

# WHAT IS PROBLEM–BASED LEARNING?

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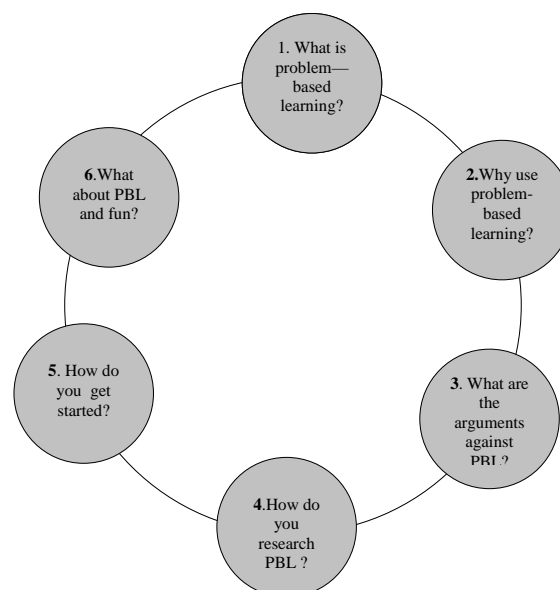
Problem–based learning has been the one of the most important recent developments in the university education of the professions (Boud and Feletti 1977). It started with medical education in North America and has spread across the globe and across most disciplines. Its potential to develop student learning has not been exploited in higher education (Savin-Baden 2000). Students report that problem–based learning is fun (The Irish Times 2002). So, what is problem–based learning?

This introduction to problem–based learning will give an overview of problem–based learning by answering some of the questions, which I am often asked when facilitating PBL staff development initiatives. It aims to encourage you to explore the idea of using or not using PBL in your teaching. It highlights areas of research you may be interested in considering.

I was course co-ordinator of the Postgraduate Diploma in Third Level Learning and Teaching at the Dublin Institute of Technology. This course was a problem–based learning course. The lecturers became problem–based learners for the year. I have worked as an education developer in a number of universities facilitating academics to plan and implement PBL initiatives. I have worked with staff across a range of disciplines including physics, computer science and speech and language therapy.

Based on my experience as a PBL curriculum designer, programme leader, tutor, education developer, consultant and researcher I will give a brief overview of some questions about PBL.

The following diagram gives you a visual overview of the structure of the chapter



**Fig. 1:** Questions about PBL that will be addressed in this chapter

## What is problem-based learning? and What is not problem-based learning?

Barrows defines it as follows:

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 and Tamblyn 1980:1 my emphasis)

An operational definition of problem-based learning is as follows:

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. The information sources they draw on include: library, databases, the web and resource people
4. They come back to the PBL tutorial (s) sharing information, peer teaching and working together on the problem
5. They present and discuss their solution to the problem
6. They review what they have learnt from working on the problem. All who participated in the process engage in self, peer and tutor review of the PBL process and each person's contribution to that process.

Problem-based learning is "**Problem**"....."**based**" ....."**learning**". Let us look at each of these words. A **problem** is something that is problematic to the student; something that cannot be resolved with the current level of knowledge and/or way of thinking about the issues. The nature of effective problems in problem-based learning is that they are ill-structured as opposed to well structured. The characteristics of PBL ill-structured problems are that they are real-life and authentic not teacher's exercises, messy not tidy, incomplete in the sense of lacking information needed for their resolution and iterative in the way that they produce further ideas,/hypotheses and learning issues (Barrows 1989; Stephen and Pyke 1977; Margeston 2001). It is vital that the problems are engaging, that they "smell real", are interesting and challenging to students. This engagement stimulates further learning and requires research, elaboration, further analysis and synthesis together with decisions and action plans.

The word "problem" in problem based learning needs to be interrogated. Problems are not always about something that is in difficulty that needs to be sorted out. An ill-structured design brief for an artist or an architect can be a problem. A dilemma for a doctor or a challenge for an engineer can be a problem. Problems are not always how to do something immediately practical in professional practice. Problems can also be about how to understand something. Problems can be presented to students in a variety of formats including: scenarios, puzzles, diagrams, dialogues, quotations, cartoons, e-mails, posters, poems, physical objects, and video-clips

One of the most important points about problems in problem-based learning is that it is not a question that first the students receive inputs of knowledge e.g. lectures, practicals, handouts etc. and then "apply" this knowledge to a problem they are presented with later in the learning process. This type of a situation is not problem-based learning it is problem solving (Savin-Baden 2000). It is like making a cake when you have already been given the recipe and all the ingredients. One of the defining characteristics of the use of problems in problem-based learning is that students are deliberately presented with the problem at the start of the learning process.

This is like getting the challenge of preparing a celebratory meal for a special occasion where no recipes or ingredients are given.

Margeston argues that the view of traditional higher education where “bodies of knowledge” have primacy over problems is flawed. He highlights the centrality of **problems** in knowledge acquisition. He asserts that:

1. Students need not only to acquire knowledge- that is the solution to problems- but also understand what the problems are that give rise to the knowledge in question:
2. Students need to gain knowledge, understanding, and experience of how knowledge is gained -essentially, that is the process through which problems are resolved:
3. Problems should be problematic for students, even though for many others (such as teachers, lecturers, researchers, and scholars) who will already have the knowledge constituting solutions to the problems these problems will no longer be problematic.
4. The process of learning itself must model crucial aspects of (1), (2), and (3): effectively, this means that students must pursue their study in a way which requires that they gain a realistic sense of why certain problems are or can be, seen as sufficiently important to justify inquiry into them, of how this enquiry proceeds, and of how to evaluate the knowledge gained through inquiry (Margeston 2001:9)

Starting with problems can be very motivating for students who may not see why they should be interested in inputs of bodies of knowledge but may become very engaged in researching these bodies of knowledge to address the learning issue they have identified themselves from working on the problem. Problem-based learning forces students to name what they need to learn to work on the problem. Some forms of lecturing in contrast have been referred to as the process of answering questions students never asked in the first place.



Fig. 2: I said that I taught him not that he had learned

Problem-based learning is problem-based **learning** not problem-based teaching. It fits into the learning paradigm not the teaching paradigm and is part of a set of student-centred approaches which are discussed in another chapter. A lecturer using a PBL approach is not concerned with what and how they are teaching. Rather they are observing, looking, listening, stimulating and provoking student learning. The learning of the students is their focus not the teaching of the teacher.

Problem-based learning is **based** on problems, which are discussed in **PBL tutorials**. The PBL tutorial is the pivotal discursive site for students working through problems. Research (Barrett 2004c) into the lived experience of students in PBL tutorials suggests that the PBL tutorial as a genre contrasts with traditional committee meetings in that PBL tutorials are more democratic, less hierarchical and having less social distance between participants.

PBL tutorials also contrast with individual research. Individual research was seen in terms of my knowledge and control, whereas the PBL tutorial was seen in terms of our knowledge and control. Two PBL students discuss this issue:

Philip: Well, my opinion on the idea of the PBL working in groups, if I was working independently I couldn't have been as creative as this group has been. And the number of ideas that were thrown around and developed by the group is very, very, I think it creates a whole new dynamic. Whereas if I work independently I am sure for everyone here, independently, they wouldn't have felt it was as creative a process or as interesting a process, I think.

Betty: I think what that question is more addressing is control as opposed to the standard. As an individual you have control over the start and finish of a product whereas you need to give this up as this is group knowledge and it's a group process, you don't have control over it, what the finished piece is. That is different, . . . (Barrett 2004a)

The nature of the dialogue in PBL tutorials is a process by which people together create and recreate knowledge as "true dialogue unites subjects together in the cognition of the object that mediates between them" (Freire 1985:49). Problem-based learning is an active 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). The PBL tutorial is the main discursive site for this elaboration. In PBL the learners are constructing their own knowledge together. PBL thus has a constructivist view of learning as "it suggests that learning results from a learner's actions and instruction plays a role only to the extent that it enables and fosters constructivist activities" (Gijsselaers 1966:13). Constructivism is explored further in the chapter on learning theories in this book.

Problem-based learning is **based** on the problem that is reasoned through in the PBL tutorial. However this does not mean that there are not other elements to the curricula, than the PBL tutorial where a team of students are working on a problem. The tutorial is the heart of the PBL around which other curriculum elements (practicals, information seeking skills workshops, etc.) are based and timetabled. It doesn't mean necessarily that there are no lectures in PBL curricula, but they usually take a different format. The fixed resource session is a popular format, which happens after the teams have been working on the problem for a while. Here if the resource person gives a presentation it is short. Most of the time is spent with students asking questions relevant to the problem they are working on and the general subject area with the resource person answering questions. All discuss the emerging issues. Some people use a wrap up lecture at the end of a series of problems to explore the links between different concepts. Research seminars on related topics are integrated into some curricula. Curricula where there is PBL and substantial traditional lectures are referred to as "hybrid".

Problem-based learning is not a mere technique or fashionable fad. It is a total approach to higher education. It involves designing a curriculum whose core is a set of problems. The PBL tutorial is the heart of the process where students and a tutor reason through a problem. Assessment drives learning and therefore it is vital to design assessments that will drive the desired learning, be compatible with the PBL process and match learning outcomes. If you are preoccupied with the spray of the wave you fail to realise its underlying swell, which in the case of PBL is the philosophy of problem-based learning. Discussing the philosophy of PBL encourages us to revisit what we mean by the concepts of "learning" and "teaching" in "higher education". It brings us back to basic questions like "What is PBL?", "Why are we using PBL?" It provokes us into reviewing the roles of lecturer, PBL tutor, student and librarian, where there is a focus on learning not teaching. There are many ways to explore the philosophy of PBL including reflecting on your practice as a PBL tutor, observing PBL in action in another institution and going to PBL conferences. Interrogating writings on the philosophy of PBL e.g. Margeston (2001), Barrett (2001) can help us to understand more deeply what problem-based learning is and is not. I would also assert that research is a key element in PBL. Curriculum designers and tutors can base their work on the evidence of research. Students can develop research skills through working on problems. Curricula can improve through local evaluation and national/international research

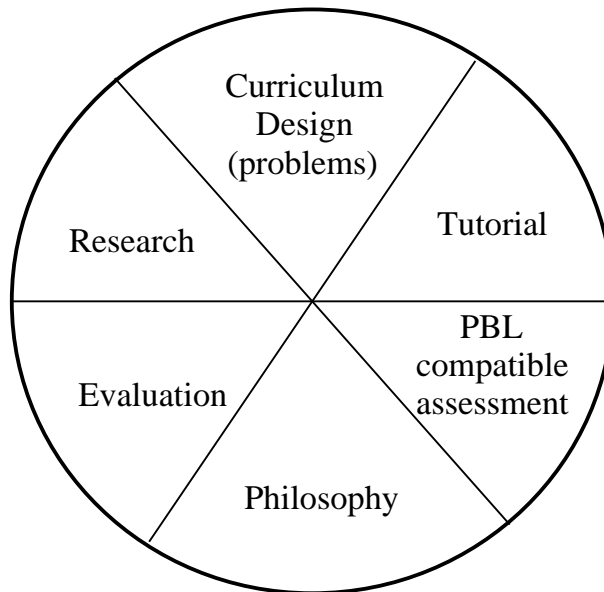


Fig. 3: Problem-based learning a total approach to learning: Turning the wheel of PBL

projects. Academics (and students!) can publish not only on specific research topics in their discipline but also on emerging issues of facilitating PBL in their discipline.

The following definition of PBL draws together the points about PBL in the most comprehensive definition of PBL I have come across:

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 commonly used systematic approach to resolving problems or meeting challenges that are encountered in life and career.

(Maricopa Community College, Center for Learning and Instruction  
<http://www.mcli.dist.maricopa.edu/pbl/info.html>)

However it would be a contradiction in terms not to treat problem-based learning itself as a problem. We all need to continually ask ourselves what is problem-based learning in our contexts, in relation to our students, our disciplines, our cultures, our philosophies and our creativity. Problems and PBL tutorials are essential characteristic of PBL so what are they like in practice?

The exploration of what problem-based learning is will continue by discussing what PBL is in practice. If problems are so important in PBL what does a PBL problem look like? Here is a sample problem This problem was used in a management of sales module in a masters course in marketing

### **The Job of My Dreams**

Mary had been feeling somewhat plateau-ed in her current job as National Accounts Manager in the Irish drinks industry. With an honours B.Sc. in Business Studies, Graduatship of the Marketing Institute of Ireland, and seven years sales experience rising to her present position, she is anxious to prove her worth and potential in next weeks final interview for the post of Marketing and Sales Manager in an existing successful business which intends to move in to the healthcare market.

Specifically the successful applicant is to be responsible for:

- The refinement and execution of the marketing and sales strategy

- The identification, appointment and management of a network of distribution partners for the preventative foot care line in Ireland
- Building, leading and motivating a marketing and sales team as the health care business grows.

(Laura Cuddihy Senior Lecturer, Dublin Institute of Technology)

To see examples of other PBL problems link to [www.udel.edu/pbl/problems](http://www.udel.edu/pbl/problems) One of the key roles for academics in PBL is writing high quality problems. Research has shown that the quality of problems affects the interest in the subject matter, the time spent in independent study and the functioning of the tutorial group (Schmidt and Moust 2000). Problem-writing and tutor facilitation are two important roles for academics in PBL curricula. So what does a PBL tutorial look like?

Problem based learning is the learning that takes place when a small group of students (usually 5-8) work together in a PBL tutorial on a real life ill-structured problem. There is usually a student chairperson, scribe and reader of the problem. The role of the PBL tutor is not to teach or give information but rather to facilitate students reasoning through the problem. If the students are using Barrows's model (1989) they may have two shared whiteboards in the room. On one whiteboard they will record a summary of their discussion under the following headings:

Ideas/ Hypotheses	Facts	Learning issues	Action Plan

Fig. 4: The shared learning environment of the whiteboard in problem-based learning

Students use another whiteboard/flipchart to record other work on the problem e.g. diagrams or flowcharts. Having given an overview of what problem-based learning is the next issue to explore is the rationale for using problem-based learning

### Why use problem-based learning?

Problem-based learning is introduced and continued for many reasons including:

1. Acquiring subject matter knowledge
2. Motivating students to learn
3. Helping student retention
4. Developing students thinking skills
5. Developing students key skills relevant to employment e.g. interpersonal communication skills, information seeking skills and presentation skills
6. Fostering professional competence and confidence together with professional identity
7. Mirroring the interdisciplinary team process graduates will be using in work and research
8. Facilitating students learning how to learn
9. Encouraging students to integrate knowledge from different subjects, disciplines and sources
10. Linking theory and practice
11. Having a sense of belonging and friendship

12. Having fun
13. Expressing in operational form a philosophy of learning that is student-centred and problem-focused
14. Responding to research evidence on the benefits of PBL
15. Increasing competitiveness in the higher education market
16. Producing graduates that can hit the floor running at work after graduation

These are some of the positive reasons for using PBL but a balanced view must also look at the arguments against PBL.

### **What about the arguments against PBL?**

A meta-analysis of medical students in PBL curricula and traditional curricula (Norman and Schmidt 1993) indicates that the retention of knowledge over a long period was increased and the transfer of concepts into clinical situations was enhanced for the PBL students. In addition self-directed study skills improved for the PBL students. However in the same study traditional methods of education produced higher scores on knowledge of basic sciences than problem-based learning methods. So there are some things that PBL is more effective for and other things that traditional methods are more effective for.

Another argument against PBL is that it can be very difficult to change to PBL when some or most of the students and /or staff are products of didactic teaching methods (Walton and Mathews 1989). Trigger and Prosser (1996) compared approaches to teaching and conceptions of teaching in their 24 teachers of courses in first year chemistry and physics. They found that teachers who had a particular conception of teaching tended to adopt a commensurate approach to teaching. The teachers with a student centred and learning oriented conception of teaching tended to adopt a commensurate approach to teaching. So the argument is that if you want teachers to adopt a student-focused approach to teaching such as PBL, you need to ensure that they have a commensurate conception of teaching. If this is not already present a short staff development programme will not be sufficient, but substantial appropriate staff development is needed to work at this level of attitudes, not just at the level of hints and tips about PBL. Also an effective student induction programme needs to be designed to introduce students to PBL. For any school of a university changing to PBL is a major change management initiative. Jarvis et al. (2001:118) stresses that this is not to be underestimated:

Such an approach makes demands of the organisation of educational institutions and on curriculum planning. Within universities, colleges and schools for instance, authority must shift away from disciplines toward inter-disciplinary or multi-disciplinary groupings of staff. But curricula still need to be designed, and students' educational progression monitored. Structures (committees, working groups and the like) are necessary for this.

For problem-based learning to be successful you need some enthusiastic lecturers,, management support and an effective working group. Sometimes this can prove to be difficult and hard work. Having considered some of the arguments for and against PBL you can engage in your own research about PBL.

### **How do you research PBL?**

For getting introductory information about PBL generally and your discipline in particular, I would recommend three websites; [www.adelaide.edu.au/ltdu/leap](http://www.adelaide.edu.au/ltdu/leap), [www.udel.edu/pbl/](http://www.udel.edu/pbl/), and [www.hss.coventry.ac.uk/pbl/](http://www.hss.coventry.ac.uk/pbl/) . In terms of books I would suggest the following two for an

overview; Boud and Feletti (1977) *The Challenge of Problem-based Learning* and Savin-Baden (2003) *Facilitating Problem-based Learning: Illuminative perspectives*. If you are doing a search for research papers about specific aspects of PBL or about PBL in your discipline the following three databases PBL Clearinghouse, Academic Search Premier and Eric are among the many useful ones. An interesting collection of research papers on PBL can be found in Savin-Baden and Wilkie (2004) *Challenging Research into Problem-based Learning*. If you want to discuss PBL with others JISC PBL Mailing List<sup>1</sup> is useful.

When I was talking to Helen Fallon about her chapter I highlighted that two of the most useful resources I have found were other people and bibliographies of PBL. The people that really helped were other academics who are implementing and/or researching PBL, international contacts, PBL consultants, librarians, and PBL students who are refreshingly honest about their experiences of PBL. Getting information about PBL is part of the process of starting a PBL initiative. For further information see the chapter in this book entitled "Finding information for your teaching and research work in teaching and learning".

## How do you get started?

In addition to gathering information, strategies academics have found effective include attending staff development workshops in their own institution or at a major PBL university such as Maastricht or MacMaster, visiting a university that is implementing PBL in a particular discipline and working with an internal/external PBL consultant to plan, implement and evaluate a specific PBL initiative. When starting a PBL initiative it is very important to be aware of the success factors that are well documented in the literature and to make plans using this awareness.

Implementing PBL is introducing major curriculum change. Research indicates that the success factors in PBL include:

- An understanding of the philosophy of PBL
- A commitment to the philosophy of PBL
- High quality problems
- A major acceptance of the role change
- An ability to model process skills
- Assessment compatible with PBL
- Substantial appropriate staff development
- A pragmatic and realistic approach
- Institutional and management support

(Little in Boud and Feletti 1977; Murray and Savin-Baden 2000; Schmidt and Moust 2000).

Whether a PBL initiative is starting with one module or a whole course it is important to be mindful of these success factors. The opposite factors are barriers to implementing PBL. That sounds like a lot of work and it is in the first years. However there is fun in PBL too!

## What about PBL and fun?

As effective PBL problems are personally and socially engaging, PBL can be fun for students and tutors. The following is a quote about a PBL first year physics course at the Dublin Institute of Technology: "The students have already judged PBL: "It's not so boring. It's fun. It's easier to

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<sup>1</sup> <http://www.jiscmail.ac.uk/lists/pbl.html>



learn.” (The Irish Times 2002) Who said learning couldn’t be fun? Who said learning has to be always heavy?

I view PBL as “**hard fun**” (Papert 1996). I would argue that the fun in PBL is not a superficial or frivolous fun or a gimmicky by-product of doing PBL. Rather PBL is **fun because it is hard** as it presents students with a problem that they cannot solve with their current level of knowledge and/or way of thinking.

Play can be viewed, not as something separate from work and learning but as a media for both. Kane (2004) explains that play is about engagement and that the Indo-European root behind the old English *plegian* is found in Celtic, German, Slavic *dtegh* meaning to engage oneself. If PBL problems are well written to be engaging for students they will enjoy playing with them. I agree with Feyereabend (1999) about the importance of initial playful activity with ideas in moving towards understanding.

## Concluding comments

Some academics adopt PBL because it corresponds to their own philosophical and epistemological stances. For others, adopting PBL has meant a shift in their beliefs about how we learn. I would like to finish with a poem that a team of lecturers who became problem-based learners for a PBL staff development module wrote, which was part of a paper about lecturers as problem-based learners (Barrett 2004b). They are talking about how their thinking about learning has changed. Each student wrote one or more verses. There was great laughter, energy and fun when they did a team presentation of this poem. I hope you enjoy it!

### **I used to believe ... and then I learned some more**

I used to believe  
that I was the lead, and what the students need was to follow  
and then I learned some more.

I used to believe  
that my teaching style gave cause to smile  
and I enjoyed my delivery style  
and then I learned some more

I used to believe that students learned according to my notes  
would give me cause to gloat  
and then I learned some more.

I used to believe  
that students will always be bright and white  
and all would be enabled and not disabled  
and then I learned some more.

I used to believe  
that the knowledge learnt in college  
gave lifelong sources for my courses  
and then I learned some more

I used to believe with all my might and height [she is short]  
I could shelter students from the mess of real life  
and .then I learned some more.

I used to believe  
that I’d be beholden

to the curriculum of olden  
and then I learned some more

I used to believe  
that there were new learning and teaching methodology  
and they were a load of codology  
and then I learned some more.

I used to believe  
that talk of process  
was all hocus-pocus  
and then I learned some more.

I used to believe  
that their workload was vicious  
and that their assessment was not pernicious  
and then I learned some more.

I used to believe that education of the visceral should be peripheral  
and stirring emotion would cause commotion  
and then I learned some more.

I used to believe  
that the role of assessor was not an oppressor  
that lecturers grades need not to be explained  
and then I learned some more

I used to believe  
that you can start new courses  
with promises of resources  
and then I learned some more

I used to believe  
that Heads where there to fear  
I'd better watch out and steer well clear  
and then I learned some more.

Now we are going to ask for ear  
Its time we got everything out in the clear.

I argue that problem-based learning puts problems, challenges, creativity and fun into learning. It provokes us in to revisiting our conceptions of both learning and teaching in higher education. But what about you, what are the questions you are now asking about PBL? What are your learning issues, the questions you want to know more about?

## **Online resources**

### **Websites**

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

McMaster University where PBL began. <http://www-fhs.mcmaster.ca/mhsi/problem-.htm>

PBL Clearinghouse. <http://www.mis4.udel.edu/Pbl/index.jsp>

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

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

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

## Discussion List

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

## Databases (available on subscription in libraries)

Academic Services Premier. ERIC.

## Recommended Books

Boud, D. and G. Feletti (1977). *The Challenge of Problem-based learning*. London: Kogan Page.

Savin-Baden, M. (2003). *Facilitating Problem-based Learning: Illuminative perspectives*. Buckingham: Open University Press.

Savin-Baden, M. and K. Wilkie (2004). *Challenging Research into Problem-based learning*. Buckingham: Open University Press.

## Other References

Barrett, T. (2001). Philosophical Principles for Problem-based Learning: Freire's concepts of personal development and social empowerment. In L. P. and K. P. (Eds.), *The Power of Problem-based Learning. Refereed proceedings of the 3<sup>rd</sup> Asia Pacific Conference on PBL*, 9–12 December, Callaghan, Australia. PROBLARC.

Barrett, T. (2004a). My knowledge and my control versus Our knowledge and Our control: Lecturers as problem-based learners talking about the PBL tutorial. In *Problem-Based Learning 2004: A Quality experience?* 15–17 September The University of Salford.

Barrett, T. (2004b). Poetry and Fun; The Discourse of Learning in a PBL staff development module. In *Mapping the Landscape of Higher Education in Ireland. AISHE Inaugural Conference*. 2<sup>nd</sup> and 3<sup>rd</sup> September Trinity College Dublin.

Barrett, T. (2004c). Researching the dialogue of PBL tutorials: a critical discourse analysis approach. In M. Savin-Baden and K. Wilkie (Eds.), *Challenging Research into Problem-based learning*. Buckingham: Open University Press.

Barrows, H. (1989). *The Tutorial Process*. Springfield, Illinois: Southern Illinois University School of Medicine.

Barrows, H. and R. Tamblyn (1980). *Problem-based Learning: An Approach to Medical Education*. New York, NY: Springer Pub Co.

- Boud, D. and G. Feletti (1977). Changing-problem learning. Introduction to the Second Edition. In D. Boud and G. Feletti (Eds.), *The Challenge of Problem-based learning*. London: Kogan Page.
- Feyerabend, P. (1999). *The Conquest of Abundance: A tale of Abstraction versus the Richness of Being*. Chicago: The University of Chicago Press.
- Freire, P. (1985). *The Politics of Education*. London: MacMillan Publishers Ltd.
- Gijselaers, W. (1966). Connecting Problem-based Practices with Educational Theory. *New Directions for Teaching and Learning* (68 Winter), 13–21.
- Jarvis, P., J. Holford, and C. Griffin (2001). *The Theory and Practice of Learning*. London: Kogan Page.
- Kane, P. (2004). *The Play Ethic : A Manifesto for a Different Way of Living*. London: Macmillan.
- Margeston, D. (2001, 29 September). Can all education be problem-based: can it afford not to be? Problem-based Learning Forum, Hong Kong Centre for Problem-Based Learning.
- Murray, I. and M. Savin-Baden (2000). Staff Development in Problem-based learning. *Teaching in Higher Education* 5(1), 107–126.
- Norman, G. and H. Schmidt (1993). Does problem-based learning work? A meta-analysis of evaluative research. *Academic Medicine* (68), 557–565.
- Papert, S. (1996). *The Connected Family : Bridging the digital generation gap*. Atlanta, Georgia: Longstreet Press.
- Savin-Baden, M. (2000). *Problem-based Learning in Higher Education: Untold Stories*. Buckingham: SRHE and Open University.
- Schmidt, H. (2004, 15-17 September). The Current State of Problem-based Learning. Problem-Based Learning 2004: A Quality experience? The University of Salford.
- Schmidt, H. and J. Moust (2000). Factors Affecting Small-Group Tutorial Learning : A Review of Research. In *Problem-based Learning : a Research Perspective on Learning Interactions*. London: Lawrence Erlbaum Associates Publishers.
- Stephen, W. and S. Pyke (1977). Designing Problem-based Learning Units. *Journal for the Education of the Gifted* 20(4), 380–400.
- The Irish Times (2002, April 23rd). Education and Living. 15.
- Trigger, K. and M. Prosser (1996). Congruence between intention and strategy in university science teachers' approaches to teaching. *Higher Education* 32, 77–87.
- Walton, H. and M. Mathews (1989). Essentials of problem-based learning. *Medical Education* 23, 542–558.