ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 06, pp.17181-17187, June, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

REVIEW ARTICLE

PROBLEM BASED LEARNING

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ARTICLE INFO

Article History:
Received 17th March, 2015
Received in revised form
10th April, 2015
Accepted 25th May, 2015
Published online 30th June, 2015

Key words:
PBL,
Active learning,
Student centered.

ABSTRACT

Problem-based learning (PBL) has become the most significant innovation in medical education of the past 40 years. In contrast to exam-centered, lecture-based conventional curricula, PBL is a comprehensive curricular strategy that fosters student-centered learning and the skills desired in physicians.PBL is an effective way of delivering medical education in a coherent, integrated program and offers several advantages over traditional teaching methods. It is based on principles of adult learning theory, including motivating the students, encouraging them to set their own learning goals, and giving them a role in decisions that affect their own learning. Predictably, however, PBL does not offer a universal panacea for teaching and learning in medicine, and it has several well recognized disadvantages. In this article we discuss about the definition of PBL, stimulus for this type of learning, role of the facilitator, advantages and disadvantages of PBL.

***Citation*:** Usha Adiga and Sachidananda Adiga, 2015. "Problem based learning", *International Journal of Current Research*, 7, (6), 17181-17187.

INTRODUCTION

What is PBL?

An instructional student-centered approach which uses carefully constructed clinical problems as a context for students to define their learning needs, conduct self-directed enquiry, integrate theory and practice, and apply knowledge and skills to develop a solution to a defined problem. It is the process of acquiring new knowledge based on recognition of a need to learn. The problem comes first without advance readings, lectures, or preparation. The problem serves as a stimulus for the need to know. Based on theirown prior knowledge and the identified gaps in that knowledge, students determine the learning issues within their own group. They then identify and use a variety of learning resources to study these issues and return to the group to discuss and share what they have learned.

History of PBL

Problem-based learning (PBL) was first utilized in the 1960s by McMaster University in Canada in the instruction of medical students. Since that time, it has been successfully used as an educational tool for nursing, dentistry, pharmacy, veterinary medicine, and public health professional programs (Camp, 1996). Knowles defined self-directed learning in 1975 as ''a process in which individuals take the initiative, with or without the help of others, in diagnosing their needs, formulating learning goals, identifying human and material resources for learning, choosing, and implementing appropriate learning strategies and evaluating learning outcomes'' (Knowles, 1975). Margetson described the link between problem-based learning and self-directed learning as problem identification, followed by students engaging in self- directed learning to solve the problem (Margetson, 1994). The use of problem-based learning in the training of healthcare professionals incorporates goals for students that are much broader than the acquisition and application of content. PBL is expected to influence the ''whole'' student or at least most aspects of the students' learning experience (Knowles, 1975).

Stimulus for PBL

PBL was developed by modeling the process of how we actually learn each day during our working lives. Patients pose a diagnostic dilemma, which results in either a ''patient unmet need'' where the diagnosis is missed or a ''doctor's educational need'' where reference is made to learn from the signs presented (Gammon, 2001). This stimulates the clinician to read around the subject once recognized deficiencies are identified.

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No-one gives practicing doctors a curriculum, lecture notes or suggested reading for each patient, but we acquire the knowledge and skills that allow us to practice competently from the repeated application of these principles. It is the patients who provide the stimulus for life-long learning. Students have to recognize the need to maintain learning. PBL poses these diagnostic dilemmas to students in the form of case-based problems, giving the student the opportunity to acquire knowledge but also a method of applying it and developing a diagnostic sieve to implement the newly found knowledge. This represents a more useful form of learning than merely memorizing and regurgitating facts for a multiple choice exam. It can be seen that this approach does not necessarily require an underpinning of didactically taught basic science (as per the traditional model) but rather the student gains basic science information relevant to each particular problem through this self-directed learning.

Key steps in the PBL tutorial process

In problem-based learning (PBL), students use 'triggers' from clinical scenarios to define their own learning objectives and inform independent research, the findings of which are refined in group discussions (Wood, 2003). Knowledge is acquired in an active and self-directed way, unconstrained by subject divisions (Maudsley, 1999). PBL is being increasingly favoured by medical educationalists, as it has been shown by some to better prepare students for the teamwork, communication skills and patient interaction required in clinical practice (Prince *et al*., 2005; Cohen-Schotanus *et al*., 2008). However, other studies have concluded that there is no convincing evidence that PBL improves knowledge base and clinical performance (Cohen-Schotanus *et al*., 2008; Colliver, 2000).

It is a teaching technique used in many medical schools to facilitate learning basic science concepts in the context of clinical cases. Students are assigned to groups of 8-10, and each group is assigned a faculty member who plays the role of a tutor or facilitator as the students work through a case or a problem. This model is very student-centered. In the PBL approach, complex, real-world problems are used to motivate students to identify and research the concepts and principles they need to know to work through those problems. Students work in small learning teams, bringing together collective skills at acquiring, communicating, and integrated information. In PBL curriculum the problem scenarios serve as central component, a set of problem situations that equip students to become independent inquirers, who see learning and epistemology as flexible entities and perceive that there are also other valid ways of seeing things besides their own perspective. PBL instruction addresses several desirable outcomes of an undergraduate education, particularly critical thinking, research skills, communication skills, and other lifelong learning skills. PBL strategy is remarkably a datable vehicle to develop in students, core knowledge in a content area, cognitive skills (analysis, synthesis, application, evaluation, and critique) and action skills (organizing time, resources, coordination, negotiating, tolerating). In PBL, students first encounter a problem, followed by a student centered inquiry process (Norman and Schmidt, 2000; Distelhorst *et al*., 2005). PBL emphasizes active student centered learning in which students are challenged to examine, inquire, reflect, make meaning, and understand the sciences basic to medicine as they develop approaches towards the solutions of defined problems in a context relevant to their future professional careers (Norman and Schmidt, 2000). Both content and the process of learning are emphasized in PBL. Key elements of the PBL include the formulation of questions that can be explored and answered through systematic, self-directed inquiry and the testing and revision of hypothesis through the application of newly acquired knowledge. Active discussion and analysis of problem, hypothesis, mechanisms, and learning issues among students are essential to this process, enabling students to acquire and apply content knowledge and to learn and practice both individual and group communication skills critical to learning and teaching. PBL curricula are often integrated across the sciences basic to medicine, as well as among departments and activities such as clinical skills and doctor-patient-society courses that have traditionally been restricted to particular years of the curriculum.

Two fundamental pedagogical principles underlie PBL: students learn best (NIH, 1989) in groups rather than alone and (NIH, 2009) when they actively participate in identifying and addressing their knowledge gaps. PBL differs from other case-based instructional methods in several ways. It encompasses the '5E' instructional model (engage, explain, explore, elaborate and evaluate), and each problem-case unfolds over two group sessions separated by 4 to 7 days, to promote a learning cycle. In session one, students identify learning issues needed to solve the problem. During the interval, individual students acquire specific content knowledge to address these learning issues. At the second session, students collaboratively use their knowledge and resources to solve more complex controversies and problems revealed as the case continues.

Main steps

Clarify terms and decide the problems

Some terms may need clarification; make sure all group members understand the same thing and all members understand the terminology.

Analyze the problems

This consists in large part of utilization of students' prior knowledge, to try and formulate hypotheses to explain the processes that have contributed to this clinical presentation. It commonly becomes a ''brainstorming'' session. The aim is to encourage all group participants to develop some insight into the underlying issues that might be at play.

Identify study priorities for the scenario

Usually, there will be insufficient time to address all the issues raised. This important step entails prioritization of those aspects of the scenario needing most attention—just as in real life.

Formulate learning objectives for the problems

It is usual to draw up a list at this point on which all the group can agree: the objectives upon which the learners will concentrate are set out. It may be helpful to delegate tasks at this stage. The group must also identify what resources will be needed to help answer the questions they have set.

Individual study

This step requires a high degree of motivation if the PBL is to be effective. There are real constraints in finding the time and energy to search out and assimilate the information needed. At this stage, the facilitator must be available when needed to assist with finding the information or to deal with problems in completing the tasks within the given time.

In the next session, the group meet and share their findings. It is important that each participant fully contributes, they may make presentations to other group members, lead a discussion, or produce a handout. New questions may have arisen, and the group may decide to ‘‘step back’’ and re-analyse their priorities in this scenario.

Identify areas for improvement

In this phase, group members look at how they approached the earlier steps and consider if they have developed new skills as a result of their studies. This reflective activity can be very revealing and is a powerful motivator to further useful clinical learning.

What makes a good PBL Problem?

PBL only has the potential to be effective if care is taken to set problems that work well with this learning style (Neame, 1981). The following points must be considered

- There should be a neutral description of a realistic and fairly common clinical scenario that needs explanation in terms of underlying principles or processes
- There must be the scope for problem solving activity
- The problems must be formulated in a clear and concrete manner

There should be a degree of complexity to the scenario that is appropriate to the participants: too simplistic a scenario will not motivate anyone. One of the strengths of PBL is that ‘‘simpler’’ tasks can be allocated to those whose knowledge base or learning skills are comparatively weak, and ‘‘complex’’ tasks allocated to stronger group members, without anyone necessarily being disempowered (Dolmans, 1997), within an adult learning environment, it is crucial to acknowledge all contributions to the learning, and responsible participants work within this framework quite easily;

An element of medical urgency to the problem helps promote high quality participation for learners whose clinical work role is in the emergency department;
Problems raising issues that are often poorly handled by healthcare staff are particularly powerful learning tools.

Creating effective PBL scenarios

Learning objectives likely to be defined by the students after studying the scenario, should be consistent with the faculty learning objectives. Problems should be appropriate to the stage of the curriculum and the level of the students' understanding. Scenarios should have sufficient intrinsic interest for the students or relevance to future practice. Basic science should be presented in the context of a clinical scenario to encourage integration of knowledge. Scenarios should contain cues to stimulate discussion and encourage students to seek explanations for the issues presented. The problem should be sufficiently open, so that discussion is not curtailed too early in the process. Scenarios should promote participation by the students in seeking information from various learning resources.

Role of facilitator

DOES PBL REQUIRE A TEACHER?

There has been little mention of the ‘‘teacher’’ in problem based learning. PBL differs radically from traditional teaching styles in that it centres on ‘‘problem first’’ learning, rather than the more usual ‘‘subject first’’ way using scenarios to illustrate previously taught material. The leader of a PBL program acts as a facilitator rather than a teacher, using their expertise not primarily to transmit facts, but to provide encouragement and guidance as the participants tackle the problems they have identified. The skill of PBL facilitation is that of knowing when to provide assistance to the group, be it suggesting useful resources they might like to consider or interjecting with thought provoking comments to guide the breadth and depth of learning, without necessarily imparting facts (Maudsley, 1999). There has been debate as to whether the facilitator needs to be an ‘‘expert in the field’’ regarding the subject matter being tackled, but the consensus view is that expertise in group dynamics together with supportive enthusiasm is more valuable than deep subject knowledge. This has been a difficult idea for some medical teachers to grasp (Vernon, 1995).

This educational tool utilizes facilitators rather than lecturers. The responsibility of facilitators in PBL may include: encouraging critical thinking; fostering self-directed learning; monitoring group progress; and creating a learning environment that stimulates group members, generates thorough understanding, and promotes teamwork (Azer, 2005).

What instructors do

Develop real-world, complex and open-ended problems such as might be faced in the workplace or daily life. Act as facilitators, making sure students are staying on track and finding the resources they need. Raise questions to student groups that deepen the connections they make among concepts. Strike a balance between providing direct guidance and encouraging self-directed learning.

What students do

Address the problem, identifying what they need to learn in order to develop a solution and where to look for appropriate

learning resources. Collaborate to gather resources, share and synthesize their findings, and pose questions to guide further learning tasks for the group.

The function of the tutor in PBL differs considerably from that of the tutor in conventional tutorials in which the tutor assumes a comparatively didactic role. A major feature of PBL is that learning is student-centred in that students take responsibility for identifying and addressing their own learning needs; tutors are required to facilitate this rather than adopt the position of content expert. Facilitation requires understanding of the learning process and primarily involves monitoring of student learning and promotion of effective group function. The student centered learning approach of PBL means that for tutors, content knowledge should be subordinate to proficiency in group facilitation (Barrows and Tamblyn, 1980). Thus, effective tutors promote student learning by creating a supportive environment which encourages active participation by all members of the group, by monitoring the quality of learning through questions and feedback and by encouraging the development of students' metacognitive skills (Maudsley, 1999). Thus tutoring in PBL tutoring has two components: facilitation skill and content knowledge. It may be expected that students would consider the principal strength of clinically qualified tutors to be their greater relevant content knowledge. In contrast, the principal strength of non-clinically qualified academic staff to the PBL process would be the facilitation skills derived from (often extensive) teaching experience.

Advantages of PBL

Much of the early work on PBL described its use in the undergraduate setting, particularly the preclinical years. There remains little information about its use in postgraduate education (Smits *et al*., 2002). The issue of PBL's effectiveness is a vexed one because of difficulties surrounding terminology—several literature reviews have discovered that many papers seemingly reporting ''PBL'' initiatives actually describe activities such as journal clubs or self directed study groups without several of the components of PBL proper (Foley *et al*., 1997). There are further difficulties, as with much educational research, in determining exactly what we mean by ''does it work?'' If we are asking whether PBL leads to greater participant enjoyment and enthusiasm for learning than more ''traditional'' methods of medical education, then there is plenty of evidence to support this: PBL learners feel they are being treated as mature professionals who are developing effective and clinically relevant study skills as well as useful skills in problem solving that are vital in their working life. They also value the interpersonal skills that PBL encourages and that are also key to effective clinical practice (Colliver, 2000). There is practically no evidence, however, that PBL participants demonstrate improved clinical competence or have more effective clinical consultations, although it might be argued that in becoming more confident and self aware as professional learners they will presumably become more efficient and enthusiastic in the workplace (Albanese, 2000). These remain broad assumptions, though, and the relative newness of postgraduate PBL accounts for the lack of clarity in this area.

PBL provides a potentially challenging, more motivating, and enjoyable approach to medical education, and may promote lifelong habits of self-directed learning (Albanese and Mitchell, 1993).

Main features of PBL

Student centered: It fosters active learning, improved understanding, and retention and development of lifelong learning skills
Generic competencies: allows students to develop generic skills and attitudes desirable in their future practice
Integration: PBL facilitates an integrated core curriculum
Motivation: PBL is fun for students and tutors, and the process requires all students to be engaged in the learning process
"Deep" learning: PBL fosters deep learning (students interact with learning materials, relate concepts to everyday activities, and improve their understanding)
Constructivist approach: Students activate prior knowledge and build on existing conceptual

Generic skills and attitudes

- Teamwork
- Chairing a group
- Listening
- Recording
- Cooperation
- Respect for colleagues' views
- Critical evaluation of literature
- Self -directed learning and use of resources
- Presentation skills

PBL provides an antidote to the increasing fragmentation of information and knowledge and promotes the connectedness of ideas, information and knowledge. PBL needs to be seen as an approach to learning that really does help students to engage with and live in a complex world. Assessment in PBL focuses on multiple skills and abilities, on process as well as product. PBL's student-centered focus and emphasis on Self- directed learning (SDL) create unique challenge for development of an effective assessment technique. Evaluating the success of PBL as compared to more traditional Lecture Based Learning requires more complex techniques. The guiding principle to assessment includes content learning. An effective assessment and evaluation program can ensure that students are deriving maximum benefits from PBL. Teaching program evaluation in medical education presents a different set of challenges. Many methods (quantitative, survey, checklists, interviews, document reviews, observations, focus groups, Nominal Group technique, Case Studies) have been used to evaluate PBL programme. Most of the studies evaluate outcomes – knowledge, learning process and skills.

Outcome of PBL

Knowledge

Knowledge and test performance have been the most widely researched outcomes. PBL is thought to improve learning and

retention of information and Norman and Schmidt, in their review (Norman and Schmidt, 1992) found several studies supporting improved retention of knowledge.

Skills

Since clinical problems provide the basis for learning in PBL it is assumed that knowledge should be better integrated in the clinical setting. Reviews found that PBL students scored comparably or better than traditionally taught peers in clinical skills (Van den Bossch *et al*., 2000; Albanese and Mitchell, 1993 and Vernon and Blake, 1993). Schmidt also reported higher diagnostic skills in Dutch students following integrated or PBL curricula compared to conventional teaching (Schmidt *et al*., 1996) although only part of this variance may be attributable to PBL per se. (Colliver, 2000). At Harvard PBL graduates showed higher ratings for humanistic and psychosocial skills (Peters *et al*., 2000) and better relational skills (Moore *et al*., 1994)

Preference

Students report high satisfaction ratings for PBL (Abu-Hijleh *et al*., 2004) and a preference for small group learning (Smith, 2002) and four reviews also suggest that it is more enjoyable (Albanese and Mitchell, 1993; Vernon and Blake, 1993; Newman, 2003; Smits and Verbeek, 2002).

Does PBL continue to benefit?

Self-directed or deep learning is thought to be more suitable to continuing medical education (CME), (Spencer, 1999) but harder to achieve with a heavy clinical workload (Delva *et al*., 2004). Two reviews found that PBL promoted selfdirected learning and that this was sustained (Norman and Schmidt, 1992; Newman, 2003). Higher resource uses by PBL graduates has been observed (Albanese and Mitchell, 1993). The deep approach is the most appropriate and desirable way of learning that is closely linked to the intellectual processes we would wish to see in all medical students and is the means of life-long learning. A deep approach is likely to result from relevance of the subject matter to students' interests (Groves, 2005), the interest, support, and enthusiasm shown by the instructor (Ramsden and Entwistle, 1981), and the environment where students have an opportunity to manage their own learning (Richardson, 1990). It was also found to be related to what students perceive as "good teaching" and "freedom in learning" (choices in what and how to learn). Measuring students' approaches to learning has been seen as a means of the following: helping students become better learners (Dart and Clark, 1991), assisting individual academics who are concerned inmonitoring and improving the effectiveness of their ownteaching (Svensson, 1977), identifying students at risk because of ineffective strategies (Shreemathi, 2001),observing the outcomes and experience of learning (Newble and Entwistle, 1986).

Disadvantages of PBL

PBL is more expensive than conventional curricula, especially in larger medical schools (Donner and Bickley, 1990). In the early literature reviews, PBL graduates tended to rate their basic science background weaker than their conventional curriculum counterparts. These results suggest that PBL may not develop in students an effective cognitive foundation (Albanese, 2000). Other studies have indicated that while students favor PBL curricula, they also express dissatisfaction about a lack of a structure or direction (Blumberg and Eckenfels, 1988).

Tutors who can't "teach": Tutors enjoy passing on their own knowledge and understanding so may find PBL facilitation difficult and frustrating

Human resources: More staff have to take part in the tutoring process

Other resources: Large numbers of students need access to the same library and computer resources simultaneously

Role models: Students may be deprived access to a particular inspirational teacher who in a traditional curriculum would deliver lectures to a large group

Information overload: Students may be unsure how much self directed study to do and what information to be studied.

Some reviews found PBL students scored lower in basic sciences or knowledge, (Van den Bossche *et al*., 2000; Albanese and Mitchell, 1993) or demonstrated inferior exam performance (Vernon and Blake, 1993) However the effect size was small (Colliver, 2000) and not reproducible. The commonest concern is the higher delivery costs of the PBL curriculum, both financial and in staff time (Albanese and Mitchell, 1993; Berkson, 1993) The PBL approach is dependent on the functioning of the group,(Stratman and Dyer, 2002) and requires an effective tutor who should be expert in facilitation rather than subject matter (Barrows and Tamblyn, 1980). A review of PBL in CME found little evidence for superiority (Smits *et al*., 2002) Shin *et al* found higher levels of current knowledge in PBL than traditional graduates, (Shin *et al*., 1993) but the PBL graduates were more likely to be involved in teaching, which confounds this finding.

The descriptions of medical educators about the PBL approach focused on the process of PBL, the characteristics of a good PBL facilitator and the advantages and disadvantages of PBL. It has been well documented that the facilitator role is central to PBL. As the importance of faculty development in PBL was valued by participants in the forum discussion this may suggest more facilitator development workshops to help achieve competence as skilled facilitators of the PBL process. Such workshops may uncover conflicting roles of tutors in the steps of the PBL process. As Irby indicated, identifying and practicing these roles (mediator, challenger, negotiator, director, evaluator and listener) is a key skill of effective facilitation (Irby, 1996). In addition to this, one medical educator had a negative approach about PBL, and reflected: "*PBL is still unclear in GEM*". It seems that some medical educators have negative perceptions of PBL. For instance, a qualitative study was conducted to explore how a cohort of tutors made sense of PBL. In a study participant stated:

"*absolutely not, no views not reallychanged at all. I'm still not convinced that PBL, despite the factthat [I will tutor again] is the proper way of teaching"* (Maudsley, 2002).

When asked about their experience in a PBL tutorial course, medical educators indicated they had few negative feelings with respect to facilitating self-directed learning and student learning. There are several possible reasons for this. Firstly, in the beginning of the course, it seems that the students find adopting a self-directed problem based approach to learning difficult as they "do not know what they do not know". This may be attributed to the fact that students may have a restricted personal knowledge of the complexity of the "case". Secondly, students may not have clear objectives for the behavior that they have to achieve, particularly in clinical settings. Thirdly, learning styles, both deep, surface and 'strategic', are determined at secondary school, and it is also difficult to influence learning styles even with a PBL curriculum (Carter and Peile, 2007; Reid *et al*., 2005).

Conclusion

PBL is an effective way of delivering medical education in a coherent, integrated program and offers several advantages over traditional teaching methods. It is based on principles of adult learning theory, including motivating the students, encouraging them to set their own learning goals, and giving them a role in decisions that affect their own learning. Predictably, however, PBL does not offer a universal panacea for teaching and learning in medicine, and it has several well recognised disadvantages. Traditional knowledge based assessments of curriculum outcomes have shown little or no difference in students graduating from PBL or traditional curriculums. Importantly, though, students from PBL curriculums seem to have better knowledge retention. PBL also generates a more stimulating and challenging educational environment, and the beneficial effects from the generic attributes acquired through PBL should not be underestimated.

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