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PROBLEM BASED LEARNING (PBL): AN INNOVATIVE APPROACH TOWARDS TEACHING AND LEARNING PROCESS

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Abstract

Our education system is changing tremendously causing the replacement of traditional strategies of education in which students are the passive listeners and their only effort is to acknowledge, memorize and reproduce the already fabricated knowledge in an evaluation context. Such approach towards learning doesn't inculcate the desired learning skills among students. Moreover the researches conducted over the last couple of years have clearly mentioned this fact that the conventional methods of teaching generate stoicism among students. So, there is an acute requisite for the evolution and implementation of a new constructivist and technology based instructional method that exposes students to new learning experiences, allow them to go beyond rote learning, to think critically and creatively and to apply their knowledge in solving new and contextual problems. Problem based learning (PBL) is such an approach that has its roots in the theory of constructivism. Education planners and academicians are now moving towards this new approach of education system. The present article first describes the historical origin, theoretical framework, characteristics of PBL and implementation of PBL in educational settings. Then it reviews the researches on PBL. In addition to it, the paper examines the effectiveness of PBL in terms of student learning outcomes and look at implementation issues. Lastly, it provides recommendations for future researchers to carry forward their research work.

Keywords: Problem Based learning (PBL), Teaching, Learning

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I. Introduction

Concept and historical background of PBL

Problem Based Learning (PBL) is absolutely a new idea in the education system. Problem Based Learning (PBL) as its name implies, always begins with a problem. This problem refers to an academically or professionally relevant issue of which students are supposed to learn more (Yew & Schmidt, 2009). It is a didactical instructional strategy in which students are exposed to ill structured, contextualized and real world problems. Students in turn make every possible effort to find meaningful solutions to those problems. It triggers students' learning by creating an urgency to unfold a legitimate problem. PBL provides the opportunity to think beyond the four walls of the classroom and scrutinize the truth. The learning of students is promoted towards the pursuit of meaning. Thus, PBL is truly students-centered, integrated, cumulative and progressive kind of instructional approach. According to Barrows and Tamblyn (1980) PBL is a motivating, challenging and enjoyable learning approach that has resulted from the process of working towards understanding or resolving a problem. Besana, Fries and Kilibarda (2001) described PBL as an instructional method that challenges students to learn, work cooperatively in groups to seek solutions to real world problems.

Problem-Based Learning (PBL) was introduced in the late '60s by an American physician and medical educator, Howard Burrows, within the framework of the medical program at McMaster University in Canada. PBL was assumed and brought about in response to the unsatisfactory clinical performance of Problem-Based Learning students (Barrows, 1996; Barrows and Tamblyn, 1980) that resulted from an emphasis on memorization of fragmented biomedical knowledge in the traditional health science education. This emphasis was blamed for failing to equip students with clinical problem-solving and lifelong learning skills (Albanese and Mitchell, 1993; Barrows, 1996). In the 1980s, the GPEP report (Report of the Panel on the General Professional Education of the Physician and College Preparation for Medicine) sponsored by the Association of American Medical Colleges (Muller, 1984) accelerated the wide spread of PBL in the United States. Later, a number of medical schools adopted this approach and convert their entire curriculum to PBL. Until recently the PBL approach has flourished mainly in medical and professional schools. Slowly the sciences in general have begun taking it up, and even more slowly, the humanities. Throughout 1990s the PBL was also adopted in the higher education and

K-12 settings. Now PBL has been globally implemented in number of professional schools such as business administration, architecture, chemical engineering, leadership education, nursing, social work and teacher education. in addition to it a wide range of other disciplines like biology, chemistry, physics, biochemistry, geology, economics, psychology, history, leadership education, nutrition and dietetics and other domains of post secondary education have adopted this instructional strategy in the curriculum.

Theoretical Framework of PBL

The Problem Based Learning approach (PBL) has its roots in the learning theory broadly labeled as "**constructivism**". It is a theory of knowledge (epistemology) given by Jean Piaget (1972) and Vygotsky (1978) that argues that the knowledge and its meaning is generated by humans from an interaction between their experiences and ideas. Jean Piaget suggested that individuals construct new knowledge from their experiences through processes of accommodation and assimilation. Individuals when incorporate the new experience into an already existing framework the process is termed as assimilation. In contrast, accommodation refers to the process when individuals' experiences contradict their internal representations, they may change their perceptions of the experiences to fit their internal representations. According to the theory, accommodation is the process of reframing one's mental representation of the external world to fit new experiences. It is important to note that constructivism is not a particular pedagogy. In fact, constructivism is a theory describing how learning happens. Piaget's theory of constructivist learning has had wide ranging impact on learning theories and teaching methods in education and is an underlying theme of many education reform movements.

Process of Problem based learning (PBL)

The process of PBL transforms the student from passive information recipient to active, free, self learner and problem solver, and it slides the emphasis of educational programs from teaching to learning. Here are the steps of the PBL approach. Students are informed about the Problem based learning (PBL) process before implementing it in the classroom and small groups comprised of 8 to 10 students are formed. The PBL learning process comprises of the following steps as proposed by Wood (2003).

1. **Clarifying unfamiliar terms**: In the foremost step the unfamiliar terms and concepts are clarified by the facilitator. The main aims of this step are to engage all members of the group encourage clarity in the use of language and technical terms and provide a definition for any term whose unfamiliarity is an obstacle to group work.
2. **Defining the problem**: In this phase a problem scenario is given to the students. Students assume a role other than that of the student. In this situation students are given the opportunity to take initiative in order to solve a contextualized and ill-structured problem.
3. **Brainstorming session**: This phase helps students to develop a deeper knowledge and understanding of the given problem. In this phase, students discuss the problem and suggest the possible explanations based on the previous knowledge. The teacher guides students to articulate what is known, and what knowledge must be created so the problem can be solved. The problem is bounded by the students and learning goals are set by identifying what they know already, what hypotheses they can think of, what they need to learn to better comprehend the dimensions of the problem, and what learning activities are required and who will perform them.
4. **Identifying explanations:** This is the stage where the problem is most extensively explored and restructured. As well as restructuring existing knowledge this process leads to the identification of gaps in understanding. The problem is looked at in fine detail and compared against the proposed explanations to see whether they match or if further explanation is needed. All students are involved in the discussion as it continues the initiation of prior knowledge. It should end with a schematic representation of the problems and their explanation.
5. **Defining learning objectives:** Here the achievable learning outcomes are focused and defined by the groups. This stage basically involves the expertise of entire tutorial group to discuss important and appropriate learning objectives and concludes the discussion. The learning outcomes should be in the form of specific questions that address the problems/ hypotheses and look into the gaps that students have identified in their knowledge.
6. **Gathering of information and self study:** At step six, students end with the PBL session and start their private or self study. Students should use a wide range of resources to meet the learning outcomes. All the students collect information regarding every learning objective from different sources.
7. **Amalgamating results:** After gathering of the information and self study on the learning outcomes, students pool and incorporate the data they have gathered. Each student talks through

and shares the work they have done on each of the set learning outcomes. The aim of poling information from self study helps to identify areas where confusion or uncertainty still exists. It is probable that not all issues will be resolved and new ones may appear.

Attributes of PBL

Problem-based learning is a didactic solution to the learning dilemma. The primary goal of PBL is to enhance learning by requiring learners to solve problems. It is a methodology with the following characteristics:

1. **Problem Focused**: Problem based learning is a problem focused approach in which learners begin their learning by labeling simulations of an authentic and ill-structured problems. There exists a reciprocal relationship exists between knowledge and the problem because the content and skills to be learned are organized around problems, rather than as a hierarchical list of topics.
2. **Self Directed:** It is self directed because students are responsible for their own learning. It is a student centered approach as well. Students gather information, formulate hypotheses, evaluate them and find possible solutions to the problems by their own. Required assignments are rarely made.
3. **Self reflective:** It is self reflective such that learners invigilate their understanding and knowledge and determine how to use strategies for learning.
4. **Instructional Methodology:** Problem based learning is a new and technology based instructional strategy that is supplementing the commercial method of teaching. It transforms the learners from the passive learners to the active and free learners.
5. **Facilitated Learning:** Here tutors are the facilitators who support and model reasoning processes, facilitate group learning and interpersonal dynamics, probe student's knowledge deeply and provide direct answers to the questions.
6. **Development OF HOTS:** Problem based learning is responsible for the development of the HOTS i.e. higher order thinking skills such as critical thinking, creative thinking, problem solving, decision making and many more.

Learning Outcomes of Problem Based Learning: Problem based learning helps in the achievement of various learning objectives. A detailed description is as follows.

1. **Knowledge, Acquisition and Applications:** Earlier it was criticized that PBL emphasized only on facilitating higher order thinking skills (HOTS) and problem-solving skills at the expense of lower level knowledge acquisition and understanding. This concern has been expressed by teachers (Angeli, 2002) and students (Dods, 1997; Lieux, 2001; Schultz-Ross and Kline, 1999). In some cases, it was believed by the students that content was inadequately covered, even though they understood the content more thoroughly (Dods, 1997) and performed equally comparable to traditional students on assessments (Lieux, 2001). Polanco et al. (2004) investigated the effect of PBL on engineering students' academic achievement. They found that, when compared to their counterparts, PBL curriculum significantly enhanced engineering students' performance on the Mechanics Baseline Test, in which the focus of the test was on understanding and application of the concepts rather than recall of factual knowledge. Also, to evaluate the validity of the criticism that PBL students tend to underperform on knowledge acquisition when being measured with standardized tests, Gallagher and Stepien (1996) embarked upon an investigation in which they devised a 65-item multiple-choice test intentionally imitating typical final exams on the topic of American studies. The results showed that no significant difference existed in the content acquisition between students who were in the PBL course and students who were in the non-PBL course; in fact, the PBL students' average gain was higher than the other three traditional classes.

2. **Retention of Material or Content:** A very interesting fact was figured out about the retention of knowledge through PBL method of learning. No difference was found between PBL and traditional students in terms of short-term retention (Gallagher and Stepien, 1996) or PBL students recalled slightly less (Dochy et al., 2003); but, PBL students consistently outperformed traditional students on long-term retention assessments of the memory. (Dochy et al., 2003; Martenson et al.,1985; Tans et al., 1986, as cited in Norman and Schmidt, 1992). Tans and associates investigated that the students' learning through PBL method, recalled up to five times greater on the concepts studied than traditional students 6 months after the course was completed. The study conducted by Martenson et al. (1985) showed that there was no difference in the short-term retention of the content between PBL students and traditional students; however, the PBL students' long-term retention rate (average 25 points out of 40) was 60% higher than that of traditional students (average 16 points out of 40) 2 to 4-1/2 years after the

course was completed. Also, the PBL students remembered more about principles, whereas the traditional students retained more rote-memorization types of knowledge. Similarly, Eisensteadt et al. (1990) found that PBL students retained less than traditional students in the immediate recall test. Nonetheless, their retention rate remained rather consistent 2 years later, while the traditional students' retention had declined significantly.

3**. Problem-Solving Skills:** It was revealed by number of studies that PBL enhances problem solving skills among students. Lohman and Finkelstein (1999) found that the first-year dental education students in a 10-month PBL program improved significantly in their near transfer of problem-solving skills by an average of 31.3%, and their far transfer of problem- solving skills increased by an average of 23.1%. Based on their data, they suggested that repeated exposure to PBL was the key for facilitating the development of problem-solving skills. Several studies have shown that PBL has very positive effects on students' transfer of problem-solving skills to workplaces; for example, Woods (1996) reported that employers praised McMaster University's PBL chemical engineering graduates' outstanding problem-solving skills and job performance. Compared to other new employees who typically required 1 to 1-1/2 years of on-the job training to be able to solve problems independently, " [the PBL graduates] think for themselves and solve problems upon graduation" (Woods, 1996, p. 97).

4. Higher order thinking skills: Higher order thinking is an important cognitive skill required for developing sophisticated problem-solving skills and executing complex ill-structured problem solving processes. To be an effective problem solver, students need to possess analytical, critical thinking, and metacognitive skills. Articulating problem spaces requires analytical skills (Newell and Simon, 1972), evaluating information involves critical thinking skills, and reflecting on one's own problem-solving process requires metacognitive skills. Shepherd (1998) reported that fourth- and fifth-grade students gained a significantly greater increase in critical thinking skills measured by the Cornell Critical Thinking Test (CCTT) than did the comparison group after participating in a 9-week PBL course (the Probe Method). Schlundt et al. (1999) also observed an improvement of self-efficacy in insulin administration management, problem-solving skills, and flexibilities in choosing coping strategies to overcome the difficulty of dietary adherence among adolescent diabetic patients who received a 2-week

PBL summer program. They concluded that, instead of just teaching the facts, the PBL course helped the patients rationalize the self-care guidelines and consider more alternatives to seek better solutions and strategies to cope with the difficult lifestyle. Furthermore, in a longitudinal study of the problem-solving performance of medical students using PBL and traditional methods,

5. **Self Regulated or Directed Learning:** The ultimate goal of PBL is to educate students to be self-directed, independent, life-long learners. Through actively executing problem-solving processes and observing tutors' modeling problem-solving, reasoning, and Metacognitive processes, PBL students learn how to think and learn independently. Though their data did not support the superiority of PBL on knowledge or general problem-solving skills acquisition, Norman and Schmidt (1992) concluded that PBL appeared to enhance self-directed learning. This conclusion was supported by Woods' (1996) assessment of chemical engineering students' comfort level toward self directed learning. Moreover, Blumberg and Michael (1992) used students' self-reports and library circulation statistics as measures of students' self-directed learning behaviors between a PBL class (partially teacher-directed) and a lecture-based class. They concurred that PBL promoted self-directed learning behaviors in students. The long-term effects of PBL on helping students develop self-directed/life-long learning skills and professional preparation was even more evident in other research results. Two studies revealed that PBL graduates rated themselves better prepared professionally than their counterparts in terms of interpersonal skills, cooperation skills, problem-solving skills, self directed learning, information gathering, professional skills (e.g., running meetings), and the ability to work and plan efficiently and independently (Schmidt and van der Molen, 2001; Schmidt et al., 2006).

6. **Self Confidence:** Numerous studies have shown that students consider PBL to be effective in promoting their learning in dealing with complex problems (Martin et al., 1998), enhancing their confidence in judging alternatives for solving problems acquiring social studies content (Shepherd, 1998), enriching their learning of basic science information (Caplow et al., 1997), developing thinking and problem-solving skills (Lieux, 2001), improving interpersonal and professional skills (Schmidt and van der Molen, 2001; Schmidt et al., 2006), and advancing self-

directed learning, higher level thinking, and enhancement of information management skills (Kaufman and Mann, 1996).

In summary, PBL research results overall have clearly demonstrated advantages of PBL for preparing students for real-world challenges. The emphasis of PBL curricula on application of domain knowledge, problem solving, higher order thinking, and self directed learning skills equips students with professional and life-long learning habits of mind, which are indispensable qualities of successful professionals. This speculation may suggest further research issues and merit empirical evidence to shed deeper insight on these aspects of PBL.

Effectiveness of Problem based learning (PBL) approach

As Problem based learning method has its roots in the constructivist theory it always enables students to construct their own knowledge by using the already existed knowledge. So this method of learning is the most effective method for teaching and learning process. Moreover, by setting off the idea underlying the fact that life means to recognize problems faced, to be aware of the importance of these problems, to understand why these problems occur and to eradicate possible problems at an earlier stage, the problem-based learning serves the view that learning must be complete and must be based on adequacy. The efficiency level of problem-based learning should be examined in order to acquire the skills of reflecting on problems faced and of solving these problems, to increase critical thinking level and not to be afraid of possible or actual problems. Problem-based learning model orients students towards reflecting on, interpreting and searching solutions to the problems faced by them not only in science classes but also in their daily lives, instead of compelling them to ignore all these problems. In the classrooms within which problem-based learning model is applied, students are encouraged to access knowledge by themselves. The fact that the scenarios implemented as required by problem-based learning model are connected with students' daily lives enables students to understand how science classes are so interrelated with real life. Furthermore, since students find the events and characters pictured in these scenarios so close to themselves, science classes become attractive to them automatically. In problem-based learning model in which teaching activities are carried out with small groups composed of 6 or 8 students, it is achieved that these students could strengthen their interaction and communication with each other and their

environment. Their skill to express themselves develops. In general, students define problems as incomprehensible, complicated, complex and abstract. This prevents students from reflecting on, interpreting and solving problems. In order to change this situation, it is necessary to concretize problems and associate them with students' lives. It is an issue of great importance that the science knowledge assumed to be learned through science education in school could not be transmitted to their actual lives by students and some misconceptions are carried again by them.

Throughout the past several decades, a vast body of research on various aspects of PBL has contributed to our knowledge of PBL. Although PBL has gained popularity in K–12 and higher education, the majority of PBL research continues to be conducted in the medical education field. Within that body of research, some issues, such as the effects of PBL on student performance, have received more attention than others.

Problem Based Learning and Science Education

The facts that science education is based on both practice and interpretation, that it is so connected with real life and that it requires cooperation facilitate the problem-based learning practices. Many people see science as students taking real measurements and working with this real information to learn scientific concepts, and to be involved in developing their own problem solving methods. Therefore, schools need to change their approach to science education if they want to prepare citizens to make decisions on science-related issues. When the aims of science education are examined, it is seen that the problem-based learning is quite appropriate for realization of these aims (Tobin, 1986; AAAS, 1993). Today, many science educators considering this connection have increasingly started to apply problem-based learning approach in science education (Lazear, 1991; Treagust & Peterson, 1998; Gallagher *et al.,* 1999; Slavin, 1999; Greenwald, 2000; Yuzhi, 2003; Şenocak, 2005; Wilson, 2005; Kılıç, 2006). The curriculum must be changed so that science instruction becomes relevant in the real world. Stepien & Gallagher stated the brief steps of the scientific process:

1. Determine a good problem
2. Learn information about the problem
3. Decide which experiments and observations can help a solution of the problem
4. Conduct the experiments, observations, and calculations
5. Decide whether the results help to a better understanding of the problem.

6. Share your results

Most science programs focus only on the second and fourth items on the list, leaving out some of the most important parts of the practice of science. However, the scope of scientific reasoning reflected in the list is closely related to the reasoning students experience in problem-based learning. Therefore the practitioners found that "the problem-based learning structure could be adapted for science by ensuring the inclusion of some important components of the scientific process and by careful attention to the inclusion of science concepts". Specifically, the practitioners identified four adaptations essential making problem-based learning reflect closely possible science practice.

- Students focus on the problem concerning a science concept. Using that problem and the concept, students investigate the significance of science content.
- Students have the opportunity to test their ideas experimentally. Students should generate some of the data to solve their problems themselves rather than depending on the work of others (teacher - supplied information, or information from experts and mentors).
- Students have the opportunity to manage their own data that is, students learn how to keep good notebooks, learn techniques to record data, save and store data.
- Students have the opportunity to present their solutions which can be arranged in either the "talk" or the "publish" format. Groups of students present their reports orally in a conference format, develop a poster session, or put together an issue of scientific journal for distribution. Students are involved in the instructional process; respond by building their own cognitive structures which form the meaning of their world.

Conclusion: In the end it can be said that Problem based learning approach as its name suggests make students the active, free and self regulated learners. This method of learning should be undertaken by the academicians and the government educational plans so that the budding population should have all the capacities and potentials to deal with the problems. Moreover it is the most effective method in terms of development of higher order thinking skills and learning outcomes such as knowledge acquisition and application.

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