Some Strategies for Making Problem-based Learning Teaching Plans

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ABSTACT: *The two most important features of problem-based Learning (PBL) are: 1) students' active learning ability and 2) students' ability to identify problems through brainstorming. Therefore, if a PBL process is to be carried out smoothly, dialogues and situations that can arouse students' motivation to and interest in study must be selected and included in teaching materials and teaching plans. This research explored into the discussion results made by elementary, junior high and senior high school teachers who learned how to design PBL curricula. After many inductive experiments and revisions, it was found that some strategies could be applied to achieve expected results. These strategies are described as follows. Firstly, focus on the steps for making teaching plans:*

1. select appropriate unit titles — problems that frequently occur in daily life, can draw a lot of attention, and are urgent and dangerous tasks in nature.

2. transform the units into acts: (a) use the concept map to describe core knowledge (b) solve problems after understanding how to use the core knowledge (c) develop plans for the expansion and extention of core knowledge.

3. decide the learning objectives (teachers' version) that must be learned, should be learned and are nice to learn in a specific act.

4. use key words and transitions to connect the contents of acts.

Secondly, make checklist for the making of teaching plans and use content, available resources, question statements, motivation, focused question as check benchmarks.

1 INTRODUCTION

In a knowledge-based economy, innovation, speed, application and a short knowledge half-life are much emphasized. From an educational perspective, traditional education is no longer sufficient. Therefore, it is important that a student's diversified abilities are cultivated through innovated teaching and learning methods (Tien & Chi, 2002). The constructivist spirit of thematic instruction, which includes project-based learning and problem-based learning, should be able to better realize through collaborative learning (Wang, 2003).

Problem-based learning (PBL) is to cultivate students' ability to learn actively, to think critically and to solve problems through an instruction process that focuses on practical problems and encourages students to conduct group discussions (Wu, 2002). In other words, PBL is an effective tool to help cultivate a student's critical and creative thinking abilities and hence enhance his or her innovation ability (Hong, 2001).

As outlined above, it is clear that, in a knowledge-based economic era, the focus of education should be on the cultivation of students' self-learning and innovation abilities. Curricula must be designed in a flexible way and teaching materials must be diversified. PBL is a learning method that caters to the educational needs in a knowledge-based economy because it encourages students to learn collaboratively in small groups, to assimilate, transform and apply knowledge through discussions, analyses and inductions, to develop creative and innovative abilities, and to solve problems. Therefore, this research purposed to propose some strategies making PBL teaching materials.

2 RESEARCH PURPOSES

1. designing PBL modular curricula
2. developing checklists for PBL teaching plans
3. proposing strategies for making PBL teaching materials

3 RESEARCH METHODS AND STEPS

This research adopted the action research method. Its research subjects were 46 students in the on-the-job training program for teachers of secondary schools. The teachers, also the authors of this paper, of the program explained the conceptions, methods and steps and then helped those students to select themes and make concept map and unit teaching materials through group discussions. After reaching some consensus, they went back to their respective schools, tested it out and made revisions. After getting suggestions from expert meetings, the researchers proposed research results.

4 RESEARCH DESIGN AND IMPLEMENTATION

The two most important features of PBL are to cultivate students' active learning ability and to help them identify problems through brainstorming. Therefore, if a PBL process is to be carried out smoothly, dialogues and situations that can arouse students' motivation to and interest in learning must be included in the curriculum design, theme selection, and teaching plans. In other words, how to develop students' active learning ability must be taken into consideration when making teaching strategies.

Strategies for making PBL teaching materials are divided into two aspects: A) designing PBL teaching plans; B) making teaching plan checklists. These two aspects are described as follows.

(A) The steps for designing a PBL teaching plan:

1. Fully understand the curriculum outline of the whole subject.

   Each subject has its own features, covering different scope and having different levels of difficulty. Therefore, it is important that the curriculum outline of the subject and all students' background be understood before designing a curriculum and then starting to teach.

2. Identify the chapters and contents that are appropriate to use PBL methods

   Analyze curriculum outlines and select the chapters and contents that are appropriate to integrate with PBL methods when resources are sufficient. Select a good theme for each chapter or for all chapters. The chapters and contents that are appropriate to integrate with PBL methods can also be selected by teachers' instruction research meetings or by school-based curriculum design committees based on cross-discipline consideration or different learning fields.

3. Establish subject-specific or cross-discipline modular curricula

   Establish several modular curricula based on the size of subject-specific or cross-discipline chapters and contents, and describe the designing process of specific curricula with tree map or concept map.

4. Design a comparative concept table for modular curricula based on different levels of abilities

   Even for the same theme, different levels of contents should be decided to suit the needs of students of each level.

5. Select a good theme or unit title that goes along with PBL methods.

   - The theme or unit should be a problem that students encounter frequently and can easily relate to their daily experience, or an issue that can catch students' attention and are urgent, hazardous and task-oriented in nature.
   - The theme should be ill-structured, which means that such a theme or unit should be able to guide students to conduct divergent thinking and think of at least ten ideas in brainstorming.
   - The theme should be able to provide guidance and catch students' attention. PBL is student-centered so a PBL theme must be able to guide students and be attractive to them in order they can learn actively and make learning objectives themselves.
   - The theme should be clear and concise.

Table 1 Features of Good PBL Themes or Units

Module	Theme Name	Note
Printer	1. What can we do when the printer can not be linked to the computer?	The themes listed in the "Theme Name" column have the following features: They are closely related to daily experience, encountered frequently, urgent, clear and concise, and can provide guidance.
	2. What can we do when there is a paper jam in the printer?	
	3. What can we do when blurry pictures come out from the printer?	

6. Select appropriate titles for different acts under the theme
   - Divide a theme into 3-5 situational acts depending on the size and requirement of each theme or unit.
   - The naming of different acts should follow a hierarchical order and the act titles should cover sufficient scope and level of difficulty.
     Take a three-act unit for an example:
     i. In Act Ⅰ, the focus should be on core knowledge – telling of, writing down or drawing out a concept map.
     ii. In Act Ⅱ, the focus should be on the comprehension and application of the unit – proposing problem-solving methods and steps.
     iii. In Act Ⅲ, the focus should be on the expansion and enhancement of knowledge – proposing solutions and drawing up a development plan. Figure 1 turns the unit title into three acts with different emphases; that is, the core knowledge, the comprehension and application of that unit, and the expansion and enhancement of knowledge, as shown in Table 2.

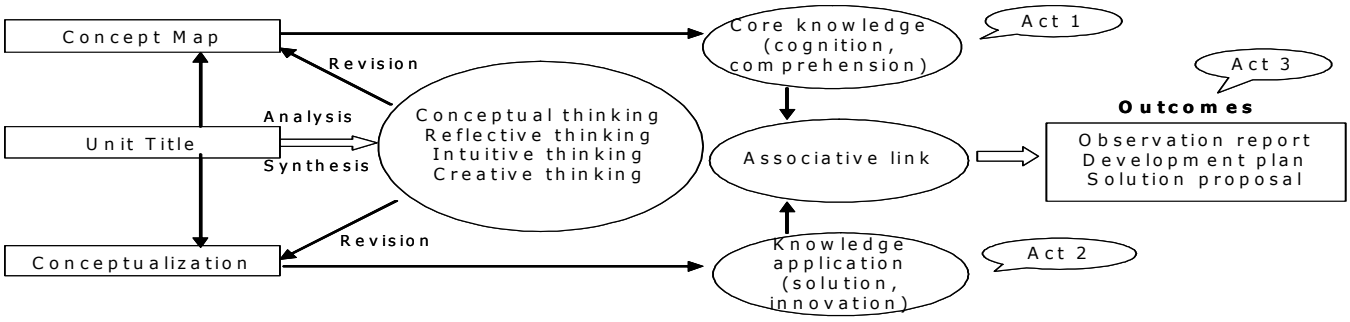


Fig. 1 The Thinking Flow for Act Title Selection by Theme (Unit Title)

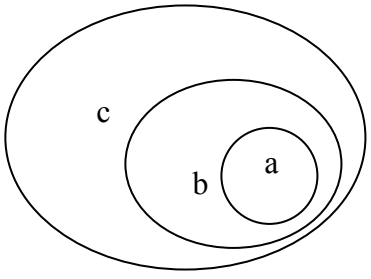
Table 2 Selction of Act Titles of a PBL Unit Title

Unit	Unit Title	Act Title
1	1. What can we do when the printer can not be linked to the computer?	How do we install the printer software correctly?
		How do we deal with a glitch in the printer?
		How do we link the printer to different computers and operating systems?
2	2. What can we do when there is a paper jam in the printer?	How do we judge and analyze the possible causes of a paper jam in the printer?
		How do we deal with a paper jam in the printer and how to maintain a printer?
		How do we solve the paper jam problem of different brands of multi-functional printers?
3	3. What can we do when blurry pictures come out from the printer?	How do we judge and analyze the possible causes of blurry pictures coming out from the printer?
		How do we deal with the blurry pictures if it is caused by the internal structure of a printer?
		How do we deal with the blur problem of a color laser printer?

7. Select learning objectives based on act titles

- The learning objectives for each act should be specific, using the statements of A, B, C, and D to describe specific behavioral objectives. (Kang, 1982).
  A (Audience) – The "who" that will carry out the behavior. If the "who" is the students, it is often omitted.
  B (Behavior) – The "actual behavior" needed to achieve the objective.
  C (Condition) – the "relevant conditions" required to complete the behavior.
  D (Degree) – The 'level' or 'standard' successfully achieved by the behavior.
  Example 1. Can accurately use proper terms to describe briefly the problem
  D B C B C
  and the damaged component that possibly causes the problem
  C
  Example 2. Can propose a layout and installation plan for a computer lab that
  B D C
  has 20 computers, 4 laser printers, 4 ink-jet printers and one color printer
  C
- The learning content for each act is divided into three parts accordingto student level:
  - must learn--- the core knowledge that students must learn
  - should learn--- content that students should learn
  - nice to learn--- content that it is nice for students to learn

The identification and selection of the three parts are better left to the hands of the curriculum development committee members, who should decide through discussions a correct weighing to each of the learning objectives based on their importance, demand and obstacles, or through voting (Hong, 1996).



"a" represents "must learn"
"b" represents "should learn"
"c" represents "nice to learn"

Table 3 Specific Learning Objectives for the Acts

Unit	Act Title		Specific Learning Objectives	
What can we do when there is a paper jam in the printer?	Act I	How do we judge and analyze the possible causes of a paper jam in the printer?	must learn	1. Can accurately use proper terms to describe briefly the exterior problem and the damaged component . 2. Can identify the possible causes of a paper jam in the printer.
			should learn	3. Can induce and categorize the possible causes of a paper jam in the printer.
			nice to learn	4. Can judge the paper size and pound specification.
	Act II	How do we deal with a paper jam in the printer and how to maintain a printer?	must learn	1. Can accurately use proper terms to describe briefly the interior problem and the damaged component. 2. Can tell the paper feeding process from the roller to the print head. 3.Can judge possible damaged components through information gathering and discussions.
			should learn	4.Can write down the steps to assemble the exterior components and to install the toner cartridge or ink-jet print head. 5. Can deal with the paper jam and know how to maintain a printer. 6. Can induce how to correctly prevent paper jams from occurring after maintain a printer and know how to solve a paper jam.
			nice to learn	7. Can identify and judge the size of the screws used to fixing the printer case and where to fix them.
	Act III	How do we solve the paper jam problem of different brands of multi-functional printers?	must learn	1. Can accurately use proper terms to describe briefly the exterior malfunction of a multi-functional printer and the possible damaged components. 2. Can identify the possible causes of a paper jam in a multi-functional printer.
			should learn	3. Can write down the steps to assemble the case of a multi-functional printer. 4. Can write down the steps to change the toner cartridge or a ink-jet print head. 5. Can induce and analyze the possible causes of a paper jam in a multi-functional printer.
			nice to learn	6. Can list various types of malfunction of a multi-functional printer and its maintainance methods. 7. Can list the correct methods for preventing a paper jam from occurring to a multi-functional printer and the solutiona for a paper jam in a multi-functional printer.

7. Link the content of an act with keywords and transitions

Each unit is divided into three to five acts, with each having a different focus.

- The first act emphasizes core knowledge.
  Identify possible causes of the problem, summarize the factors behind the problem, and use concept map or other methods to form a continuous series of conceptual knowledge. Therefore,

teachers should use some keywords or transitions to link the whole content of an act to inspire students to apply divergent thinking skills to propose and list problems through brainstorming, thereby making their teaching lively and arousing students' interests to learn actively.

For example:

Tom is a college student. One day he sat in front of the computer, studying very hard and typing his final-term paper. When he finished his report, he was ready to print it out and made the final check. So he moved the mouse to the file menu and pressed the "print" button. Then he went out to have some water and take a rest. When he came back, he found his laser printer didn't finish the job and the paper was stuck in the printer. He didn't think much and just removed the paper. But he had a paper jam again after successfully printing out three or four pages. However, this time the situation was different and he could not solve paper jam from outside. His roommates started to tell about their experience of encountering troublesome paper jams in ink-jet printer and color printer. If you were Tom's good friend, what would you do about this situation? Please discuss.

Description:

a. The keywords of this act include "printer" and "paper jam," which can be used to guide students to diverge their thinking into other kinds of man-made or mechanic printer or paper jam problems

b. The transitions of this act include "he didn't think much and just removed the paper," which can be associated with other exterior structure of the printer or environmental factors, and "this time the situation was different and he could not solve paper jam from outside," which can be associated with interior structure of the printer or other factors.

- The second act emphasizes comprehension and application

Based on the conceptual knowledge acquired from the first act, students are encouraged to propose maintenance methods or deal with the malfunction through brainstorming again. Therefore, when describing the situation of the act, the teacher should use keywords or transitions as linkage to engage students to apply their divergent thinking skills through brainstorm. These keywords or transitions should also be used to link the content of the act to make it interesting in order to achieve the goals of active learning.

For Example:

Tom hurried to use another classmate's printer to print out his paper. The next day, he discuss heatedly with his classmates about different kinds of malfunctions of laser printers. They also collected some materials for discussion. They believed that the reason why Tom couldn't solve the problem when the paper was jam the second time was because he didn't clear off all the jammed pieces of paper, which meant that there was still some paper stuck inside the printer. Therefore, out of curiosity and agile mood, Tom decided to fix his printer himself. First he used a cross screwdriver to take the screw out and prepared to open the exterior case of the printer, but he found he just couldn't open it. Then he took a flat screwdriver to pry up several trips and finally open the case successfully. However, he still couldn't remove the stuck paper scraps inside the printer. At this moment, Tom became very frustrated. His roommates said they also encountered the same paper jam problem in other ink-jet printers and color printers. If you were Tom's good friend, please discuss how to disassemble the interior components of the printer and how to deal with the situation when the paper was stuck inside a printer.

Description

a. The keywords of this act include "decided to fix his printer himself" – which can be used to guide students to diverge their thinking into the tools that can be used to solve the problem.

b.The transitions of this act include "just couldn't open it" and "the stuck paper scraps inside the printer," which can be associated with case and interior structure problems.

The third act emphasizes the expansion and enhancement of knowledge – proposing development plans

Based on the conceptual knowledge acquired from the first act and the problem solving experiences from the second act, students can connect the previous two acts and propose development plans or solutions through brainstorming. They can also expand and acquire more knowledge through issues with high levels of similarity with the current one through comparison

and analysis. In other words, when describing the context of the act, the teacher should use keywords or transitions as linkage to encourage students to diverge their thinking into proposing solutions through brainstorming, hence arousing students' interest and achieving the goal of helping students to learn actively.

For example:

Tom and his classmates understood the paper jam problem of the printer through the paper jam situation in Act 1 and had some basic understanding of the interior mechanism and structure of the printer through the disassembly process described in Act 2. One week later, Paul, Tom's classmate, also encountered a paper jam. Tom looked at Paul's laser printer, thinking that they had very similar situations but the brand, model and functions of Paul's multi-functional laser printer are all different from that of his laser printer. So he started to discuss heatedly with other classmates about how to help Paul.

Description:

a. The keywords of this act include "multi-functional printer," which can be used to guide students to diverge their thinking into different types of printers and the complexity of various functions.

b. The transitions of this act include "they had very similar situations but the brand, model and functions of Paul's multi-functional laser printer are all different from that of his laser printer," which can be used to diverge students' thinking into the similarity and differences of various types of printers.

8. PBL instruction guide

The content of this guide includes the PBL Group Discussion Guide, How to Arouse Students' Motivation, Focused Questions and References (websites and publication references).

- Checklist for making PBL teaching plans

  The quality of a PBL teaching plan depends heavily on student age, use situations and student ability. The following checklist has undergone many times of teaching trials and revisions and is developed around several indicators, including content, available resources, problem description, motivation arousal, focused questions, etc.

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Table 4 Checklist for A PBL Teaching Plan

No.	Checklist items		Yes	No	Note
1	Is the unit theme appropriate?				
2	Are there sufficient resources?				
3	Problem description	Is it suitable for students at this age?			
		Is it related to students' experience?			
		Is it based on the content of specific subject?			
		Is it applicable to different instructional and learning methods?			
4	Can the design that can arouse students' motivation effectively link the problems described in each act?				
5	Can focused questions guide students toward their learning objectives?				

4 CONCLUSION

PBL is a student-centered learning method. Its goal is to help students to learn actively and explore more fields of knowledge. It emphasizes the problem-solving process, training students to learn through thinking steps, research topics and development plans, instead of finding the best solutions. Therefore, when making teaching materials, in addition to a close relevance of theme or unit titles to daily experience, the teacher should also focus on core knowledge of a unit, the comprehension and application of that unit, and the expansion and enhancement of knowledge. They also need to fully play the functions of keywords and transitions and check the efficacy of their teaching. This research hdesigned the teaching plan making process toward this direction and has gained positive results. Therefore it is believed that the process is worthy of promotion.

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