

2. UNDERSTANDING PROBLEM -BASED LEARNING

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INTRODUCTION

This chapter focuses on Problem-based Learning (PBL). Enquiry-based Learning is defined in the first chapter as “a broad umbrella term used to describe approaches to learning that are driven by a process of enquiry,” O’Rourke and Kahn (2005:1). Within this context Problem-based Learning is seen as a set of approaches under the broader category of Enquiry-based Learning. One of the main defining characteristics of Problem-based Learning, which distinguishes it from some other forms of Enquiry-based Learning, is that the problem is presented to the students **first** at the start of the learning process, before other curriculum inputs. Another defining characteristic of PBL is that in PBL tutorials students define their own learning issues, what they need to research and learn to work on the problem and are responsible themselves for searching appropriate sources of information.

I understand Problem-based Learning not as a mere teaching and learning technique but as a total education strategy. Four components of Problem-based Learning, as a total education strategy, are:

- PBL curriculum design
- PBL tutorials
- PBL compatible assessments
- Philosophical principles underpinning PBL

These are discussed in turn. The chapter ends by highlighting some of the starting points and success factors to consider when starting a PBL initiative. I draw on my experiences as a Problem-based Learning course co-ordinator, tutor and researcher, together with my experiences of working as a PBL education development consultant with PBL initiatives in different universities and Institutes of Technology. I base this practical introduction to PBL on theory, research and practical experience. An important part of this chapter is the voices of PBL tutors. Quotations from PBL tutors are from my current doctoral research unless otherwise stated.

DEFINING PROBLEM-BASED LEARNING

Since the first humans were on this earth there have been forms of Problem-based Learning as people tackled problems including the basic issues of survival, finding food and shelter and protecting themselves against enemies. What is being discussed in this chapter is a particular set of approaches of Problem-based Learning (PBL) in higher education. This Problem-based Learning follows the research of Barrows and Tamblyn (1980) and was first implemented in medical education in McMaster University in Canada in the 60’s. The rationale for this strategy centred on the argument that, based on their research on clinical reasoning, it was more effective to teach medical students through them solving problems than through the established traditional methods of medical education. Barrows (2000: vii) outlines the original motivation for the change to PBL:

They [medical students] were bored and disenchanted when medical education should have been exciting. The committee noted that medical education didn’t

become exciting for students until residency training, when they were working with patients trying to solve their problems. They decided that from the beginning of school, learning would occur around a series of biomedical problems presented in small groups with the faculty functioning as “tutors or guides of education.”

Having started with medicine in Canada, PBL has spread across the globe and across the disciplines. In exploring the issue of defining Problem-based Learning I consider:

- Barrows classical definition of Problem-based Learning
- Essential features of PBL
- My operational definition of PBL
- A web-based definition of PBL

Barrows defines it as:

The learning that results from the process of working towards the understanding of a resolution of a problem. The problem is encountered **first** in the learning process
(Barrows 1980:1 my emphasis)

That does not mean that there cannot be other curriculum inputs e.g. lectures, labs etc, rather, the students are presented with the problem or trigger first and other curriculum inputs follow later and may take a different format than traditionally in order to complement/enhance the work on the problems in the PBL tutorials.

Problem-based Learning is part of the shift from the teaching paradigm to the learning paradigm (Barr and Tagg, 1995). The focus is on what students are learning rather than what the teacher is teaching. Lloyd-Jones, Margeston and Bligh (1998: 494) reconsider the “essential features of Problem-based Learning”. They argue that:

Three shared elements stand out from the current picture of PBL in action: the initiating trigger, the learning that students undertake by researching the learning issues identified in the first tutorial, and the use of knowledge in furthering their understanding of the trigger situation particularly in the final tutorial. (emphases my own)

The following definition is also pertinent as it highlights PBL as a way of replicating problem-solving processes used at work and in life generally:

PBL is both a curriculum and a process. The curriculum consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem-solving proficiency, self-directed learning strategies and team participation skills. The process replicates the common used systemic approach to resolving problems or meeting challenges that are encountered in life and career (Maricopa Community Colleges, Centre for Learning and Instruction: <http://www.mcli.dist.maricopa.edu/pbl/info/>)

But what exactly do students do in Problem-based Learning? My operational definition of Problem-based Learning is as follows:

Figure 1: Operational definition of PBL

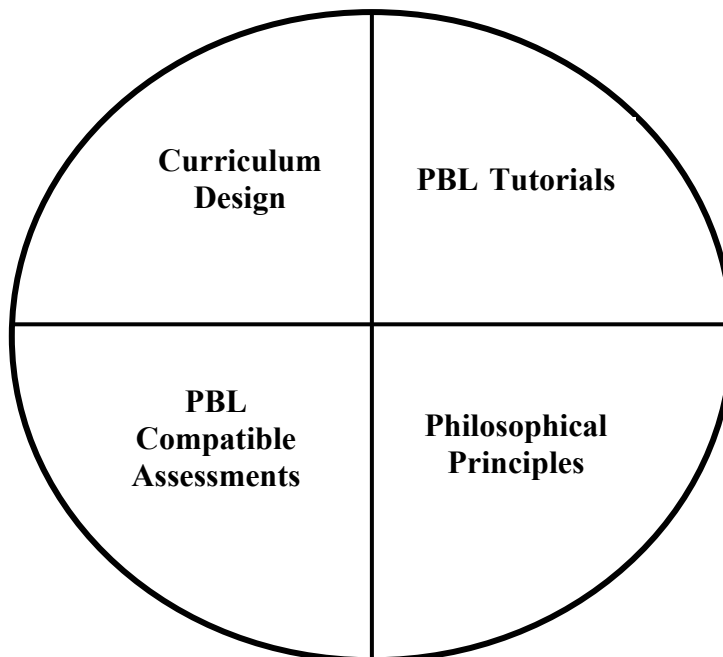
- 1) **First** students are presented with a problem
- 2) Students discuss the problem in a small group PBL tutorial. They clarify the facts of the case. They define what the problem is. They brainstorm ideas based on the prior knowledge. They identify what they need to learn to work on the problem, what they do not know (learning issues). They reason through the problem. They specify an action plan for working on the problem
- 3) Students engage in independent study on their learning issues outside the tutorial. This can include: library, databases, the web, resource people and observations
- 4) They come back to the PBL tutorial(s) sharing information, peer teaching and working together on the problem
- 5) They present their solution to the problem
- 6) They review what they have learned from working on the problem. All who participated in the process engage in self, peer and tutor review of the PBL process and reflections on each person's contribution to that process

When beginning a PBL initiative it is important to have a starting point definition of PBL. However it would be a contradiction in terms not to treat PBL itself as a problem (Barrett 2001) and I would encourage people to redefine what PBL means in their specific contexts. The PBL case studies in this handbook have elements in common but also other elements that were developed in relation to organisational and discipline needs, local constraints and the critical and creative thinking of the curriculum designers.

PROBLEM-BASED LEARNING AS A TOTAL EDUCATION STRATEGY

I consider that PBL is not merely a teaching and learning technique, but a total approach to education. I would advise people starting a PBL initiative to consider four important components of PBL, namely: PBL curriculum design, PBL tutorials, PBL compatible assessments and philosophical principles underpinning PBL.

Figure 2: Problem-based Learning as a Total Education Strategy



Problem-based Learning curriculum design

Starting to develop a framework for curriculum design of any type including PBL provokes us to asking some basic questions. These questions include:

- What are the fundamental ideas, knowledge, skills and attitudes which should be developed through the programme?
- What are the internal and external drivers for curriculum change?
- Who do we need to involve in the curriculum design process?
- What are the stakeholders (including students, academic staff, employers, professional bodies) saying about current educational needs?
- What are our beliefs about higher education generally and our profession/discipline in particular?
- How are these beliefs and values translated into action in our curriculum design?
- How should the course be structured?
- How will students learn on the course?
- What prior knowledge, skills and attitudes do we consider as entry requirements?
- What kinds of assessment will be appropriate for the kinds of learning we are trying to encourage?
- Do we have a unique selling point?
- How do we plan to market this course?

(Toohey, 1999)

At the core of PBL curriculum design is a set of well designed, ill-structured or open-ended, real-life, engaging problems. Problems are not always about difficulties that need to be sorted out. Challenges, dilemmas, and triggers are problems. Understanding a puzzling phenomenon or a difficult concept can be a problem. How to find a better, more ethical or cheaper way of doing something is a problem. How to design or create something is a problem.

There are different ways of getting involved in a Problem-based Learning curriculum. Some people decide to have only one or two modules on the course as PBL modules. Others decide that the full course will be PBL. As an implementation strategy some start with first years and others with final years.

Designing a PBL curriculum means reconceptualising our curriculum in ways that emphasise:

- Selection of content from practice
- Concepts as the organising structure of the curriculum [and expressed as learning outcomes for the whole unit]
- Process as content
- Graduate outcomes not subject-based outcomes

(Conway and Little, 2000)

Clarifying the learning outcomes for the unit/module of the curriculum is a very important stage of curriculum design. The next step is to write problems that will stimulate student learning in relation to these outcomes. A curriculum matrix where the problems are plotted against the learning outcomes is helpful in designing a PBL curriculum ensuring that all learning outcomes will be addressed at least once.

Figure 3: PBL curriculum matrix

| Problems⇒ | Name of P1 | Name of P2 | Name of P3 |
|---------------------------|------------|------------|------------|
| Learning outcomes↓ | | | |
| L.O. 1 | | | |
| L.O. 2 | | | |
| L.O. 3 | | | |
| L.O. 4 | | | |

Variety and challenge are very important in designing PBL problems

...a measure of the quality of a problem is the degree to which it stimulates the students' desire to learn. The two features highlighted by the study were the levels of variety and challenge perceived by students.

(Mauffette, Kandlibinder and Soucisse 2004:11)

Problems can vary in size in terms of length of study. Some problems are designed to be resolved in two tutorials. Others are designed to last weeks or months. Sometimes problems can be presented in a progressive disclosure mode. This means giving students the initial trigger at the outset and then giving them further information at later stages. This mirrors real life e.g. results of a report arriving, a new phone or e-mail message received in relation to the problem etc. Another option is that one problem can be a follow-up to another problem. The following are some ideas for providing variety in problem formats

Figure 4: Some Different problem formats

| | | |
|------------------------|-----------------------|------------------|
| Scenarios | Video clips | Physical Objects |
| Dialogues | Photographs | Letters |
| Cartoons | Poems | Metaphors |
| Diagrams | Limericks | Requests |
| Set of Playing cards | Audio-tape recordings | Posters |
| Dilemmas | E-mails | Briefs |
| Progressive disclosure | Follow-ups | Quotations |
| Newspaper articles | T.V. Shows | Literature |

Writing PBL problems combines critical thinking with creative thinking and is best carried out in small teams. For more discussion and examples of PBL curriculum design see chapters 4, 5 and 6 of this handbook. For more examples of PBL problems see the University of Delaware website: www.udel.edu/pbl/

PBL tutorials

The students work on resolving these problems in PBL tutorials. In a PBL tutorial a small group of students (usually 5-8) work together on a problem. Often there is a tutor per group. Where this is not possible there is a roving tutor(s). The role of the tutor is not to give information or a mini-lecture on the problem but rather to facilitate the PBL process and students reasoning through the problem. Different students act as chairperson, scribe,

timekeeper and reader of the problem. Sometimes students decide to assign other additional roles, e.g. presentation editor.

Students brainstorm ideas for solving the problem, review the facts of the problem, name things they need to learn about and make an action plan. In practice, learning issues are handled in a variety of ways in different PBL initiatives. Some initiatives get all students to research all the learning issues. Other initiatives encourage students to divide out the learning issues to different group members. A middle stance is to get the group to divide the learning issues into major and minor learning issues. All students research the major learning issues and the minor ones are divided between the group members. Whichever approach is used it is important that students develop their information skills, which is discussed in chapter 17 of this handbook. There are different PBL tutorial models that act as a scaffold rather than a straightjacket for the process. The central part of the Barrows model (Barrows, 1989) following *setting the climate* and *defining the problem* is summarising the discussion of the PBL tutorial under the following headings.

Figure 5: Barrows PBL tutorial model

| Ideas/Hypotheses | Facts | Learning issues | Action Plan |
|------------------|-------|-----------------|-------------|
| | | | |

Students using this model may summarise their discussion under these headings on one shared learning environment, which may be a whiteboard or flipchart. In addition students will have a second shared learning environment for other work on the problem.

Another model for scaffolding the PBL process is the seven jump approach

Figure 6: Seven jump approach

1. Clarify unknown terms and concepts in the problem description
2. Define the problem: that is list the phenomena to be explained
3. Analyse the problem: “brainstorm”: try to produce as many different explanations for the phenomenon as you can. Use prior knowledge and common sense
4. Criticise the explanations proposed and try to produce a coherent description of the processes that, according to what you think, underlie the phenomena
5. Formulate learning issues for SDL[self-directed learning]
6. Fill in the gaps in your knowledge through self-study
7. Share your findings with your group and try to integrate the knowledge acquired into a comprehensive explanation of the phenomena. Check whether you know enough now.

(Schmidt and Moust, 2000: 23)

The following quotations reflect two PBL tutors’ perspectives on models for PBL tutorials

There has always been independent learning but PBL puts a process on it. It gets them to think how they think. There is a metacognitive level.

It’s a structure but you have a lot of freedom. It’s a light structure, scaffold

In PBL tutorials there is a move to more democratic social relations than a traditional committee meeting (Barrett, 2004a). PBL differs from individual research or project work as it is a question of “our knowledge and control,” rather than “my knowledge and control” (Barrett, 2004b). In a PBL tutorial, students co-elaborate and co-construct their knowledge together. Staff and students need induction, time and practice to adjust to their new roles.

The role of the tutor includes listening attentively, facilitating the learning process and asking stimulating questions appropriately. Schmidt and Moust (2000) highlight the importance of “cognitive congruence,” the tutor being able to express her or him self at the students level of understanding:

If a tutor is not able to frame his or her contribution in a language that is adapted to the level of understanding of the subject matter being studied, these contributions will go unnoticed. In addition, cognitive congruence assumes sensitivity of the tutor concerning the difficulties of students may come across while dealing with a problem or with subject matter relevant to that problem.

(Schmidt and Moust, 2000:43)

They argue that “social congruence,” an interest in students and their learning is required in tandem with cognitive congruence for effective PBL tutoring: Poikela (2005) has researched learning to work as a tutor and discusses how tutors view their role change. The following quotation from a tutor is a striking metaphor:

In earlier days, the teacher was sitting alone in a fully loaded boat almost sinking, and the poor teacher was trying to row with the last energy/he had. After PBL the tutor is sitting in a boat with a group and guiding while others are rowing and eagerly looking ahead.

(Poikela, 2005: 189)

A new website gives some very practical advice on ways to be an effective PBL tutor that includes the following:

Figure 7: Ways to be a great PBL facilitator

- Be interested and enthusiastic
- Forget lecturing
- Tolerate silence
- Get students talking to each other and not to you
- Make sure the group agree on learning issues before the group ends
- Promote the use of accurate current information resources as students research their learning issues
- Remember the learning outcomes of the case and course
- Establish a good learning environment for the group
- Be yourself

(Catchum PBL users guide www.catchum.utub.edu)

The following quotations show two PBL tutors’ perspectives on PBL tutorials:

They break into groups and work on the problem. I am not good at getting them to reflect. I am directive and not good at staying out and letting them be confused. I am absolutely fascinated by the way they are doing it. Yesterday one of the girls

produced a cardboard box with a face painted on it and said let's use this to get a handle on Mary, on whom the problem is based.

We are trying to get them to focus on the process. If we don't get them to develop their own systems and processes, ways of working, I think we are wasting our time. And I do think my thinking has changed because of PBL.

In Problem-based Learning academic staff are involved in curriculum design, writing problems, the facilitation of PBL tutorials, and in assessment of learning.

PBL compatible assessments

I agree with the assertion in the first chapter of this handbook that assessment drives learning. If you really want to see what a curriculum is about, look at the reality of its assessment system. I argue that it is important to design assessments that are not only aligned with learning outcomes but that are also compatible with the Problem-based Learning process. For helpful advice and an introduction to a range of appropriate and effective assessment methods see Section 4 of this handbook.

Philosophical principles underpinning Problem-based Learning

I agree that PBL is essentially a philosophical position in relation to knowledge in higher education, (Margeston, 1997) and with the assertion that there is “nothing as practical as a good theory.” (Lewin, 1943: 35) For these two reasons, I argue that it is essential to understand and develop philosophical principles which underpin PBL. This helps us to address the essential questions “What is learning in higher education?” “What is teaching in higher education?” “What is PBL?” “Why are we using PBL?” “What are my roles as an academic in PBL?” “What are the roles of students in PBL?” If you are too preoccupied with the spray of the wave, you fail to realise its underlying swell, which in the case of PBL is philosophies of PBL. These are challenging questions for members of a team starting a PBL initiative to ask themselves.

I argue that Margeston's primary contribution is his elaboration of a post-modern philosophy of PBL. Margeston (1997) highlights that PBL is not a mere superficial educational technique, but rather it is a deep philosophical position in relation to knowledge, understanding and education. His philosophical position underpinning PBL is:

A conception of knowledge, understanding and education profoundly different from the more usual conceptions underlying subject-based learning. The difference can be seen in the notion of expertise (Margeston, 1997: 37-38)

He develops this by discussing how subject-based expertise is expertise in terms of knowing a lot of content. This is propositional knowledge - *knowing that*. In contrast, expertise in a Problem-based Learning context presupposes propositional knowledge. It stresses the importance of *knowing how* to work with problems. He argues that Problem-based Learning “requires a much greater integration of knowing *that* with knowing *how*.” (Margeston, 1997: 38) Problem-based Learning, considered as a philosophical position, has huge implications for all stages of PBL implementation and for staff development, student induction and change management in particular.

I consider that Freirian philosophy (Freire, 1972; 1985) provides philosophical principles to underpin Problem-based Learning (Barrett, 2001). Freire's concepts of problematisation and dialogue are particularly relevant. Why should anyone learn anything? It is important to

problematise learning. Then the only way of working on resolving a problem is to learn more. From Freire's perspective the concept of dialogue is much more than a technique, it is an epistemological position that sees knowledge not as something static but rather something that is made and remade through dialogue:

What is dialogue in this way of knowing? Precisely this connection, this epistemological relationship, the object to be known in one place links the cognitive subjects leading them to reflect together on the object. Dialogue is the bringing together of the teacher and the student in the joint act of knowing and reknowing the object of study. Then instead of transferring the knowledge statically, as a fixed possession of the teacher, dialogue demands a dynamic proximation towards the object. (Shor and Freire, 1987: 100)

This dialogue is the means by which people together create and recreate acts of knowledge. Cognitivism, social constructivism and postmodernism provide theoretical foundations for understanding PBL. Cognitivism means that Problem-based Learning is an active mental process of accessing prior knowledge, making connections between old and new concepts and using the elaboration of relationships to engage in theory construction (Schmidt, 2004). In PBL the learners are constructing their knowledge together in PBL tutorials. PBL has a social constructivist view of learning. It sees learning as something that results from the learner's actions and the role of the PBL tutor is to enable and encourage learners to construct their knowledge together. A key point in the connection between PBL and postmodernism is that there is a fit between PBL and changing postmodern concepts of knowledge. I agree with Cowdroy's argument that to exploit the full potential of PBL it is vital that it is underpinned by post modern concepts of knowledge. On the other hand PBL underpinned by "modernist, structural thinking" is in danger of "slipping back into mediocrity" (Cowdroy 1994: 45). Cowdroy summarise the link between PBL and postmodern concepts of knowledge as follows:

Changes in professional practice and in technology and society alter the relevance of particular sets of knowledge. This state of change of relevance is the basis of Heidegger's concept of the changing meaning of "knowledge" which challenges Cartesian concepts of finite knowledge and thought. By adherence to the principle of relevance. Problem-based Learning accepts Heidegger's concept of indefinite knowledge and eschews the Cartesian certainty of thought and knowledge...

It is important to explore these philosophical principles underpinning PBL not only when starting a PBL initiative, but on an ongoing basis.

GETTING STARTED WITH PBL

When starting to design a PBL initiative it is very important to be aware of the research evidence about success factors in PBL implementation (Figure 8) and to plan with this awareness in mind.

In addition to gathering information about PBL generally and about PBL in a specific discipline, there is a range of effective strategies for starting a PBL initiative. These include attending PBL staff development workshops in your own institution or a major PBL university such as Maastricht or McMaster. Visiting a university that is implementing PBL and listening to the perspectives of academics and students can be very helpful. Working with an internal/external PBL consultant to design, implement and continuously evaluate a PBL initiative is another effective strategy. Framing the PBL initiative as a major action –research project or having a research project linked to the PBL initiative are ways of combining teaching and research.

Figure 8: Success factors for implementing PBL

Philosophical factors

- An understanding of the philosophical principles underpinning PBL
- A commitment to the philosophy of PBL (Little, 1997; Margeston, 1991; Barrett, 2001)

Design factors

- Comprehensive curriculum design (Conway and Little, 2000)
- Well designed problems (Gijselaers and Schmidt, 1990; Schmidt and Moust, 2000)
- Assessment compatible with PBL and the specific discipline/profession (Savin-Baden, 2004; Raine and Symons, 2005)
- Scheduled independent study time (Fincham and Schuler, 2001)

PBL tutoring factors

- Small group size (Wilkerson, 1996)
- A realistic acceptance of the role change (Little, 1997)
- Effective tutoring skills (Poikela, 2005)
- The ability to model process skills (Little, 1977)
- Frequent opportunities for students to gain feedback (Little, 1997)

Staff and student induction factors

- An acceptance of the importance of student induction to PBL and that students will take time to develop PBL process skills and may need to change their assumptions about learning (Little, 1997)
- Substantial appropriate staff development (Conway and Little, 2000; Murray and Savin-Baden, 2000; Richardson, 2005)

Management factors

- A pragmatic and realistic approach (Little, 1997)
- Institutional and management support (Little, 1997)
- A PBL co-ordinator and administrative support (McLoughlin, 2005)

CONCLUSION

My main argument is that PBL is best understood not as a mere learning and teaching technique but as a total education strategy underpinned by philosophical principles. Currently there are some interesting developments in Problem-based Learning including using technology to support Problem-based Learning, which is discussed in chapter 16 of this handbook, and the use of PBL in the workplace, a case study of which is presented in chapter 15. Dolmans et al (2005: 741), in a paper entitled “Problem-based Learning: future challenges for educational practice and research,” argues that the future challenges for educational practice and research include the need for:

Research that bridges theory and practice and extends knowledge about developing and improving PBL in everyday practice.

That is the rationale for the PBL chapters in this handbook.

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Online resources

Websites:

Catchum PBL users guide: This has some very practical advice for implementing PBL
www.catchum.utub.edu

Coventry website: Very good list of resources including: web resources, books, research papers, PBL consultants and PBL conferences
www.hss.coventry.ac.uk/pbl/

McMaster University, where PBL began
www-fhs.mcmaster.ca/mhsi/problem-.htm

Maricopa Community Colleges, Centre for Learning and Instruction
www.mcli.dist.maricopa.edu/pbl/info/htm

PBL Clearinghouse
www.mis4.udel.edu/PBL/Index.jsp

Republic Polytechnic Singapore
All the institution uses PBL. They have developed the 1 day 1 problem process
<http://discovery.rp.edu.sg/home/ced>

University of Adelaide's Advisory Centre for University Education: hosts the 'Leap into PBL' website. This is a very informative site and is a good starting point for lecturers who are new to PBL and are considering implementing it. www.adelaide.edu.au/ltdu/leap

University of Delaware site on PBL: Comprehensive introduction to PBL with lots of sample problems
www.udel.edu/pbl/

University of Maastricht: A European Centre for PBL. Runs staff development workshops and producing a range of resources including videos
www.unimaas.nl/pbl/mission/mission001.htm

Discussion List:

[JISC PBL Mailing List](http://www.jiscmail.ac.uk/cgi-bin/wa.exe?SUBED1=pbl&A=1) New members can join by visiting the following website
<http://www.jiscmail.ac.uk/cgi-bin/wa.exe?SUBED1=pbl&A=1>