

# Designing a Feedback System for Teachers to Diagnose Students' Concept Map in the Web-based PBL Learning Environment

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**Abstract:** Students learn knowledge via different teaching strategies that were taken by teachers. No matter what kinds of instructional methods are using, all of the knowledge learned by students could be stored and represented with the concept map form. PBL theory is one kind of instructional methods with it, students will learn during the brainstorm time by discussing with their group-mates. After that, a brainstorm map is then constructed for representing the knowledge which stored in minds of students in a small group. However, the brainstorm map is a little bit of harder than the concept map for teachers to diagnose learning effects of students. Therefore, this paper develops a feedback system which can translate the brainstorm map constructed in brainstorm time to a tree-liked concept map, and then provides some suitable suggestion to teachers in order to let them prepare appropriate additional teaching materials for students. Teachers could also adjust his/her teaching strategies according to the feedback provided by our system.

**Keywords:** PBL, Concept Map, Concept Similarity, Teaching Strategy, Brainstorm Map

## Introduction

Teachers always want to know that how to evaluate the knowledge had learned by students in the teaching process. With the *Problem-Based Learning* theory (PBL for short) teachers will be able to understand what students had learned through the outcome of students in a small group, the *brainstorm map* (Barrow & Tamblyn, 1980). The brainstorm map could represent the concepts which are stored in students' mind concretely, and then teachers can use the brainstorm map to check what students had learned in class and decide which learning direction should be taken by students.

In order to apply the PBL instructional methodology to web-based learning environment, an instructional model of the PBL-based Internet learning environment was proposed as so-called *Problem Based Internet Assisted Learning System* (PBILAS for short) in 2003 (Chen *et. al.*, 2003). However, the brainstorm map is still difficult for teachers to understand what supplemental concepts that students may need quickly. To solve this problem, the feedback system will generate a tree-liked concept map (can be also called concept map) from the original brainstorm map which is stored in the discussion database in PBIALS.

## Research Backgrounds

The applications of brainstorm map in PBL (Hoffman & Ritchie, 1997; Sage, 2000) point out that brainstorm map can represent the concepts in students' mind concretely. Teacher is just a facilitator in the PBL teaching process (Duch, 2001). He/she would propose real-life problems and guide students to think how to solve such problems in class. Students will discuss with their group-mates in a small group. There are four major features in PBL (Savery & Duffy, 1995):

1. Students will develop a new cognition with the goal (real-life problem).
2. The problem proposed by teacher is related to student's real-life.
3. The problem or teacher could increase learners' learning motivation.
4. Teacher is just a facilitator to learners whom will be trained to develop their problem solving abilities.

Hence, the goal of PBL is to let learners learn new concepts and develop their problem solving abilities (Beyer, 1988) with teacher's questions, encouragement and guide. The questions proposed by teacher in class should be able to make learners thinking repeatedly (Hmelo & Ferrari, 1997), therefore, the questions should be in interrogative form, for example, "Are you sure?" and "Could you prove that?".

There were many researches to implement PBL theory in web-based learning environment (Hsu et al., 2003). Figure 1 illustrates a pedagogical model, PBIALS, in which the web learning environment with teamwork tools was analyzed

and designed.

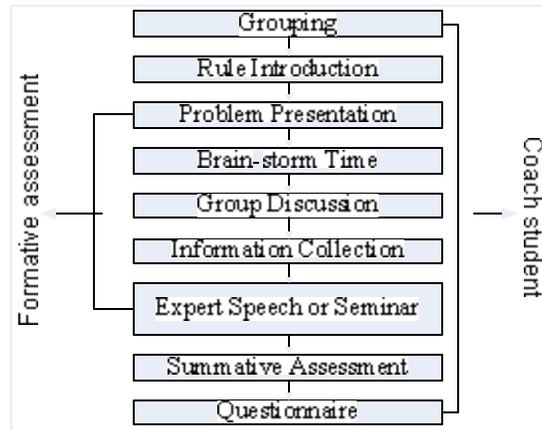
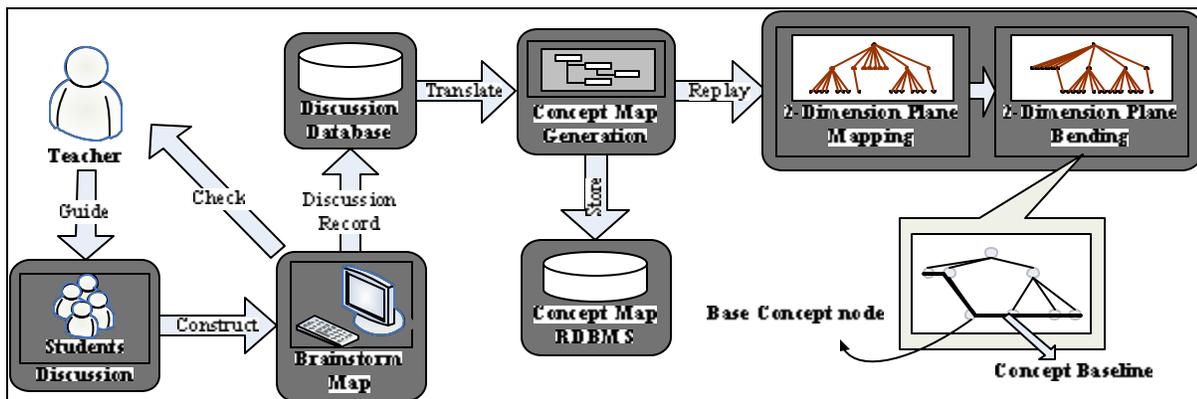


Figure 1: Pedagogical Model of the PBIALS

This paper focuses on how to provide teaching suggestions to teachers as feedbacks, the Brainstorm Time and the Group Discussion steps in the architecture of PBIALS in Figure 1 shown above will be needed to re-develop. The concept map is easier for teachers to interpret than brainstorm map which is mentioned previously. Concept map (Novak, 1981) was proposed to present what thoughts in students' mind. Moreover, concept map is much more hierarchical than the brainstorm map, which is a semantic description of the concepts and can do what ever the brainstorm map can do (Jones *et al.*, 1987). Hence, the concept map will be taken into our consideration in developing the feedback system in the rest of this paper.

### Concept Similarity Diagnosis and Supplement Concept Feedback

In the PBL learning environment, students will construct their brainstorm map with discussion. Through checking the brainstorm map was drawn by students, teacher can guide students' discussion or give students a short lecture when necessary. Also, the brainstorm map and related discussion will be stored in the built-in discussion database in PBIALS.



Figure

## 2: Tree-like Concept Map Generation, Replaying and Bending

The discussion flow is shown at left part of Figure 2 above. Concept map then is translated from the discussion database in which brainstorm maps are stored. At middle part of Figure 2, the transformation process of concept map is represented. Finally, the concept map can be stored in a concept map RDBMS for the further usage.

In order to check the similarity of concept maps between teacher and student, a tree-like concept map is needed to replay from the original concept map RDBMS. At first, the concepts will map into a 2-dimension plane with tree-based hierarchy. The leaf nodes of the tree-like concept map are called the base concept nodes which will spread at different levels. The line goes through all of the base concept nodes is called the *Concept Baseline*. It will be much more easily for teachers to observe the different concept levels if we bend the tree map at right-top corner in Figure 2 shown above.

Once the students' concept map had been bended, the teacher's concept map can be integrated correspondingly. After the integrated map is generated, an *Adjustable Baseline* will be created in the intersection of the two concept baselines. The adjustable baseline extends the line from the cross point between the concept baseline of teacher's and students' to left end of the students' concept paseline as Figure 3 shown below.

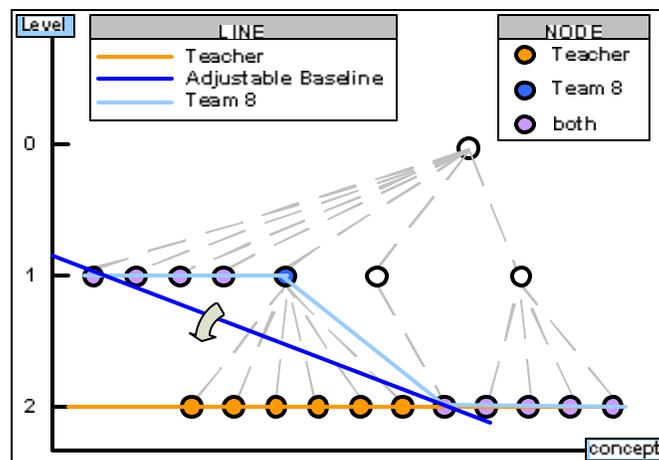


Figure 3: The Adjustable Baseline

According to the adjustable baseline, there are three conditions that a concept will be between teacher's and students' concept map:

1. teacher has the concept in his/her concept map only;
2. students have the concept in their concept map only;
3. and, both of teacher and students have the concept in their concept maps.

With knowing the conditions of each concept, teacher would be able to provide appropriate supplemental teaching

materials according to the lacks of concepts of students in different levels. The feedback system developed in this paper is providing teacher feedbacks about those concepts located in the area formed by the adjustable baseline and the concept baseline of teacher's concept map.

## Experiment System

The experiment system is a Java-based application which is running in the PBL-based teaching environment in the Information Program, Chih-Ping Senior High School. The experiment lecture is Dream Computer. There are 53 participants who are the first year students (most of them are male and divided into 8 small groups). After the lecture a self-designed questionnaire is sent to teachers in order to know their feelings about using the feedback system.

At first, the teacher proposed a topic, Dream Computer, to students for discussion. The content of discussion was recorded and translated into a concept map. The 6<sup>th</sup> team is selected as example to explain the whole analyze and feedback process. After integrating with teacher's tree map, the adjustable baseline was created as Figure 4 shown. By manipulating the adjustable baseline, the lacks of concepts will list on the right hand side of the feedback system. Teacher can adjust his teaching strategies and provide supplemental materials according to the miss-concepts listed by the feedback system.

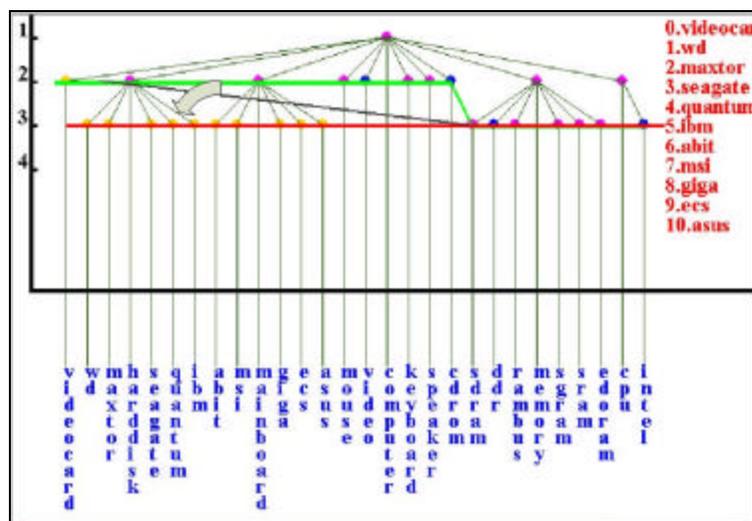


Figure 4: Adjustable Baseline & Lacks of Concepts

## Discussion and Future Works

According to the questionnaire, teachers consider that the feedback system can give a great help to let them know what students (in small groups) were learning and thinking. Besides that, it is easily for him/her to get the lacks of concepts

of students, and provide the necessary concepts to students. Teachers also feel much more comfortable in teaching with PBL theory by using the feedback system. Currently, the feedback system is provided to teachers when the discussion stage (in PBL theory) is over. However, the discussion stage could be taken for more than one class and even let students do the discussion after school with PBIALS. Hence, teachers think that the feedback system will be much better if it can provide instant (or say real-time) feedback, which means we should improve the feedback system in the near future to keep the feedback system activate anytime during the whole discussion stage in PBIALS.

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