. Learning to Learn

As the contemporary world evolves rapidly and technology develops at enormous paces, Hong Kong's economy is transforming from a labour-based to a knowledge-based one. The inability of the present education system to create sufficient talents to meet future challenges has prompted the education community to actively seek education reform in recent years. In the report "Reforming the Academic Structure for Senior Secondary Education and Higher Education - Actions for Investing in the Future", Education and Manpower Bureau highlights the imperative for a "flexible and diversified curriculum" and one that emphasizes "learning how to learn and inquiry-based learning" .

Liberal Studies, a compulsory subject in the new senior secondary education, aims to provide the kind of learning experience required to develop the student's "independent thinking, social awareness and adaptability". The PBL approach is not only already used by some curricula, but can also become the means of learning in the new Liberal Studies curriculum. The purpose of our project is three fold. Firstly, we want to provide the participating students with an opportunity to learn how to solve problems systematically and understand the importance of "life-long learning". Secondly, the project provides teachers with an opportunity to experience the PBL process as a learner. Finally, exemplary materials will be developed to be used by schools for independent enquiry studies.

2. What is PBL?

In traditional education, the teachers and the school often neglect the stage in which problems are created. Instead, they simply jump to the facts and procedures without giving students an opportunity to discover and study the problems themselves. In PBL, the curriculum designer provides students with a problem statement containing real-life scenarios, which serves as a starting point for students to analyze the problem statement, explore learning issues and suggest means of solving problems related to the problem statement.

3. Why in the Field?

A key requirement of PBL is to provide learners with a realistic, complex and interesting scenario statement. The best place to experiment with PBL is in the field environment, where there are numerous complex and ambiguous problems of such a nature and which can only be solved by combining knowledge from different disciplines.

4. Changing Roles of Teacher and Student

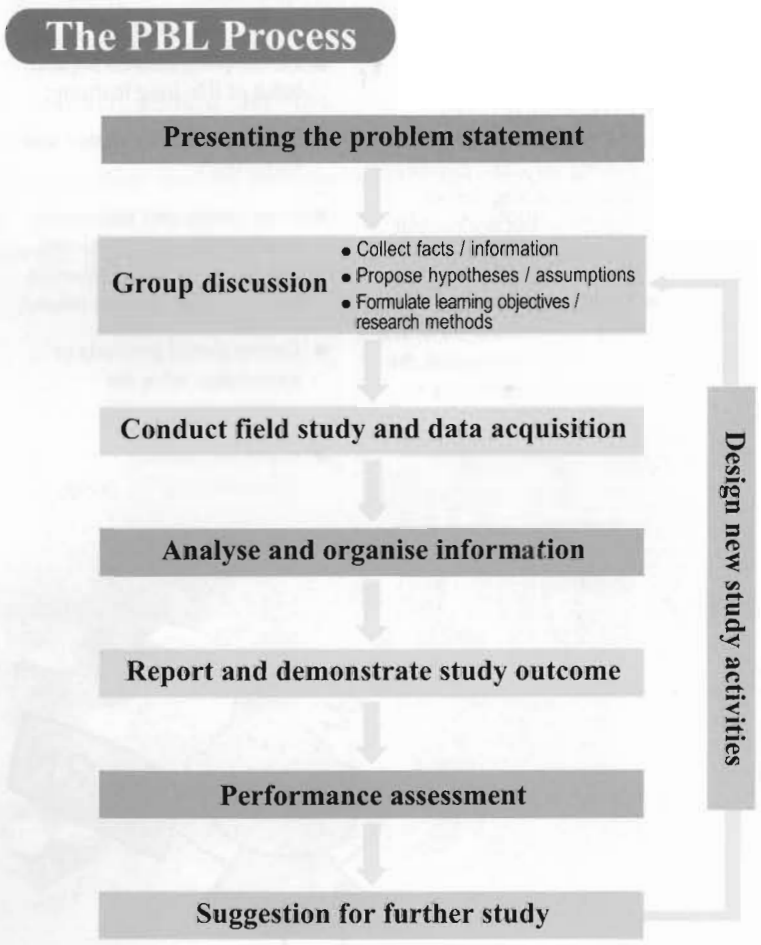
In the PBL process, teachers and students will assume completely new roles. The learning process will move from "teacher-led lecturing" to "student-centred inquiry". Instead of directly conveying knowledge to students, the teacher should let the students organise the learning issues themselves. The teacher is a facilitator rather than an information provider; he/she is there to inspire and encourage students to develop into life-long learners and self-motivated problem solvers.

Table 1 : The roles of teachers and students in PBL

	Teacher	Student
Roles	• Advisor • Facilitator • Assessor • Motivator	• Problem solver • Cooperator • Researcher • Instructor
Tasks	• Motivate students; • Coordinate between teachers and students and among students; encourage discussion and debate; supervise but not control the learning process; • Direct students' attention to the discussion topic and guide them to explore the different aspects of a problem; • Maintain learning atmosphere of the group to ensure equal opportunity for everyone to voice their opinions.	• Develop the interest for and habit of life-long learning; • Explore new knowledge and technology; • Give formal and informal instructions and comments to each other; share learning outcome and observe others'; • Derive useful products or knowledge from the exercise; • Maintain learning atmosphere of the group.

B. The PBL Process

Our "Problem-Based Learning in the Field Environment" programme is conducted in the following steps.



1. Presenting the Problem Statement

The PBL begins with a scenario statement prepared by the teacher. The teacher prepares the statement using thought-provoking and subject-relevant issues taken from his/her personal experience, clinical cases, newspapers, TV reports, films or documents. The issue selected must be of a certain level of complexity, preferably demonstrating a conflict of interest involving multiple parties or controversial issues which have no conclusion. The more roles and subjects the problem statement involves, the more effective it is in inspiring students' interdisciplinary thinking.

For instructions on writing the problem statement, please see appendix.

The following is a **problem statement** prepared for the participants of our training activity on 22 January 2005:

Example:

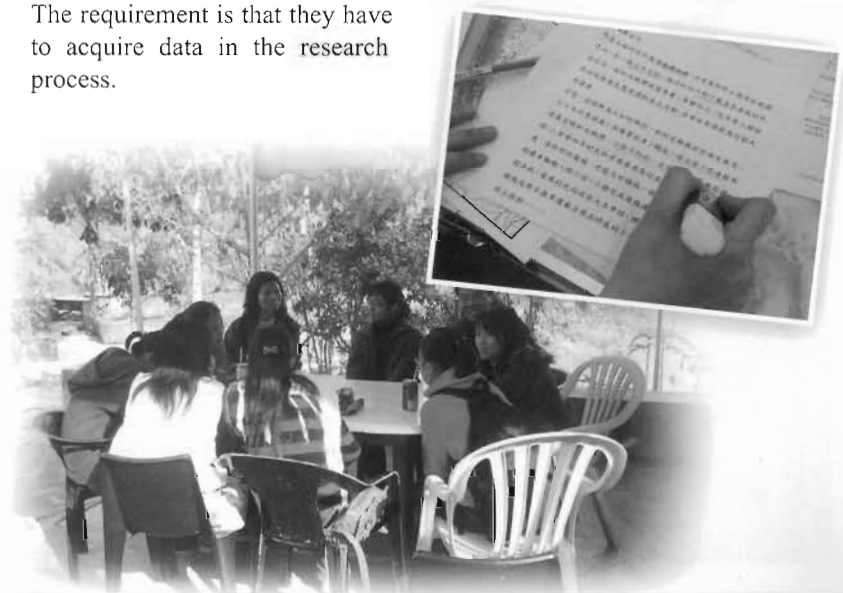
Pak Lap Village in Sai Kung is a 100-year-old village located south of the High Island Reservoir and within the boundary of Sai Kung East Country Park. The residents of the village consist of only about a dozen elderly villagers. In recent years, the village has become a popular place for eco-tourism and water sports, as many are attracted by Pak Lap Wan's natural beauty and tranquillity. Some developers even planned large-scale development projects. Recently, however, this little-known village has come into conflict with the government. In the 1970s, the Botanical and Forestry Department (later known as the Agriculture, Fisheries and Conservation Department ("AFCD")) built a footpath connecting Man Yee Road and Pak Lap Wan. The footpath had an average width of one metre with a series of flights of steps. In 2004, the villagers and a developer removed, without government approval, some of the vegetation next to the old path built by the government, and laid a new one which was without steps and wide enough for vehicles. Subsequently, the AFCD discovered the new path and proceeded to demolish it. The villagers petitioned to the government to stop the demolition work on the ground that the elderly villagers found it difficult to travel or use handbarrows on the steps.

2. Analysing the Problem Statement

The teacher should first divide the students into groups, preferably with six to eight students in each. The group will review the problem statement and extract the facts and ideas from the text through discussion, thereby forming an initial conception of the problem. Then, they will give their own opinions. A member from each group will record the facts and ideas on blackboard or paper. The facilitator must refrain from interfering with the discussion and expressing personal opinion.

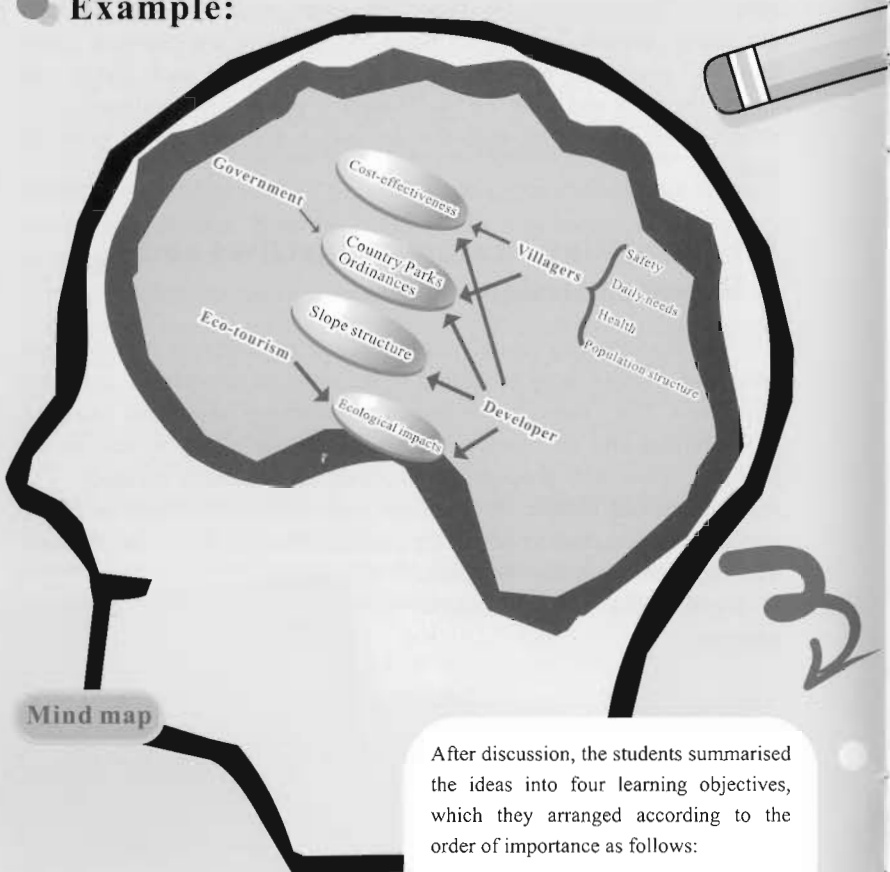
3. Formulating Learning Objectives and Research Design

The students can classify the ideas and assumptions into different areas and arrange them according to the order of importance and level of interest. They then choose one of the learning issues and based on their abilities and the resources available, design a way to resolve the problem. They will propose assumptions and research methods. The students should choose the methods that will enable them to obtain adequate information to verify the assumptions and solve the problem. The requirement is that they have to acquire data in the research process.



The following is the research and study record of the team of F.4 students from St. Catharine's School for Girls. The discussion lasted for one and a half hours:

Example:



Mind map

After discussion, the students summarised the ideas into four learning objectives, which they arranged according to the order of importance as follows:

1. Assessment of the villagers' needs and cost-effectiveness;
2. Slope structure and safety;
3. The government's country park management strategies and relevant legislation; and
4. The eco-tourism value.

The results of the discussion were recorded on paper.

Facts

- Pak Lap Village is located south of the High Island Reservoir.
- Development of the area began in recent years.
- In the 1970s, the Botanical and Forestry Department built a footpath.
- In 2003, the villagers and a developer laid another path without government approval.
- The AFCD proceeded to demolish the new path.
- Villagers urged the government to stop the demolishment.

Ideas

- The landscape is beautiful.
- It is a little known village.
- Villages found it difficult to travel on the steps.
- Should AFCD have built a ramp with steps?
- Was the demolishment appropriate?
- Were there any remedies available?
- What were the impacts of the construction?
- Do the villagers need the new path?
- Did the construction of the new path threaten the slope structure?
- Government → development/heritage preservation
- What are the impacts on eco-tourism and water sports?

Having chosen two of the learning objectives, the students proceeded to prepare the research methods, tools and the relevant definitions and indices.

Assessment of villagers' needs and cost-effectiveness:	**Tools / Methods:**
Facilities of the village	Observation
Population of the village	Interview, estimation, observation
The villagers' needs	Interview, estimation, observation
Activities in the village and volume	
Slope structure and safety:	**Tools/methods:**
The gradient and length of the new and old paths	Map, ruler, stop watch Define "difficulty" in quantitative terms
The difficulty of travel of the two paths	By walking the paths themselves, taking the average of the findings of different persons
The number of steps of the old path	Counting
The condition of the new path	Observation

4. Data Collection and Analysis

The students then use the methods they have designed to gather information. Such methods may include field observation, measurement, description and questionnaire. It is important for the students to observe and collect first hand information, as this process not only refreshes their knowledge and experience, but also provokes further inspiration and thinking. The teacher should also remind students of the necessary safety issues when working in the field.

The students then organize the information acquired, analyse the data, test the assumptions, and derive some conclusions.

Using the methods that they had designed, the group came up with the following findings during the two-hour field study:

Example:

Assessment of villagers' needs and cost-effectiveness :	Results
Facilities of the village	Store, diving school, water transportation, facilities are scarce
Size of the village's population	Small, with little demand
Needs of the villagers; activities in the village; volume of traffic	The villagers have mixed opinion; small-scale water sports; visitors come around during holidays

Example:

Slope structure and safety:	Results
Gradient and length	**Gradient:** 1 in 8.3 **Length:** 1 kilometer **Travel time:** new path - 9 mins, old path - 13 mins
Difficulty	Difficulty index (10 being most difficult) **New path -** climbing: 10/10 ; descending: 6.5/10 (dangerous) **Old path -** climbing: 8.5/10; descending: 3/10 (easy, except for the steps)
Number of steps of the old path	146
Structure and condition of the new path	Uneven surface, abandoned wooden planks with exposed rusty nails, no groove on the surface

5. Presentation of Research Findings and Evaluation

Students should demonstrate their research and report their findings in a presentation at the end of the process. It is very important for students to organise their findings immediately as it helps consolidate their memory. Moreover, students will benefit and acquire better study techniques by learning from each other. The teacher should remind students to pay attention to not just the information prepared by others, but also how they describe, analyse and criticise.

PBL provides students with a rich learning experience. Their experience during field studies, in particular, will provoke their interest in the topic or relevant topics. Thus, they may be interested in learning more about the topic or want to move on to other topics.

At the end of the learning session, the students should have another group discussion, in which they should organise their research results, discuss further action (see below), and review and assess their performance (please see the appendix for the assessment methods and sample assessment forms).

Example:

Further action:
- Study relevant legislation of AFCD;
- Find out how to assess slope safety;
- Re-visit the place to study its eco-tourism potential.

C. Appendices

1. How to Write the Problem Statement?

When writing the problem statement, the following points should be noted:

Inspire Students' Interest

- Real-life issues are more attractive to students than academic ones;
- Generally, situations that involve people are more complex, extensive and more effective in cultivating the ability to consider issues from multiple perspectives;
- Try to balance the proportion of each role. Otherwise, it may mislead the students or narrow their thinking;
- Facilitators can show the views and positions of the parties in the problem statement, but the students need to identify and verify the arguments themselves.

Choose Teaching Methods According to Students' Ability and the Curriculum

- Prepare the topic based on curriculum requirements, and consider whether it is relevant to students' daily life and knowledge;
- When writing the problem statement, try to think what kind of learning outcome the topic will lead to. For example, think about which aspects will the students analyse the topic from, or what kind of research skill will they use;
- Students' ability and background should also be considered, as students build their new knowledge on top of their existing knowledge base. Therefore, the topic cannot be too difficult or too easy, and should provide an appropriate level of challenge for them.

Loosely - Structured Statement

- The problem statement should be loosely-structured so that it will not be overly leading;
- Let students identify the core of the problem by themselves. For example, in the sample problem statement given above (see Section B, page 11), the designer expected that students would analyse the problem from the perspectives of country park related legislation, cost-effectiveness, environmental friendliness, and impacts on the eco-system and scenery. However, we should avoid leading statements or questions such as "Are the villagers' actions legal?", "Do you think the construction will have serious ecological impact on the area?" or "Are the villagers' requests economically feasible?" Otherwise, the students' thinking will become restricted;
- Even if the students' final learning objectives are different from the statement designer's expectation, they are still acceptable as long as they can help students improve their knowledge and learning skills.

2. Examples of Problem Statement

Problem Statement: Hurrican Katrina 2005

Hurricane Katrina, which made landfall as a Category 4 hurricane near New Orleans, Louisiana, was one of the costliest, and increasingly more frequent, tropical cyclones to hit the United States. Three days before it hit Louisiana, the hurricane already inflicted 7 deaths and substantial damages in Florida. On August 27, the New Orleans government ordered a mandatory evacuation of the city. On August 29, 2005, the hurricane's storm surge breached the levees that protected New Orleans from a nearby lake, flooding most of the city. Military troops were deployed in the city four days later to maintain order. The hurricane also damaged the coastal regions of Louisiana, Mississippi, and Alabama. Some estimates have placed the death toll in the thousands and the damage higher than $100 billion. Other predictions placed the minimum insured damage at around $12.5 billion. Before the hurricane the region supported about one million non-farm jobs. The event has left hundreds of thousands without homes or jobs and has inflicted both physical and mental distress on many. A national newspaper attributed the severe destruction effects of the hurricane partly to the diminishing wetlands in Louisiana area.

Expected Learning Issues:

- How do hurricanes form?
- Frequency and magnitude of occurrence of the disaster.
- What was the role of humans in the cause of the disaster?
- Effects of hurricane disasters
- How can insurance company estimate probable maximum loss?
- How should government and society plan and prepare for the disaster?
- Engineering requirements for levees.
- Effects of global warming on hurricane occurrence.

Problem Statement: SARS

In Nov. 16, 2002, the first case of an atypical pneumonia is reported in the Guangdong province in southern China. People were reported to have been stocking up on vinegar which they thought could prevent them from contacting the disease. Not many countries took serious attention to the reports. On Feb. 26, 2003, Guangdong Province reported over 300 cases of atypical pneumonia. Within a couple weeks, similar cases of unusual pneumonia were reported in Hanoi, Vietnam, Hong Kong, Canada and Singapore. Centers for Disease Control and Prevention (CDC) issued a travel advisory for the affected areas. Subsequently the global tourism industry was severely affected. Just for Hong Kong, SARS related job loss was estimated be over 27,000 and economic loss was placed at over 28.4 billion dollars. The Hong Kong Government was anxious to devise schemes to contain the spread of the virus and infrared thermograph was used to rapidly screen feverish travellers at airports. Subsequent studies by HKU scientists indicated that the infrared technique might not be very accurate. Many airports, however, went ahead to adopt the method as a monitoring measure.

Expected Learning Issues:

- The cause of SARS virus Pneumonia and atypical pneumonia, their characteristics and effects
- How should the different regions communicate information on epidemic outbreaks?
- How should government and society plan and prepare for the disaster?
- How can loss be estimated?
- The effectiveness of the monitoring measures

3. Hints for Facilitator

In PBL, the teacher has to bear in mind that his/she is a facilitator, not a knowledge deliverer. The teacher needs to master some facilitating skills through practising and experiencing with different student groups. Here are some tips:

- The facilitator must not dominate the discussion and should avoid giving too much personal opinions;
- The facilitator should ensure that the students are open to suggestions. Instead of directly negating students' opinions, he/she has to make sure that everyone has equal opportunity to voice their opinions;
- However, this does not mean that the facilitator should be an idle observer. In fact, the facilitator should pay attention to the interaction within the group and try to understand their thinking, in order to provide assistance as appropriate. For instance, when everyone in the group has overlooked an important concept, the facilitator may bring it up at an appropriate moment ;
- The facilitator also needs to intervene when some students are overly dominating or passive;

The facilitator should pay attention to the students' emotion in order to maintain a learning good atmosphere. Our experience tells us that during discussion, students habitually look at the facilitator (Picture 1) as if they are seeking his/her approval. The facilitator should find a means to divert students' eye-contact with him/her, play a secondary role, such as by sitting further away from the students (Picture 2). In this way, the students will pay more attention to discussion with other members. Very often, the students would ask the facilitator for advice or correct answers. The facilitator should not give direct answers to these questions.

[Picture 1]

Completely different atmosphere

[Picture 2]

4. Sample Assessment Forms

It is important to know how to assess the students' progress and achievements. The emphasis should be on the interaction between teacher and students. We can first let students reflect upon their experience, then lead them to think about the following questions (謝錫金, 2002; 周天賜, 2002):

1. Has my study been going smooth so far? What did I learn?
2. How is the group's progress according to the objectives?
3. What difficulties have I encountered? How did I overcome them?
4. How did we enrich our knowledge and improve our skills?
5. Which group member do I appreciate most? Why?
6. In the group, I am (the leader/ an assistant who is able to bring forth constructive suggestions/ totally submissive/ submissive but feeling discontented/ discontented but still obeyed/ completely non-cooperating) because:
7. Did I/we make any progress and in what way?
8. How can I do better?

Then, give them assessment forms for mutual assessment between teachers and students. This can enhance the communication between group members and facilitate future cooperation.

We also recommend mutual assessment in the form of group discussion.

The following are sample assessment forms for teacher's and student's use respectively (謝錫金, 2002; 周天賜, 2002):

Sample one: Student Assessment Form (for teacher's use only)

Performance assessment & problems	Excellent	Good	Normal	Acceptable	Unsatisfactory	Remarks
A. Handling of the Problem						
Identifying facts / information						
Proposing ideas / assumptions						
Defining learning objectives						
B. Research Method						
Resource assessment						
Reviewing information / assumptions						
Selecting appropriate information for the problem						
Formulating action plan						
C. Results and Performance						
Integrating information into the results delivered						
Participation in creating the results delivered						
D. Learning Attitude						
Ability to build up atmosphere						
Curiosity and attitude for research						
Earnestness / commitment						
Responsibility						
Extensive reading						
Punctuality						
E. Learning Skills						
Communication and self-expression						
Cooperation and interpersonal relationship						
Organisation ability						
Creativity						
Time management						
Analytical power and problem-solving skills						
Reflection						
Overall comments:						

Score: Highest 10; Lowest 1

	10	9	8	7	6	5	4	3	2	1

Sample Two: Mutual Assessment Form for Students (for student's use only)

		4 points	3 points	2 points	1 points	
A. Cooperation						
1. Interpersonal		Able to foster cooperation	Actively cooperating	Cooperating	Non-cooperating	
	Me					
	Student a					
	Student b					
	Student ...n					
2.Contribution		Full commitment	Active participation	Partial participation	Dependent on other group members	Total for part A
	Me					
	Student a					
	Student b					
	Student ...n					
B. Communication						
1. Written		Fluent	Easy to understand	Partially accurate	Lacking practice	
	Me					
	Student a					
	Student b					
	Student ...n					
2. Oral		Concise and polite	Easy to understand	Sometimes off topic	Inarticulate	Total for Part B
	Me					
	Student a					
	Student b					
	Student ...n					
C. Information Search						
1. Searching Method		Very Familiar	Familiar	Know a little	No knowledge at all	
	Me					
	Student a					
	Student b					
	Student ...n					
2. Recording Method		Very Familiar	Familiar	Know a little	No knowledge at all	Total for Part C
	Me					
	Student a					
	Student b					
	Student ...n					

Others' Assessment of Me	Part A	Part B	Part C
Student a			
Student b			
Student ...n			
Self-assessment			

I think the others' assessment of me is reasonable / unreasonable, because:

Sample Three: Student's Feedback on Teachers (for student's use only)

	Totally agree	Agree	Normal	Disagree	Totally disagree
1. The teacher reminded us to focus on the problem.	5	4	3	2	1
2. The teacher encouraged us to give ideas and suggestions.	5	4	3	2	1
3. The teacher provided us background information of the problem as appropriate.	5	4	3	2	1
4. The teacher led us to think critically.	5	4	3	2	1
5. The teacher encouraged us to plan our own research.	5	4	3	2	1
6. The teacher was open to our different ideas.	5	4	3	2	1
7. The teacher effectively encouraged every one of us to participate.	5	4	3	2	1
8. The teacher provided us instructions only when necessary.	5	4	3	2	1
9. Other comments:					

5. Feedback from Participants

We collected 148 and 128 questionnaires from the participating teachers and students respectively. All of them responded favourably to the programme:

- 100% of the respondents were happy with the training activities;
- 97% of the respondents thought that the training activities were helpful to their future work;
- 97% of the respondents were satisfied with the arrangement of the training activities;
- 93% of the teachers enjoyed PBL;
- 99% of the students enjoyed PBL.

Student Feedback (extracts):

I like this mode. Its advantage is that the learning is student-oriented. It is easier for us to remember and understand. It also trains our thinking. We gained not only information but also skills that are useful for life. It is more realistic when we learn from real-life issues, instead of something purely academic.

I like it! Learning becomes more relaxing for both teachers and us, and we're becoming more interested.

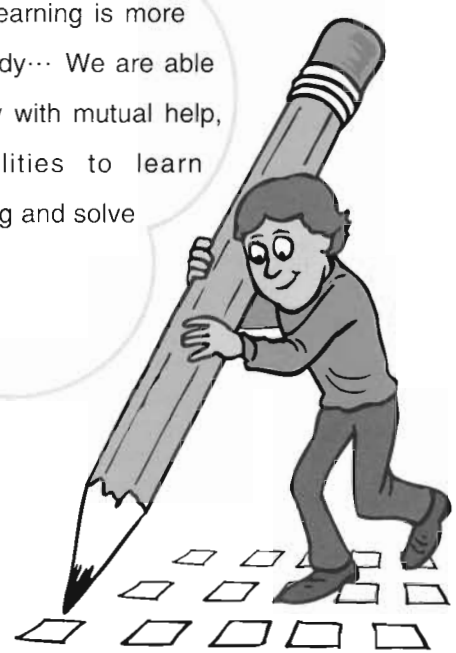
At first I thought it was rather difficult and didn't know where to start. No matter how I tried during the experiments, I always ended up in failure. However, I do feel that I've gained something from the process. We had so many opportunities to express our opinion.

I like this mode. The advantage is that we do not necessarily have to learn in the classroom or from the textbook. It also trained our thinking, and improved our analytical power and organisation skills. In comparison, we only receive the knowledge in the classroom setting. However, there wasn't enough time, space and material.

Teacher Feedback (extracts):

The field environment was radically different from what we previously imagined and inferred from the map when we were sitting in the campsite. Ideas became more divergent in field exploration. Relationship among PBL group members could be improved.

Loving it! Outdoor learning is more effective than classroom study··· We are able to establish cooperation ability with mutual help, thus we may have abilities to learn independently learning and solve problems.



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