P – 57

Developing Teaching Materials By Using Computer-Assisted Problem-Based Learning

Achmad Mudrikah
Nusantara Islamic University (UNINUS) Bandung

Abstract

Computer-Assisted Problem-Based Learning (CAPBL) as a learning approach requires good teaching materials to make the learning process works effectively according to the characteristics and objectives of problem-based learning approach. Similarly in mathematics, appropriate teaching materials are adjusted to the characteristics of the subjects of mathematics that need to be delivered through CAPBL support towards the achievement of learning objectives.
CAPBL is a learning approach that concerned extremely to the emphasis ofcomplex and open-ended problem as the basis for learning that will be faced by students in small groups; the emphasis of the role of students as who are responsible for their own learning; and the emphasis of the role of teacher as a facilitator, assisted by computer as a media that is expected to facilitate the learning process.
Defining a clear idea of the problems; group learning; student role; teacher role; and assessment in problem-based learning and the role of computer in CAPBL will make the development of teaching materials matches to the characteristics of PBL itself. When that happens, CAPBLwill work effectively to be used on the teaching materials as well as it supports the learning process.
Key Words: *Problem-Based Learning, Computer Assissted Problem-Based Learning, teaching materials.*

I. INTRODUCTION

Mathematics teachers do not only have to teach their students how to solve problems, but to learn mathematics through problem solving too. When many students develop procedural fluency, they often lack understanding of the concepts needed to solve new problems or make connections between mathematical ideas. This presents a challenge for teachers, Problem-Based Learning (PBL) provides opportunities for teachers to face this challenge.

PBL emerged as ateaching approach based on constructivism learning and the ideal student-centered learning. When using PBL, teachers help students to focus on solving problems with a real life context, encouraging them to consider the situation that posedby a problem when trying to find solutions. The majority of studies that tested the PBL focus on their role in medical schools, with key features as (a) the use of collaborative small group work; (b) a student-centered approach; (c) the teacher as a facilitator; and (d) the use of real-life problems as an organizing focus.

Engel (Halinger, 2005: 3) revealed that the PBL designers try to develop an approach to learning and teaching that has the following objectives:

1. Adapting to change and participate in it.

2. Facing the problems of complex and irregular, and make reasoned decisions in situations that are unknown.
3. To reason critically and creatively.
4. Adopting a more universal outlook and holistic.
5. Practicing empathy, to appreciate the views of others.
6. Collaborating productively in groups or teams.
7. Identify strengths and weaknesses of their own and make the appropriate repairs.

There are several things to put into account to ensure that the learning process in PBL approach is not a thing that can be detrimental. Some of them are:

a. Academic Achievement

b. Time Demands

c. The Role of Students

d. Teacher Role

e. The Problems That Fit to Learning Objectives

Five important things above can be better anticipated by such as using computers as learning tools for students. Computers are expected to overcome the learning process inefficiencies if being used effectively as appropriate tools in problem-based learning approach. This is because of computers can facilitate students when they confront with any difficulties especially when they want to presenting the problem by graphic, counting difficult calculations, and other problem that will emerge the disadvantage of five things above.

Thus, it is ecpected that problem-based learning teaching materials which are prepared by teachers and are expected to anticipate the learning process inefficiencies can be actually applied through Computer-Assisted Problem-Based Learning (CAPBL).

II. DISCUSSION

2.1 The Steps of Problem-Based Learning Approach

Barrows and Tamblyn (Halinger, 2005: 4) argue that in PBL, "learning outcomes of the activities leading to the understanding or resolution of a problem. Problems are encountered firstly in the process of learning, compared with the facts, models, conceptual frameworks, or other information. Problems, act as a stimulus and focus for problem solving and learning". The process of learning with problem-based learning approach according to Fogarty (1997: 3 – 8) run with 8 steps, namely: (1)

meeting the problem, (2) defining the problem, (3) gathering the facts, (4) hypothesising, (5) researching, (6) rephrasing the problem, (7) generating alternatives, (8) advocating solutions.

In the step of meeting the problem, learners are given ill-structured problem that is lifted from the context of daily life. Statements of the problem expressed by the sentences are short and provide little facts about the context of the problem. Statements of the problem are sought to give the learners the opportunity to conduct an investigation. The results of research on solving ill-structured problems that practiced in the classroom according to Krulik & Rudnick (Santyasa, 2008: 5) give the following effects. (1) The discovery of the problem can increase creativity; (2) Motivating learners who make learning fun; (3) Ill-structured problem requires a different skill with the form of standard-issue problem; (4) Encouraging learners to understand and have relationships with particular discipline problems; (5) The information entered into long-term memory is further reinforced by using an ill-structured problem.

In the step of defining the problem, learners are using their own words to define the problem. Problems with the parameters are stated clearly. Learners make some definitions as the initial information should be provided. In this step, learners involvetheir intra-personal intelligence and prior knowledge to understand and define the problem.

In the step of gathering facts, learners reopen the already acquired experience and prior knowledge already possessed to gather facts. Learners involve multiple intelligences that they have for searching information related to the problem. At this stage, learners organize information by using the term "what you know (know)", "what is needed (need to know)", and "what to do (need to do)" to analyze the issues and facts related to the problems.

In the step of hypothesising, learners prepareto answerthe problems by involving logical-mathematical intelligence. Learners also involveinterpersonal intelligence that they had to reveal what theyare thinking, making connections, answer the guesses, and their reasoning with the logical steps.

In the step of researching, learners do the research against the data and information obtained on the problem-oriented. Learners involve multiple intelligences they have in understanding and interpreting information and facts that are found.

Teachers make learning structure that allows learners use various means to know and understand their world.

In the step of rephrasing the problem, learners refine re-formulation of the problem by reflecting the real picture of what they understand. Learners involve their verbal-linguistic intelligence to improve the formulation of the problem statement to the extent possible using the more appropriate word. Reformulating the problem is more focused investigation, and shows clearly the facts and the information that needs to be sought, as well as provide a clear purpose in analyzing the data.

In the step of generating alternatives, learners collaborate to discuss the data and relevant information to the problem. Each member of a collaborative group began trying to discuss the issues from different perspectives. At this stage of the process of solving the problem at the stage of alternatives concluded that the resulting solutions by collaborating. Collaboration made to be a mediation to collect a number of alternative solutions to problems that generate a better alternative than done individually.

In the step of advocating solutions, learners examine alternative solutions that correspond to actual problems through a comprehensive discussion among group members to obtain the best solution results. Learners use multiple intelligences to test alternative solutions to problems with sketching, writing, debating, making the plot to reveal the ideas they had in testing alternative solutions.

Problem-based learning approach that departed from the constructivism, contain non-linear sequences. Learning tends to not begin and end (Willis & Wright, in Santyasa, 2008: 7). Learning runs in a cycle with the recursive stages (Wilson & Cole, in Santyasa, 2008: 7). Problem-based learning approach also provides opportunities for learners to engage their multiple intelligences(Gardner in Fogarty,1997: 3). The involvement of multiple intelligences in problem based learning approach can be a vehicle for learners to solve the problemoptimally.

To seek the effectiveness of problem-based learning approach, teacher grouped students in small groups of memberfour to five person. Each group collects the facts of the problem, represents a problem, formulates models to its completion, and tests with the calculations, and presents the results to the class.Teachers act as mentors and stimulate learners thinking to solve problems. As a facilitator, teacher trains the learners to think metacognition. When learners face the challenge of the problem and asked to

find a solution, they are in a situation of inequality between their thinking schemes and new informationsthat are faced by them. At this time, learners need assistance to find solutions so that gaps can be eliminated. De Porter et al (Santyasa, 2008: 8) state, in this situation, learners take risks that may be generating interest in learning. When learners are being faced the problems, they come out of their comfort zone and venturing to enter into a full of risk new situation.

Learning with problem-based learning can develop problem-solving ability. Problem-solving skills are very useful in solving problems of daily life. Learning with problem based-learning approach departs from the real contextual issues that are associated to problem solving mathematically. Learning with problem-based learning approach contains stages which are coherent to the problem solving process. Polya (1971: 5-6) proposed four stages of problem solving strategies, namely: (1) understanding the problem; (2) preparing a solution plan; (3) executing the solution plan; (4) reexamining the settlement obtained.

2.2 Assessment in Problem-Based Learning Approach

Assessment of learning according to constructivism paradigm is an integral part of the learning itself. Assessment of a teacher on the structure of concepts that the students have, according to Glaserfeld (1995: 187) is not just a random estimate only. If a teacher starts the assessment by assuming that students generally try to make sense of their experience, this usually allows teachers to gain some idea of how students think. The more experienced a teacher with his/her students way of thinking, the greater the chances of teacher to be able to make education guesses about what might be think by each of his/her students and to be able to make hypotheses about students' zone of proximal development, the zone that Vygotsky (1978) has said as the distance between what children can do by themselves and the next learning that they can be helped to achieve with competent assistance.

Departing from this view, the assessment of learning with problem-based learning approach is implemented in an integrated manner with the learning process. Therefore, learning assessment carried out in a real and authentic ways. Learning assessment with problem-based learning carried out with authentic assessment. O'Malley and Pierce (Santyasa, 2008: 8) defines authentic assessment as a form of assessment in the classroom that reflects learning process, learning outcomes, motivation, and attitudes toward learning activities that are relevant. Assessment can be

done with a portfolio which is the systematic collection of works of learners that are analyzed to see the progress of learning in a specified period, within the framework of the achievement of learning objectives.

Marzano et al., (Santyasa, 2008: 8) argued that the assessment with the portfolio can be used for the assessment of learning that is done collaboratively. According to Oliver (Santyasa, 2008: 9) collaborative assessment in a problem-based learning approach is done by self-assessment and peer-assessment. Self assessment is the assessment conducted by the learners themselves against the efforts and results of his/her work with reference to the objectives to be achieved by the learners themselves in learning (Griffin and Nix, in Santyasa, 2008: 9). Peer-assessment is the assessment when learners discuss to provide an assessment of the efforts and results of completion of the tasks that have been done alone or by a friend in the group (Griffin and Nix, in Santyasa, 2008: 9).

2.3 Computer-Assisted Instruction

Computer-assisted instruction with regard to teaching or learning presented by means of a computer device. Many educational computer programs can be obtained online and can improve teachers' teaching in various ways. Computer programs are interactive and can illustrate a concept through animation, sound and attractive demonstrations. The programs provide flexibility for students to develop through their own pace and work individually or in groups to solve problems. Computers can provide immediate feedback that allows students to know their correct answers. If the answer is incorrect the program shows students how to answer the question correctly. Computers offer a different type of activity and a change of pace through the guidance of a teacher or teaching groups.

Computer-assisted instruction develop learning for students who have less ability because students receive immediate feedback and do not let the students continue to make mistakes. Many computer programs can be run through teaching based on the students' steps and keep track between mistakes and student progress. Computers can attract the attention of students because the program is interactive and involves the spirit of students' competing to improve their scores. Similarly, computer-assisted instruction can be run through the students' steps and usually do not continue until they master a skill. The programs serve different lessons to challenge students at risk, the average student, or more capable students.

Computer Mathematics programs provide the concepts, teaching, and fixes the students' errors and misconceptions from primary school to college. The teacher shouldreview the computer program or online activity or game to understand the context of learning materials and explain which programs fit to the needs of their students and how teachers can improve teaching. Things that should be reviewed are:

1. Can the program strengthen the material, providing basic skills, or be used as an educational reward for students?
2. Is the material presented to attract students' attention not time-consuming because of difficulties in the operation? Is this program a waste of time caused by too much animation?
3. Is the program at an appropriate level for class or students individual?

There are some mathematics programs that can be used and fit to the needs of students when they learning mathematics. One of mathematics programs that available to support problem-based learning approach and also can cover the problem that mention above is MathXpert program.

MathXpert is designed to provide a self-correcting way to learn mathematics. MathXpert is meant to replace blackboards and homework (and graphing calculators), but not teachers and books (Beeson, 89: 1).MathXpert offers comprehensive support for all the topics of beginning, intermediate, and advanced algebra, trigonometry, exponential and logarithmic functions, sigma notation, complex numbers (including complex quadratic equations, polar form, de Moivre's theorem), beginning calculus including "differentiate from the definition of derivative", evaluation of limits, integration by substitution and parts. Calculus 2 includes all standard integration techniques, including partial fractions, trigonometric substitutions, etc. Graphical solution of differential equation is included but not symbolic solution. Infinite series are not supported in the commercially-available version of MathXpert.

Because of its benefit that mention above, MathXpert as a mathematical program can be used to assist problem-based learning approach in order to cover obstacles that will be find when the teacher use this approach to make students learning mathematics better. Even this program can be expected to maximize the benefits of using problem-based learning approach.

2.4 Teaching Materials Computer-Assisted Problem-Based Learning

Preparing teaching materials of computer-assisted problem-based learning can be based on the anticipation from various circumstances that can lead to a situation that not supportive to the efficiency of the application of problem-based learning approach itself. Then, on the basis of some anticipation, a teacher can easily prepare intended teaching materials. Anticipation is related to some of the following:

a. Academic Achievement

There are doubts about the ability of students to demonstrate a strong reasoning and abilities to build cooperation when given a problem-based learning approach. Because the focus of problem based learning of a specific problem-centered, academic achievement scores often resemble traditional teaching methods when standardized tests are used, but does not resemble any method when other forms of standardized testing was used (Vernon and Blake in Xiuping, 2002: 31). But problem-based learning is recognized can improve the retention, although the long term tends to reduce the levels of early learning (Farnsworth in Xiuping, 2002: 31). In contrast, traditional teaching is considered better in covering the content areas of knowledge and in evaluating students' content knowledge.This situationneeds to be resolved including throughassistancea computer thatcan facilitatestudents to gain a complex problemwitheffective steps to solvethe problem.

b. Time Demands

Although most students support PBL learning, and their ability to solve real-life problems looks more developed than that of traditional teaching, there is no support for the striking of this learning approach. This happens because the placement of the time required for the ability to assess student learning (Delafuente, Munyer, Angaran and Doering; Vernon in Xiuping, 2002: 32) and to prepare learning materials that are too much. Another deficiency is the cover subject matter required by PBL.Computer asa toolcan be usedbystudentswhen they faced theproblem ofsupportingthe mainproblemthey had ever knownthus shorteningthe settlementissue.Thus themainfocusof theproblemsdid notinterfere with the support problem resolutiontime.

c. The Role of Students

An unanticipated problem with PBL is the traditional assumptions of the students. Most students have used the assumption that their teacher is the primary knowledge giver.

Because of this assumption leads to the subject matter expertise of their teachers and the traditional memorization of facts needed by the students, many students seemed to have lost the ability to "be curious enough about something" (Reithlingshoefer, in Xiuping, 2002: 32).Computer asa toolcan be usedbystudents to find some solutions related to the problem. Despite of they only want to know how to understand the problem in learning process before they solve it. If students have a tool that make their learning process easier, they will initially use their efforts to find something they do not understand related to the learning process before they ask teacher about that.

d. Teacher Role

Teachers in PBL approaches need to change their traditional teaching methods, make some discussions, and ask students to recall material for tests. In PBL, teachers act more as facilitators than as an information provider. Ideally, the teachers focus their attention on asking the logic and beliefs of students, providing clues to improve students' reasoning errors, providing resources for research students, and ensuring that students remain engaged in the task. Because of this role will be unfamiliar to some teachers, they probably would have difficulty leaving their old habits.Teachers can direct students to use computers as a medium that can help them answer difficult questions are posed by their own. Thus, teachers will more focus on efforts to make students stay in control of the on-going learning process.

e. The Problems That Fit

Building the right questions is the most critical aspect of PBL. No one problem covering a broad goals and specific objectives that must be discovered by the students on their way to achieve the intended solution, a good chance that is important information will not be studied. In a study that linked to direct student research and targeting capabilities, it was found that the students are not on the path and neglected many important goals. (Dolmans, in Xiuping, 2002: 32). Even has done speculations that if students deviate from the directions are anticipated during the construction of a solution, they may lose the main full learning content if are not re-directed by teachers (Mandin in Xiuping, 2002: 32). Computers can provide a variety of texts and problems that fit to the subject matter that will be delivered through a variety match programs to the problems are faced by the students. Context association between the problemsthat are received by students and related to the subject matter can be done faster and more interesting through the assistance of computers.

III. CONCLUSION AND SUGGESTION

Computer-assisted problem-based learning (CAPBL) can be expected to

maximize the benefitsofProblemBased Learning. The goalsofmathematicslearningwhichallow students tohavean importantrolein the process oflearningmathematicsandmathematicalskillsobtainedin accordancewiththat goals, areexpectedto bemore easilyrealized. Another important thingto noteby the teacherisan attempttomakethe appropriate teaching materialsthrough the useofCAPBL.

The CAPBL teaching materials, of course,actually have to facilitate the learning process that isexpected to occur. Thus, the development ofteaching materials thatcreatedby the teachershould considerthe characteristics ofthe learningapproachthat will beappliedin the learning process. If this is not done, which is feared not only would the achievement of the learning process in accordance with the characteristics of PBL, but also the real objectives of learning can not be achieved according to the expectations of the teachers.

IV. BIBLIOGRAPHY

Beeson, Michael (1989). *MathXpert: Learning Mathematics in the 21st Century*. USA: Departement of Mathematics and Computer Science San Jose University San Jose California.

Fogarty, Robin. (1997). *Problem-Based Learning and Other Curriculum Models for The Multiple Intelegences Classroom*. Melbourne: Hawker Brownlow Education.

Halinger, P. (2005). *Integrating Learning Technogies and Problem-Based Learning: A Framework and Case Study*. Montreal: The Annual Meeting of The American Research Association.

Polya, G. (1971). *How to Solve It?A New Aspect of Mathematical Method.* Princeton New Jersey: Princeton University Press.

Santyasa, I W. (2008). *Pembelajaran Berbasis Masalah dan Pembelajaran Kooperatif*. Makalah, FPMIPA Universitas Pendidikan Ganesha

von Glaserfeld, E. (1995). *Radical Constructivism. A Way of Knowing and Learning*. New York: Routledge Falmer, Taylor & Francis Group.

Vygotsky, L. S. (1978). *Mind in Society. The Development of Higher Psychological Processes.* Massachusetts: Harvard University Press.

Xiuping, Z. (2002).*The Combination of Traditional Teaching Method and Problem Based Learning*. Mathematics Department of Beijing Normal University: The China Papers Vol. 1.