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Problem-based learning: Where are we now?

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Abstract

The definition of problem-based learning (PBL) as an educational concept is as elusive in 2008 as it has been since the concept was first expressed over forty years ago. A definitive guide to the practice of PBL is equally elusive. Like all worthwhile educational ideas, PBL has proved attractive to those teachers who seek improvements for their courses. Its appeal has transcended the traditional boundaries in formal education so that there are examples of PBL from primary to tertiary education, and across many disciplines within these. Dissemination, however, has wrought confusion in understanding and practice, and consequent difficulties for researchers in evaluating its efficacy, and lack of clear advice for those who would like to adopt PBL. Rather than attempting to be definitive, this Guide explores the various interpretations and practices that claim the label PBL, and critiques these against the original concept and practice. The primary aim is to provide insight into the causes of the confusion about PBL in 2008. The second aim is to point a feasible way forward so that, where appropriate, the potential of PBL as a whole-of-curriculum concept may be realised; and, where it is not possible to implement the whole concept, worthwhile educational principles that have been associated more or less with PBL may be recognised as such and given value in their own right.

Introduction

It is generally accepted that the first fully-fledged PBL curriculum was introduced by the Faculty of Medicine at McMaster University in 1968, and codified in 'The McMaster Philosophy' in 1974. In the almost 40 years since its initiation, many have attempted to explain exactly what 'PBL' means. Despite the efforts of Barrows (Neufeld & Barrows 1974; Barrows & Tamblyn 1980; Barrows 1984, 1985, 1986, 1988, 2000; Walton & Matthews 1989; Norman & Schmidt 1992; Schmidt 1993; Regehr & Norman 1996; Margetson 1997; 1999; Charlin et al. 1998; Harden & Davis 1998; Davis & Harden 1999; Maudsley 1999a; Dolmans et al. 2005) and many others to explain, clarify and justify PBL in theory and practice, a 'conceptual fog' continues to surround practice, and prevents the 'main messages for good practice' being heard (Maudsley 1999a).

In 2008, journal papers and conference presentations continue to propose a wide variety of interpretations of PBL (van Wyk & McLean 2007). The initial lack of evidence of the efficacy of PBL led to calls for it to be abandoned (Rothman 2000; Colliver 2000; Shanley 2007) although increasing evidence based on curriculum outcomes suggests some benefits from PBL (Koh et al. 2008). Some schools seek alternative approaches such as a return to the case method because of the 'afflictions' associated with PBL (Tärnvik 2007). Even New Mexico, one of the early champions of 'pure' PBL now describes its course as 'hybrid', and has recently introduced 'structured' tutorials (Espey et al. 2007). Harvard introduced a new curriculum in 2006 that has much more structured teaching, especially of basic sciences than the earlier, New Pathway 'hybrid' PBL curriculum (Harvard Medical School website (Harvard)). The pioneers of PBL, McMaster, have recently used a research-based approach to determine how to consolidate their PBL system in the light of student expectations (Cunningham et al. 2006)

Practice points

- PBL originated as a whole-curriculum concept.
- There are many variants of problem-based learning (PBL).
- The context has at least as much effect as the method in determining the success or otherwise of PBL.
- We explore the value of returning to the original focus of PBL.

In 1999, from an extensive review of the educational underpinnings of PBL in practice, Davis & Harden concluded that PBL is 'a continuum of approaches rather than one immutable process', and 'a teaching method that can be included in the teacher's tool-kit along with other teaching methods rather than used as the sole educational strategy' (Davis & Harden 1999). This definition is probably as close to the truth as any in defining what PBL is understood to be in 2008 except that, in the last 10 years, the continuing confusion and the associated lack of evidence threaten its extinction, especially in medical education.

Another review of existing definitions and existing research on which such definitions are based is no more likely to address the confusion than its predecessors. Until clarity about the meaning of PBL is achieved, further research, based on markedly different understandings of PBL, seems futile for

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guiding practice. To this end, this Guide takes a different approach.

We provide a conceptual guide based on a distinction between what PBL was intended to be, and what it is in 2008. We revisit the original conception of PBL and explore the features of its initial incarnation and the context for which the initial implementation was designed. Secondly, we critique the evolution of PBL and explore the influences and implications of the changes that have brought PBL to its current state.

There is no suggestion in our approach that the original conception of PBL is the only legitimate definition, or that others should conform to some orthodoxy of PBL. However, the way PBL was envisaged at its inception may throw light on the ways in which adapting it to different environments has led to confusion, and may facilitate a review of existing ideas and practices that exist in the name of PBL.

Finally, we propose a conception of PBL distilled from the critique which past and current research suggests is at least one plausible and effective way to understand and practise PBL in 2008.

What PBL was intended to be at its inception

It is generally accepted that PBL was developed by Barrows and first implemented at McMaster University in 1968 (Davis & Harden 1999). It was presented in full for the first time by Barrows & Tamblyn (1980).

The conception of PBL in medical education presented in the 1980 publication was a culmination of 15 years of research and development including implementation of the first PBL medical curriculum at McMaster. During those 15 years, epistemological underpinnings were developed for the concept, inspired arguably by the dominant educational theories of the time. As Norman (2001) admits, McMaster introduced the idea of the tutorial group into the concept of PBL because 'it was the 1960s'. Another theory or philosophy active and influential during the development of PBL at McMaster was Bruner's 'discovery learning' (as cited in Benor & Hobfoll 1984). The following statement from Neufeld & Barrows (1984) about the influence of Knowles (1988) on the development of PBL at McMaster illustrates the attraction to PBL of emerging educational ideas:

> Although the program was not self-consciously based on the andragogical model, its assumptions about adult learners and its strategies for facilitating learning are totally congruent with this model, and the faculty later discovered that they had also invented andragogy.

Other educational ideas that Barrows & Tamblyn (1980) use to support their approach are student-centredness and facilitation of learning, self-directed and lifelong learning, and research into clinical reasoning (Elstein et al. 1978).

In 1980, Barrows acknowledged that there was still 'much more work . . . to be done to enhance the value of problem-based learning, to evaluate its strengths and weaknesses, and to give faculty and students skills in its employment' (Barrows & Tamblyn 1980). In the next two decades, as PBL spread, emergent theories of student autonomy (Boud 1988), constructivism, elaboration of knowledge, integration, surface, strategic and deep learning (Newble & Entwistle 1986), formative and summative assessment, learning in context, teamwork (as explored by Eva (2002)), and others, came into the constellation of concepts or educational principles associated with PBL. Of major influence on the developing educational principles during this time were the cognitive learning theories honed at McMaster, Maastricht & Newcastle (especially Schmidt et al. and Dolmans at Maastricht; Norman, Regehr & Eva at McMaster, and Engel at Newcastle).

Barrows & Tamblyn (1980) eschewed the vocabulary of education, determined 'to avoid jargon' in their explanation of PBL. Over the years, however, the educational terminology that that Barrows did use to describe PBL was used inconsistently. For example, in his early publications, he used terms such as 'discovery' and 'andragogy' to explain self-directed learning (Barrows & Tamblyn 1980; Barrows 1984); he used 'problem-solving' to describe the objective of the tutorial process (Barrows 1984); and he called his version of PBL alternatively an 'approach' (Barrows & Tamblyn 1980), a 'method' (Barrows 1984), and a 'curriculum' (Barrows 1985).

Clarifying his conception of PBL was part of the motivation for continuing to publish. He was also motivated by his disquiet with the types of adaptations that resulted from rapid adoption and adaptation, 'species' that were called PBL but were not likely to achieve the objectives for which he established his 'specific' interpretation of problem-based learning (Barrows 1984). The following description of Barrows' conception of PBL is sourced from a review of his published explanations during this period. The review is comprehensive to avoid the tendency seen so often in the literature of PBL to use Barrows' ideas selectively, especially the concepts of adult learning and problem-solving. A careful examination of Barrows' explanations over time allows a refinement away from the alternative interpretations that have been attributed to his statements. As Hytten (2000, p. 454) finds with the use of Dewey's teachings, 'without careful and broad reading, it is easy to misunderstand . . . taking statements as claims out of context, and thereby altering . . . meanings and intentions'.

Barrows' PBL

In essence, there are three major objectives that Barrows stressed were to be addressed simultaneously in PBL (see text Box 1). Barrows set out distinctive features to achieve these three objectives in his 'PBL approach to medical education'. These are:

> It is a whole curriculum, not a teaching method that can be used alongside other methods (Barrows & Tamblyn 1980).

It is designed for a pre-clinical phase of a curriculum. The primary purpose of this PBL pre-clinical phase is to prepare students more effectively for clinical learning with patients. The aim is to ensure that students enter clinical apprenticeship

Box 1: Barrows' three objectives for PBL

- Students acquire an essential body of knowledge that is retrievable and usable in all domains that are required to effectively address clinical problems.
- Students develop the ability to use this knowledge effectively in the evaluation and care of patients' health problems; that is, they develop the cognitive skills appropriate to professional clinical reasoning.
- Students develop the ability to extend and improve knowledge to keep up to date and cope with new problems that may arise in their professional lives (self-directed learning skills).

as developed problem-based learners who no longer need a highly structured written problem nor the assistance of their fellow students and a PBL tutor. Instead, they will see every new clinical scenario as a chance to identify their knowledge/skill deficits, including deficits in reasoning skills, seek out resources to address these, and thus continue learning (Barrows 1984).

Barrows conceived the PBL approach as teaching medicine from the beginning of a course. That is, patient problems are designed to lead students to identify learning issues in all 'domains' of medicine – as appropriate to any particular problem; 'students must always consider the whole patient' (Barrows 1984). These might include; the underlying 'mechanics' of the body (biological science); the clinical aspects that need to be grasped in order to address the problem; the social and community aspects necessary for the doctor to deal adequately with the problem; and the personal and professional aspects that also need to be addressed in order to deal appropriately with the problem, including the doctor's feelings and any ethical issues. Not all problems necessarily involve all domains, but all problems require reasoning and application of learning to understanding and eventually, as students progress, to solving the problem. From the beginning of their study of medicine, students are encouraged to see patient problems as 'whole', requiring the acquisition of a diverse range of knowledge, skills and attributes.

The discussion and analysis of patient problems is the core of the PBL curriculum, the engine that drives learning, and the arena where cognitive skills that are the foundation of clinical reasoning are developed.

It involves the following steps:

Phase 1

- Students in a small group are presented with a clinical problem. Barrows (1984) stressed that the problem is encountered first before any specific study in the relevant areas occur (although students will have various degrees of prior learning in some areas). He also stressed that the problem is ill-structured and messy, reflecting the nature of problems in practice (PBLC 2000).
- They analyse the problem and clarify (define) significant aspects.
- They activate prior knowledge as they discuss what they already know that may explain the problem, and hypothesise from this about the underlying mechanisms that 'cause' the patient's problem (Barrows 1984).
- They synthesise their thinking at regular intervals to ensure that the analysis stays focussed, and refine their hypotheses.
- During this process, they identify what they need to find out to better understand the mechanisms and the problem: what they need to ask the patient, what they need to examine, possible tests, and study questions in relevant disciplines.
- They record significant aspects of the problem presentation, hypotheses about its cause, and areas requiring further study (learning objectives or issues or questions). Barrows (1984) suggested a blackboard to focus attention and discussion.
- They negotiate the time they intend to spend on the second phase of the process (Barrows 1984).

Phase 2

- Each student follows up the learning objectives by identifying and accessing resources that will assist in answering the questions. Barrows (PBLI 2003) calls this self-directed study (clarifying personally meaningful learning issues, and identifying and accessing appropriate resources). Students could '. . . go to the anatomist, physiologist, biochemist and behaviourist' to arrange 'to meet at times convenient to their own schedules to have discussions and seminars on whatever the students want to learn in their problem-based study' (Barrows 1984). They may access several other sources of external information as well, such as records, electronic resources, journals, consultants and colleagues (Barrows 1988).

Phase 3

- Students return to the group and apply what they have learnt to the problem. They begin by reviewing the hypotheses from the first session, re-assess their understanding of the problem by applying new knowledge to the problem, and evaluate the worth of their efforts, including their reasoning skills, according to what they have learnt. Barrows (1984) stresses that students should not give each other 'mini-lectures'.
- Specific to the context of his curriculum, Barrows argued that, because his students faced examinations that did not use clinical contexts (the certifying examinations in North America), they needed to review the new knowledge in terms of separate 'sciences' and create 'lists, taxonomies and diagrams' (Barrows 1984).

Students work in a group of 5 to 8. As noted above, the small group idea was introduced to the conception of PBL at McMaster. Barrows described its dual roles as developing the 'security and authority (students) need to be responsible for their own learning', both for later phases of medical education and throughout life (Barrows & Tamblyn 1980, p.10). This includes the group members taking responsibility for the good functioning of the group.

Students are assisted in the tutorial discussions by tutors who monitor the quality of their thinking and application, and who guide the discussion towards a systematic approach by gentle questioning and prodding (Barrows 1984). Barrows (1988) stresses that the PBL tutor should not put students into

'a passive learning situation where the tutor determines what should be learned, to what depth and in what sequence'; instead, the tutor should function at the 'metacognitive level' where questioning gives students 'an awareness of what questions they should ask themselves'.

Tutors monitor student progress, undertake individual educational diagnosis (Barrows 1988) and encourage students to address any deficits (regular informal assessment). Formal assessment reflects the learning process and is incidental, designed to reassure faculty (Barrows 1984) rather than to grade students.

The context of the original concept of PBL

To genuinely understand Barrows' conception of PBL, it is important to note the context for which it was envisaged. A curriculum is designed for a particular context because 'educational contexts and circumstances inform particular meanings' (Schwandt 1998).

For whom?

To begin with, it was designed specifically for, and first implemented in, the North American style of undergraduate medical course. Professional education in North America traditionally takes place in graduate schools. At the time of the development of PBL, medicine was studied for four years in US graduate medical schools, entry to which was dependent on successful completion of a pre-medical degree. This requirement meant that students entering medical courses were graduates and had a reasonably common scientific preparation for medical studies.

Students were selected specifically for the PBL curriculum at Southern Illinois by the medical faculty who attempted, in the admissions process, to ensure that those admitted had the following 'skills': 'self-motivation, ability to cope with ambiguity, effective interpersonal skills, and self and peer assessment skills'. Such students were expected to be more able to respond well to the reasonably unstructured environment (PBLI 2003). Students at McMaster were also selected 'for their personal qualities and academic ability, potential in problem-solving ability and self-directed learning' (Ferrier et al. 1988).

For how many?

Barrows initially perceived PBL as being implemented with a relatively small cohort of students. Its expression in his alternative problem-based learning curriculum (PBLC) at Southern Illinois illustrates the conditions under which he expected 'his' PBL to work effectively. There were 30 students in each cohort. There were 5 to 6 students in each PBL group. Barrows (1988) maintained that a small group cannot function well beyond eight members. This allowed PBL tutors to know the individual learning needs of group members and to be able to make an 'educational diagnosis' and prepare an;educational prescription' for each student (Barrows & Tamblyn 1980). It also meant that interpersonal differences that might generate dysfunction in the tutorial process were more manageable for students themselves (Barrows 1988).

For how long?

Barrows (1984, 1985) insisted that his concept of PBL was meant for the curriculum in the 2 pre-clinical years, and not for the clinical years. It was intended to 'prepare students for their clinical years and their later clinical work where I expect them to apply these learning strategies . . . to their work with real patients' (Barrows 1984). Indeed, he stated that the small group tutorial process was not mandatory even for the whole of the pre-clinical curriculum (Barrows 1985).

> . . . perhaps in the second year, after the small groups have had experience and all students are more knowledgeable about basic science and skilled in their reasoning, the group process may no longer offer educational advantages. . . . Once the students have gained sufficient knowledge and skills about their patient problems, and their clinical reasoning is secure, as is their self-directed and self-evaluative process, they might profitably move to individual study. This would be consistent with their future tasks as physicians.

Taught by whom?

In the implementation of PBL (Problem-Based Learning Curriculum PBLC) at the University of Southern Illinois by Barrows himself, a small group of dedicated faculty served as designers of the curriculum and problems, as coordinators of units, and as PBL tutors. These same teachers were available as resources in their areas of expertise for students' self-study, and were supported by others as needed. It is clear in the description of the problem-based learning process above that Barrows did not expect teachers to avoid teaching or for students to teach themselves; expertise was available when students needed it to satisfy their learning needs during the second phase of PBL, that is, the self-study phase. This teaching is devised in response to students' learning needs at a particular point, to use as he or she feels fit (Barrows & Tamblyn 1980). In the PBLC (PBLC 2000), the same lectures were available to students in the PBL course as to students in the more traditional curriculum at the School of Medicine. However, for PBLC students, textbooks were not prescribed and laboratory sessions were not pre-scheduled. Resources included: faculty, libraries, computer information systems, computer laboratories, and staffed gross anatomy, histology, microbiology and pathology laboratories. Students were able to attend or to schedule a variety of additional activities including seminars, lectures and special laboratory sessions.

PBL tutors were drawn from this small group of dedicated faculty. Although Barrows did not specify the academic qualifications of PBL tutors, it may be assumed from the

medical school context for which he designed PBL that he intended tutors to be doctors.

This review indicates that the aim of the PBL pre-clinical curriculum conceived by Barrows was to prepare students entering medical education with specified qualities and qualifications for independent, more effective learning in the clinical years. It was designed as a 'whole' approach to education for a specific pre-clinical phase of the medical curriculum, with features that are interdependent and simultaneously achieve the three major objectives.

In summary, and mindful of Norman's (Norman 2001) admonition against 'quasi-religious dogma', we present this original conception of PBL not as orthodoxy but as a basis on which to examine the effects of some other contexts in order to facilitate conceptual clarity.

What PBL is in 2008

As all of the researchers cited at the beginning of this Guide have recognised, what PBL is in 2008 is a product of decades of adaptation and development in a variety of settings. The following analysis builds on the work of these researchers by drawing together the effects of adaptation that they have identified, and critiquing them against the original conception. We do not question the legitimacy of adaptation: educational ideas are not static nor are they the preserve of the few (Unruh and Alexander 1974; Rogers 1995). However, we are concerned with the angst arising from the confusion of ideas, and our aim is to highlight the sources of confusion surrounding PBL to which these adaptations have contributed.

The dissemination of PBL is extraordinary (Finucane et al. 1998; Albanese 2000) in the history of educational ideas in terms of the range of academic disciplines affected and in its transcendence of the primary-secondary-tertiary education divide. Research and experience in education shows that the dissemination and adoption of innovative educational ideas leads to differences of interpretation (Stenhouse 1975; Rogers 1995), and that these differences are inevitable. Rogers (1995) argues that new ideas are not simply disseminated (communicated directly to others) but are rather 'diffused', where there is always uncertainty as to whether mutual understanding is reached. In the communication of new ideas, the characteristics of the innovation itself, the quality of the communication channels, the timing of the introduction of the idea, and characteristics of the setting, including power structures, norms and values, presence of opinion leaders and change agents, decision-making structures and projected consequences of change affect both the way the new idea is understood and the way it is implemented (Rogers 1995).

An examination of four of these factors – norms, beliefs and values of PBL practitioners, the adoption of PBL in different settings, the costs of change to PBL, and implementation of PBL in different contexts–shows the extent of influences on the understanding and interpretation of PBL in any institution, and the source of much of the confusion.

The consequences of norms, beliefs and values

While there are clearly semantic difficulties causing confusion about PBL (Maudsley 1999a), it is useful to consider why individuals use different expressions and, more telling perhaps, why they 'hear' ideas differently (see Text Box 2).

Researchers in education propose that the 'essential values' (Walker 1989) of teachers are at the core of their assumptions about education and therefore reactions to curricular proposals, and that these exist at a fundamental, taken-for-granted level. They are '... built up from a wide variety of sources, including knowledge, images and experiences, and are necessarily somewhat idiosyncratic', 'carry personal meaning', and are relational – 'activated and potentially altered by specific contexts' (Entwistle et al. 2000). They are 'deep metaphors' that are not readily discernible by either teacher or researcher at the conscious level' (Corbett & Rossmann 1898). These tacit and generally unexplored 'metaphors' affect the way we 'hear' new ideas as well as the way we explain them to others.

Egan (1978) goes further: he draws attention to the deep-seated nature of some beliefs. At the most fundamental level, human beings, including teachers, hold beliefs concerning such issues as whether human nature is essentially 'good' or 'bad'; whether 'culture is within or without'; whether the 'centre of value' is 'body, soul or mind'; whether 'truth' is 'relative' or 'objective'. He calls such fundamental beliefs or values 'presuppositions'. He finds that teachers, like all human beings, are able to hold all beliefs, including these fundamental presuppositions separately, and, in combination with any or all elements of conceptions, individual and different combinations of beliefs and presuppositions are capable of being activated and potentially altered by specific contexts. However, in teachers' reactions to educational/curricular proposals, he Egan (1978) argues that teachers/academics are most likely to respond in a particular way because:

> ... underlying all the above presuppositions, or perhaps constituted by them, is a complex of presuppositions ... designed to produce people like its proposer.

In other words, in professional courses particularly, the primary source of the way in which individuals interpret educational ideas is their desire to produce an engineer, dentist, architect, or doctor like themselves or, given that we all recognise flaws in our own education, some idealised version of themselves.

Box 2: The consequences of norms, beliefs and values

- individuals will understand educational ideas such as PBL in different ways;
- appeals to a purely intellectual or rational analysis of educational ideas such as the PBL tutor role may or may not have an impact on some although it will have an impact on others depending on the stability of their world-view;
- different interpretations of ideas are natural and to be expected. They deserve respect even when we disagree with them.

There is an unfortunate tendency in the literature to perceive the views of faculty, teachers and students as faulty, and to 'blame' (Maudsley 1999a) them for less-than-satisfactory PBL curricular change. For example, in medical education, Dolmans et al. (2005) argue that:

> . . . the problems encountered in educational practice usually stem from poor implementation of PBL. In many cases the way in which PBL is implemented is not consistent with the current insights on learning.

Fisher (1991) argues that the reason for resistance to PBL in medical education is that:

> Some (faculty) cannot survive the loss of influence and prestige that can occur. Some have great difficulty with losing a conventional disciplinary badge as a source of professional identity.

Jason (2000) argues that '. . . much of what teachers do are expressions of who they are more than a response to evidence they have reviewed', and he judges his clinical teaching colleagues harshly for this. Van der Vleuten et al. (2000) express frustration at the intransigence of teachers:

> As teachers, we seem to have a different attitude. We do the things we do because that is the way we have been raised ourselves and that is the way it has been done for many years, even centuries.

While it is understandable that those who believe altruistically that their interpretation of PBL provides the best professional education, Egan (1978) reminds us that their beliefs are also products of their own values, including their views of what is educationally sound. Whether the values of some are ever able to be seen as more worthwhile than the values of others is a moot point, but their right to hold different views is not debatable.

If the views of these curriculum researchers are accepted, it appears that there are complex, interacting layers of values that affect the interpretation of curricula in schools but, crucial among these is the way of thinking about or conception of education which 'unavoidably, . . . affects practice' (Margetson 1999). The following brief exploration of the impact of the 'deep metaphors' of some of the individuals who contribute to the conception and practice of PBL serves to illustrate the futility of further attempts to find a definitive meaning for PBL, or, to paraphrase Simon (as cited in Maudsley (1999a), 'to cleanse the term rather than dispense with it'.

Beliefs and values of decision makers

The influence of the assumptions/beliefs/values about education held by those in positions of power on the nature of curriculum change has been reported in several medical schools (Abrahamson 1991; Schwartz 1991; Shue & Lacroix 1998). Buckley (1998) advises that would-be innovators identify the 'traditions, prejudices and power relationships' within institutions that might confound their efforts to bring about change. Bernier et al. (2000) describe the force of 'very respected faculty' and 'alumni' to proposed change to PBL. In these situations, compromises are not unexpected. A common result of resistance is compromise, even if this is 'unpalatable' to the innovators. As happened at Otago (Schwartz et al. 1994), where, instead of overall curriculum reform to PBL, individual departments separately introduced various degrees of PBL, a further conception develops to complicate the description, if not the definition of PBL.

While the decision-makers (such as faculty boards, Deans & Department leaders) can exert negative effects on the innovation (Schwartz 1991; Miflin et al. 1999), they can also be positive in the sense that, when the innovators themselves are in a position of power, resistance can promote 'care-ful' reflection (Margetson 1991). This can allow rational consideration in the face of what Albanese (2000) has called the 'religious fervour' of some PBL enthusiasts. Other positive influences of decision-makers have been identified by Bland et al. (2000a) in their comprehensive review of the curricular change process in American medical schools.

Beliefs and values of teachers

Values and beliefs about education are particularly honed when the proposed curricular change is perceived as 'radical' or 'revolutionary', as PBL often is (Kaufman & Holmes 1998). Interpretations based on beliefs and values are brought to a PBL curriculum by those who lead curriculum change, those who control curriculum change as well as teachers and students (Margetson 1991; Finucane et al. 1995; Kaufman & Holmes 1998; Jason 2000; Miflin & Price 2000; McCrorie 2001; Taylor 2004).

Leaders. While Bland et al. (2000b) emphasise the power of leadership to effect change in the sense of supporting the change, the educational ideas held dear by the leaders of change–the innovators–are arguably most influential in determining how PBL is interpreted in schools. Because the spirit and energy of change resides in the innovators, they have a powerful influence on the design and development of the curriculum. Three examples of the beliefs of the architects (leaders) of change at work in PBL curricula serve to illustrate their effect. Margetson (1999, p.364) found that, as a result of curriculum designers' beliefs about the foremost foundational place of science in medical curricula, the medical courses that he examined were 'semi-problem-based courses' as distinct from problem-based courses. Doig & Werner (2000) explain that the PBL curriculum at Michigan State was modified to a 'marriage of a traditional lecture -based curriculum and problem-based learning' on the basis of making basic science preparation a central goal.

At the other end of the spectrum ironically, Harvard's initial 'hybrid' PBL curriculum (Armstrong 1991) developed on the basis of the faculty's desire to make 'the idea that adult learners teach themselves' the 'first principle' of their curriculum. Similarly, Miflin & Price (2000) found that, in the medical course at the University of Queensland (UQ), the conception of self-directed learning in adult learners held as a central principle by the leaders of change meant that didactic teaching

was minimised in the PBL curriculum to the extent that students complained that they had to 'teach themselves medicine'. For example, demonstrators in anatomy labs were instructed not to answer students' questions.

Line teachers. Small-group learning facilitated by a 'PBL tutor' is almost universally common in those curricula claiming the PBL label. Not surprisingly, the views of PBL tutors have been widely recognised as vital influences on the way PBL is implemented (Creedy & Hand 1991; Schmidt et al. 1993; Dolmans & Schmidt 1994; Vernon 1995; Kaufman & Holmes 1996; De Grave et al. 1998; Miflin et al. 1999; Lloyd-Jones & Rushworth 2000; Lindberg & Greene 2001; Dolmans & Wolfhagen 2005), and training for PBL tutoring is considered mandatory for the implementation of a PBL curriculum (Bland et al. 2000b; Taylor 2001). Despite this, ensuring the quality of PBL tutoring has been an on-going issue. In their report on an international symposium, Walton & Matthews (1989) found that:

> ... the greatest problem, acknowledged by all schools, is the variation in quality of teachers. It is the link represented by the teacher's ability as a tutor that the strength or weakness of the PBL chain lies.... Many attempts at PBL fail because of inadequate tutorial skills... clinical teachers were reluctant to design problems; basic science teachers were not always capable as facilitators of clinically based problems.

The educational views of the 'troops' can have significant effects on the introduced curriculum, and can be more challenging because they are made at the 'micro-level' (Jason 2000). In general, different educational views are perceived as resistance rather than as legitimate alternatives to the prevailing view. Consequently, teachers' antagonistic views are attributed to emotion, illogical assumptions and myth (Margetson 1991; Jason 2000), and, as noted above, tend to be seen as flawed. In the change to a PBL approach, line-teachers, often without genuine consultation in the decision to change, are required to re-train in order to teach in an environment that is alien to all that they know and believe to be valuable in teaching in their subject areas (Ludvigsson 1999). It is no surprise that some of what they believe is 'good' teaching transfers to the new environment, producing PBL tutors who continue to talk too much and direct learning. Teachers who have provided conventional lecture series where their subject is presented systematically, particularly if they have taught in this way for the entirety of their professional careers, find the 'piece-meal' approach to the integrated PBL curriculum difficult to accept, and the 'characteristics required of the facilitator are often the antithesis of what conventional wisdom would regard as the attributes of a 'good' teacher' (Olmesdahl & Manning 1999). Stunkel (1999) sums up the feelings of lecturers in traditionally structured higher education to the changes sweeping their world:

> Sitting alone under a tree with a book is pedagogically unsound. Paying close attention for an hour to a professor informed about the subject is also a dead end... Interactive pedagogy reduces the professorial role to 'facilitation' and 'partnership' in the 'learning process'. The professor becomes a congenial traffic officer for the classroom or the computer network – as the cliché puts it, a 'guide on the side' rather than a 'sage on the stage' – while students supposedly learn from each other... The best of all worlds for interactive pedagogy is to eliminate the professor altogether, to let the students 'take control of their own learning'.

At the same time, even when approaches to PBL tutor training recognise the influence of teachers' beliefs and treat them as professionals (Wilkerson & Hundert 1991; Vernon 1995; Evans & Taylor 1996; Kaufman & Holmes 1996, 1998; Vernon & Hosokawa 1996; Rostas & Rolfe 1997; Olmesdahl & Manning 1999), research shows that the results in terms of changing teachers into effective PBL tutors, let alone changing their beliefs about teaching, are equivocal (Gilkison 2003; Lloyd-Jones & Hak 2004; Maudsley et al. 2007a, 2007b). The upshot is that compromises are made, and further ways of understanding PBL emerge. For example, in acknowledging the concerns of tutors about the 'non-directive' tutor role, Shields et al. (2007) 'trained' their tutors to be discussion leaders rather than facilitators, but continued to label their curriculum 'PBL'. In other PBL curricula, PBL tutors take the opposite view: they do not want to direct and are reluctant to intervene in the tutorial process because, like the leaders of change described above, they believe that students should be 'self-directed' (Kaufman & Holmes 1996; Miflin et al. 1999). It bears repeating that Barrows saw the PBL tutor's role as active rather than passive, but active in a different sense from traditional, knowledge-imparting teaching.

As in other elements of PBL, there has been no resolution and no consensus about the role of the PBL tutor. It may be simply that the different interpretations of PBL inspired by different environments legitimately require qualities in tutors that are different from one to the next. Again, anyone seeking to determine the appropriate role for tutors for a new PBL curriculum is sure to find the different views confusing, especially since the debate tends to be of the type that asserts supremacy of one view over the other (Berkson 1991; Neville 1999).

As noted above, Egan (1978) argues that reactions to curricular change are not a result of bloody-mindedness on the part of teachers. Instead, the variations in the ways in which teachers react are a factor of their fundamental belief that they are 'good' examples of their disciplines/professions and therefore desire to produce people like themselves. This may be a more plausible explanation for the passionate attachment to the types of education that made them what they are, and the sometimes hostile reaction to proposals for new ways of teaching (Margetson 1991; Abrahamson 1991; Bernier et al. 2000; Jason 2000).

Regardless of their motivations, however, it seems that teachers will practise PBL according to their own 'inner lights', subtly and sometimes not so subtly altering it, and adding to the confusion about what PBL is.

Beliefs and values of students

Like their teachers, students bring a variety of complex beliefs and values to the study of medicine. Bowles (2000, p. 223) advises that:

> Medical students, like patients, are human and constructed with all the interdependent complex dimensions that go with our species. Every learner is unique and brings to the learning process a special intellect and the emotional idiosyncrasies far too complicated to be well understood by the student, let alone the faculty member.

When selection policies for medical schools and associated class assignment policies mean that students from an extensive range of ages, academic backgrounds and life experiences are scheduled to learn together in a PBL group, the variety of beliefs in groups about problem-based learning process is multiplied. This affects the functioning of PBL groups internally (Miflin 2004a) and the reaction of teachers, especially tutors in the small group environment. Bowman & Hughes (2005) find that students as well as their tutors have emotional responses to small-group work.

Incongruence in the views of students and teachers further complicates the way in which any curriculum develops, and it has been shown to be particularly problematic in innovative curricula such as PBL (Kaufman & Holmes 1996; Miflin et al. 1999). It also complicates the definition of PBL, especially for those who aim to evaluate PBL.

Beliefs and values of researchers

The variety of interpretations of PBL in medical courses has been recognised as causing difficulties with evaluating PBL's efficacy (Barrows 1984; Berkson 1991; Albanese & Mitchell 1993; Vernon & Blake 1993; Maudsley 1999a; Dolmans et al. 2005), and to inconclusiveness in outcomes evaluation of PBL curricula (Finucane et al. 1998; Schmidt 1998; Koh et al. 2008; Watmough et al. 2006a, 2006b, 2006c, 2006d, 2006e). Some argue that the problem lies in inappropriate and inadequate evaluation methods such as random-controlled experimental approaches borrowed from biomedical research. For example, Norman & Schmidt (2000) and Dolmans (2003) argue for further development of cognitive theory and associated research methods that '... capture and measure precisely those (myriad) variables that the hard-core experimentalist seeks to randomise away'. Some (Campbell & Johnson 1999) argue for the benefits of qualitative research methods; others (Morrison 2003; Maudsley et al. 2007b; Norman 2008) argue for a combination of qualitative and quantitative methods.

While these proposals recognise some inadequacies in empirical research in education, they do lie firmly within the positivist paradigm which Pirrie (2000) argues dominates medical education research because it fits comfortably with the positivist culture and associated research paradigm of medicine itself. The theoretical assumptions of this paradigm have been described as, *inter alia*: that there is objective and dispassionate 'scientific truth'; that events have causes which are distinct and analytically separable from them; that observation and experiment are the appropriate methods for establishing the truth, and that theories derived from these methods are universal and the basis of law-like generalisations; that variables can be identified and defined and knowledge can be formalised; and that the relationships between variables can be expressed in mathematically precise ways in the development and testing of theoretical propositions (Candy 1991).

Some believe that this positivist approach to evaluation is at the core of the confusion surrounding PBL. Cribb & Bignold (1999) propose that medical education research needs to be more 'interpretative and reflexive'; '... we need research approaches which positively explore cultures and subjectivities as well as those which try to control for them'; and, '(While) interpretative research may not generate explanatory 'nuggets' of knowledge ... it can produce insights into the social world which are at least as crucial to informing change'. Leung (2002) encourages an ethnographic methodology. However, Jennings (cited in Candy 1991) points out that, because

> '... like the empirical sciences, the interpretive tradition seeks objectivity and value-free inquiry ... many interpretive studies are covert forms of positivism'.

Gordon (2005) reminds us that not everything that counts can be counted. As argued above, all views deserve respect whether we agree with them or not. The philosopher, Schumacher (1977), argues that we all need each other to be adequate to any task, which suggests that all methods and all of the values underlying them play a part in understanding the nature and effects of PBL, provided the particular nature of the 'PBL' being evaluated is clear.

Although it is often difficult to discern the exact criteria used in evaluations, evaluators regularly analyse results in terms of the first expression of PBL (usually citing Barrows) and/or from the original practice of PBL at McMaster, and find that their versions do not fulfil the promises of the original. As has been argued elsewhere (Miflin 2004b), 'while it is legitimate for a good educational idea to be adopted and changed to suit particular circumstances, it is not legitimate to judge the results of the idea in practice against the original criteria when these have not been maintained in the change'.

Studies that fail to take account of differences in interpretation – of different expressions of PBL – are guilty of comparing 'apples with oranges'. Even when care is taken to ensure external similarities (Albanese & Mitchell 1993; Vernon & Blake 1993; Colliver 2000; Koh et al. 2008), the influences on how PBL is understood in different curricula and the associated influence on the way it is practised in different schools caution against generalisation. This analysis suggests that external appearances hide multiple, complex and confounding factors in the practice of PBL in different contexts, which is why 'further research in PBL curricula will be fruitless until the confusion in thinking about PBL itself is addressed' (Miflin 2004b).

The effects on the interpretation of PBL of adopting meanings and practices from others

Different views diffuse within an institution and from one institution to another. Few individuals develop new educational ideas, especially in higher education where it is widely acknowledged that expertise in disciplines and associated research is more highly valued and more generously rewarded than teaching/education (Andresen 2000). In medical schools particularly, several commentators have identified the dominance of research over teaching in limiting the resources available to invest in teaching (Bligh & Parsell 1999; Papp & Aron 2000). Even fewer institutions have the willing manpower or other resources to spend on curriculum design and development *de novo*. As a result, those academics who do have the interest and drive to introduce innovative educational approaches often seek the assistance of those who have gone before. There has been little acknowledgement, at least in the research on PBL curricula reported in the literature, of the effects on the interpretation of PBL in the new school of relying on the advice and experience of other schools. Do we check where the school we 'borrow' acquired its understanding of PBL? Has the version of PBL in the source school been borrowed itself from another school? For example, some have found that, in trying to convert faculty to PBL, demonstration of the way it works in a small group in a 'working PBL group', such as the 'Goldfish Bowl' exercise employed as Newcastle for in-house tutor training (Rostas & Rolfe 1997) and at New Mexico for training for staff from other schools, is the most effective means of defining it for reluctant staff (Abrahamson 1991; Schwartz et al. 1994; Holmes & Kaufman 1994). However, what one observes as a PBL group at work in any school is dependent, as argued above, on the composition of cohorts, which is, in turn, dependent on admissions policies. Unless any differences in the constitution of cohorts within groups and between schools are recognised in considering what PBL is, confusion is likely. Abrahamson (1991) reported that teachers from his school returned from New Mexico with the view (which they aired widely) that PBL needs enthusiastic students and so would never work in their school (where students were in a traditional course).

One of the consequences of the promotion of the successes of PBL is that would-be innovators tend to adopt ideas and practices (Holmes & Kaufman 1994) perhaps without questioning the fidelity of the interpretation of PBL that they adopt. This is especially true when a degree of expertise in PBL through publication and promotion is awarded to successful early innovators, for example, those at McMaster, Maastricht, New Mexico & Newcastle. It seems, however, that in their enthusiasm to promote PBL in other places, the leaders of change can be excessive in their attempts to 'sell' the concepts (Norman & Schmidt 2000). Although generally well-intentioned, promoting successes leads to further dissemination of some interpretations of PBL rather than others. There is also a history of providing programs of instruction in PBL to others who aim to introduce PBL curricula (Abrahamson's experiences are an example). New Mexico's Programs in Problem Based Learning and for visiting scholars are provided under the auspices of the World Health Organization as a Collaborating Centre for the Dissemination of Community-Oriented, Problem-Based Education. Most Medical Schools with PBL curricula provide similar on-site programs (for example, the universities of Melbourne, Miami, Saskatchewan, McMaster, Maastricht, Flinders), and others provide outreach services for preparing teachers for PBL (for example, Maastricht, Liverpool, Flinders). Others sell their PBL curricula *in toto* to new schools (McCrorie 2001), and the interpretation of PBL on which the source curricula function. Once the adopting school introduces its own inevitable changes, PBL develops yet new personae.

When, as Maudsley (1999a, p. 178) suggests, PBL is borrowed for 'prestige' and 'subversion', compromise and dilution of concepts are inevitable. Another phenomenon of the huge interest in adopting PBL is the movement of personnel across schools. Institutions seek the services of experienced 'PBLers' in reforming curricula. In Australia, for example, staffs from the first 3 graduate-entry PBL medical schools (Flinders 1996; Sydney & Queensland 1997) have subsequently been appointed to lead and/or facilitate the design, development and implementation of PBL curricula in each of the new medical schools. This represents another mechanism by which a particular understanding of PBL theory and practice moves from one institution to another. The transferred version of PBL tends to become the 'norm' for the new institution, even with subsequent modifications required by different contexts (Lawson et al. 2004b).

The effects on the interpretation of PBL of the costs of curricular change

Many factors influence the extent to which change occurs, ranging from external imperatives from regulatory bodies, for instance the publication of 'Tomorrow's Doctors' in the United Kingdom (GMC 1993, 2003) to the very practical considerations of the availability of staff. Colliver (2000) believes that the promises made for PBL have not been kept to the extent that the expense it generates warrants. In response, Norman & Schmidt (2000) admit that PBL 'has been oversold by its advocates, promising enormous benefits and largely ignoring the associated resource costs'. Given the rapid dissemination of PBL however, it seems that the desire (or imperative) to innovate obscures the costs, resulting in inevitable compromises (adaptations).

Finucane et al. (1998) advise that 'the point where the costs of PBL and conventional curricula are the same is with an annual student intake of between 40 and 50'. Barrows had a cohort of 30 at Southern Illinois. While new medical schools have difficulty in restricting their numbers to these limits, older schools have rarely had the luxury of cohorts of this size. One of the compromises that occurs is that the PBL tutorial process is adapted to accommodate large group teaching. It is indicative of the extent of adaptation that has been required that Barrows (1988) felt obliged to provide guidance for schools of up to 100 students 'where sufficient numbers of well-prepared tutors to guide smaller groups are not available'.

Alternatively, while small groups are retained, the size of the groups is increased.

When traditional medical schools adopt PBL, existing structures such as recruitment of teaching staff, including PBL tutors, affect the nature of the PBL curriculum that is implemented. In Australia, in medical schools based on the British model of pre-clinical and clinical phases, basic science departments generally take responsibility for the teaching of the first three years. In some traditional schools undertaking change to PBL, science departments provide the bulk of staffing for PBL (Miflin 2004b). Given the didactic, large-group nature of traditional science teaching in most universities, the transition to PBL tutoring can be difficult for these teachers. Moreover, teachers in basic science departments are not always involved in decision-making for change either by choice or because of existing power structures in medical schools (Harden & Crosby 2000). A further complication is that clinicians are not as readily available for PBL tutoring because it inevitably takes them away from the clinic for more time than traditional clinical teaching. Holmes & Kaufman (1994) report that the initial determination to have non-expert tutors at Dalhousie was modified because of 'the need to fill the quota when some tutors would only work in their own discipline'. On top of this are the costs of providing tutor training, universally considered mandatory for PBL tutors (Todd 1991; Kaufman & Holmes 1996; Evans & Taylor 1996) for a large teaching force, and the efficacy of training and monitoring so many tutors. In combination, these factors mean that schools appoint PBL tutors with a variety of backgrounds, including tutors with neither science nor medical backgrounds (Gilkison 2003).

Despite a huge investment in teaching staff development for PBL in medical schools during the last twenty years, there is little evidence that the difficulties identified by Walton and Matthews in1989 have been effectively addressed (Holmes & Kaufman 1994; Kaufman & Holmes 1996; Virtanen et al. 1999; Lloyd-Jones & Rushworth 2000; Gilkison 2003). If the motivations of teachers explored here have any truth, there is little hope that there is a 'magic bullet' for tutor training. Even experienced PBL tutors are therefore unlikely to assist in parting 'the conceptual fog', and are probably more likely to contribute to it.

Recently, the costs of providing accommodation in lecture theatres for a cohort that has grown from 240 in 1997 to 400 in 2007 has forced the School of Medicine at The University of Queensland to change the way in which it delivers resource sessions to support student learning in the PBL curriculum. Face-to-face lectures are no longer viable so all basic science lectures are now delivered as electronic resources via the internet. Other Institutions, for example the University of Liverpool, have invested in very large (600 seats) lecture theatres, the lectures being supported, as in Queensland, by electronic resources.

Educational technology has also been reported as influencing the way in which the PBL tutorial process is practised. For example, Kerfoot et al. (2005) found that that access to the Internet via plasma screens in tutorial rooms changed the tutorial process. Does the use of technology such as this then become part of this school's definition of PBL?

Large schools (cohorts over 50) require exceptional resources and management skills to provide 'negotiated' times for problem discussion and negotiated times for students to meet with faculty, access labs, and speak with consultants,

Providing sufficient tutors is equally difficult, and one wonders if the decision to use 'expert' or 'non-expert' tutors, as well as the way expertise is defined variously, is really a matter of choice or a matter of necessity in large schools. The implications for the quality of tutoring and therefore the achievement of goals are widely recognised (Berkson 1991; Schmidt 1993; Gilkison 2003). The indication again is that dissemination of PBL has caused an obfuscation of the original view that PBL tutors are qualified professionals and that this quality is one of the interdependent parts constituting the 'whole' that is designed to achieve the interdependent objectives of the original PBL curriculum.

The effects on the interpretation of PBL of implementation in different contexts

From the beginning of its dissemination, PBL has been implemented in two distinct demographic contexts in undergraduate medical education. In the United States, where undergraduate medical education takes place in graduate medical schools, all students are graduates; in Canada, entry to medical school requires at least two years of post-secondary study. While admissions requirements vary from school to school, the requirements for the composition of previous studies ensure a degree of commonality in student preparation for medical studies across these countries, especially in terms of biological sciences. It may be assumed that the vast majority of students studying medicine in these countries in PBL curricula have the type of academic preparation similar to that which Barrows envisaged for 'his' PBL.

In other countries, PBL curricula are implemented with students directly from secondary school. For example, in Australia & New Zealand, the policy of the medical school accrediting body, the Australian Medical Council, ensures that there is approximately 50% graduate and 50% school leaver entry provisions across the two countries (Lawson et al. 2004a). The graduate entry schools require completion of a baccalaureate degree in any discipline, and success in the Graduate Australian Medical Schools Admissions Test (GAMSAT), which is designed, *inter alia*, to ensure a basic level of biological science knowledge. These graduate entry schools add another dimension to PBL because the aim of changing admissions policies, including interviewing all candidates, was to broaden the intake to medicine from heavily science-oriented school-leavers and/or graduates to candidates from a wider variety of social, academic and professional backgrounds. The Australian PBL pioneer, Newcastle, takes school-leavers and those who have completed at least one year of a tertiary degree. In continental Europe, the norm is school-leaver entry, for example the University of Maastricht. Graduate entry to medical school is fairly recent in the United Kingdom but there is a growing interest in diversity in the UK system (Howe et al. 2004).

The influences on curricula resulting from different demographics of cohorts are not always given sufficient attention in

studies of PBL curricula nor in evaluations of outcomes, and especially in judging PBL against its original premises. This contributes to the lack of evidence of efficacy and to the general confusion about PBL.

Even when selection policies and populations from which students are drawn are the same, there are differences in the way PBL evolves, as Howe et al. (2004) report for four new UK medical schools. Although cooperative planning and deliberate cross-fertilisation of ideas was a feature of the development of curricula in the inaugural three graduate entry PBL Australian schools mentioned above, their curricula have some remarkably different features (Sefton 1995)

Substantial confusion also arises from the use of the name PBL to describe extreme variations on the original concept in undergraduate medicine. A fairly common variation on PBL in older medical schools, especially those with school-leaver entry, is of the type where PBL is described as 'an adjunct to more traditional lecture and laboratory-based instruction' (Steele et al. 2000) or a combination of problem-based learning and information-based learning (Harden & Davis 1998). In one version of PBL reported in the literature, students are used as PBL tutors (Steele et al. 2000) because 'cases are designed primarily to reinforce and to supplement information presented in lectures and to provide students with opportunities to use their knowledge to solve clinical problems'.

The label PBL is also used to describe the learning approach adopted by individual subjects in a range of professional courses and in individual disciplines within medical courses. For example, it was 'adopted' by several subjects independently from the rest of the department in Biochemistry at UQ. The School of Dentistry at the University of California employs PBL in the singular subject 'Craniofacial Molecular Biology'. At least one source of this interpretation of PBL reported in the literature is lack of more general support for innovation, for example, the type of adaptation necessary at Otago (Schwartz 1991). Indeed, Charlin et al. (1998) argue that PBL is present in all educational environments, including single subjects, in which three core principles are in place.

Although Maudsley (1999a) finds these adaptations of PBL are particularly far-fetched: '. . . (they) do not use PBL at all', the innovators report their changes as PBL. The effect of this evolution is that PBL came to be understood in some schools as simply an alternative teaching method 'that can be included in the teacher's tool-kit along with other teaching methods' (Davis & Harden 1999). It bears repeating, however, that this is a legitimate interpretation of PBL according to the views and circumstances of those who have developed it. Again, the difficulty is that it adds another manifestation to PBL as a curricular concept.

That PBL has also been adopted in the clinical years of undergraduate medical courses is another indicator of the extent of change to the original conception that diffusion has effected. PBL in the clinical years tends to use the same structure as in the preclinical years, with small group, facilitated learning from patient problems (real or simulated) with local variations (compromises) dependent on resources and the degree of acceptance. As in manifestations of PBL in other arenas, there is no widely accepted version in the clinical years.

Reports in the literature suggest that the transfer has had mixed success. Rothman (2000) finds little sound evidence of PBL adding any value to the clinical curriculum. In their paediatrics course, Renko et al. (2002) report 'lack of participation, lack of interaction, lack of elaboration, lack of cohesion, lack of motivation and difficult personalities'; McParland (2004) reports that only one of the four objectives for introducing PBL into the psychiatry attachment were achieved; Ryan et al. (2004) reports that implementation of PBL in the clinical years presents particular challenges, including student and clinician resistance and Farmer (2001) reports that students do not want to continue with the PBL approach. Davis & Harden (1999) recommended Task-based Learning as a natural extension of PBL into the clinical years. On the other hand Medical Schools such as Manchester anf Liverpool find benefit from extending PBL across the clinical arena since it allows students to revisit and discuss basic concepts in a clinical setting (O'Neill et al. 2006).

PBL has also aroused interest and some practice in the postgraduate and continuing professional education spheres (Heale et al. 1988; Engel et al. 1992; Gagliardi 1998). Again, while it is legitimate to adapt educational ideas into different arenas, PBL was designed for a specific context, being the pre-clinical phase of the undergraduate medical curriculum. By all means, the educational principles that underpin PBL are worthwhile adopting; as noted above, confusion only arises when educational programs in contexts different from the original context are judged against the criteria that pertained to the original context.

Finally, PBL (or versions/adaptations of it) has been adopted by educators in a wide range of other professions and in primary and secondary schools. PBL is reported to be the curriculum model used in non-professional courses at Maastricht, that is, Arts and Culture courses. In 2000, Albanese reported that there were 30 individual disciplines registered with the Problem-Based Learning Assessment and Research Centre (PBLARC) at the University of Newcastle, Australia. The Illinois Mathematics and Science Academy (IMSA) and the Center for Problem-based Learning at the University of Southern Illinois serve the interests of primary and secondary schools implementing PBL.

In summary, PBL has evolved into a genus with many species during almost 40 years of dissemination and evolution. As noted above, there is widespread acknowledgement that, in 2007, almost any form of learning which incorporates at least one of the elements described by Barrows (1980) is legitimately dubbed PBL. Many of these species, however, have been found wanting in terms of the initial promise.

A conception of PBL for the 21st Century

Given the extensive variations of PBL that are grounded in different views of what is fundamentally important and what is practicable in education, attempts to 'rescue the term PBL' (Maudsley 1999a) by seeking agreement about 'ground rules' seem doomed to failure. As we have argued, educational

ideas are not owned by particular individuals or particular institutions. This also means that there is little clear evidence from research on which to advise others because different interpretations of PBL are the bases of research in different institutions, so the results are not readily generalisable. In critiquing existing interpretations, we have instead aimed to enhance critical awareness of the differences, and the sources of different interpretations, including different contexts. We highlighted the ways in which these differences have generated confusion for those seeking to adopt PBL and at least some of the causes of frustration for those who currently use PBL.

At the same time, there are certain features of PBL explored in this analysis of its origins and evolution that we believe are more likely than others to achieve the goals of modern professional education. We present them here for the 'care-ful' consideration of present and future practitioners of PBL. Where possible, we give examples from practice to illustrate ways in which the features can be incorporated in different contexts and remain true to the original intent. We do not reproduce existing practical guides to writing problem scenarios, the structure of the PBL process, and the like; there are several excellent examples of these already published, and these are referenced in the following.

PBL in 2008 – a proposal

The goals of medical education

There is general consensus that the aims and purposes of medical education, however this might be specifically defined in different medical schools, are to graduate medical professionals who are clinically competent. Barrows defined clinical competence as a combination of the knowledge, skills and attributes that underpin efficient, effective and humane dealings with patients. In the 21st century, efficiency, effectiveness and humaneness in dealing with patients requires and therefore automatically includes both effective, efficient and humane dealings with others who are essential to the competent care of patients, and regular and effective up-dating of knowledge and skills. PBL, conceived as follows, is at least one 'whole-of-curriculum' model that has the potential to achieve these three interrelated and interdependent goals.

Curriculum design

The review of the original conception of PBL shows that Barrows proposed and practised a carefully planned and highly structured curriculum, a feature that has been obfuscated with time.

Miflin (2004a) argues that a pivotal cause of movement away from this essential structured characteristic in subsequent adoption of PBL is widespread misconception about self-directed learning. Arguably, Barrows' inconsistent use of 'discovery' and 'self-directed learning' terminology, taken out of context, contributes to the misconception, but there are other factors. For example, Candy (1991) argues that the concept of self-directed learning has a strong emotional appeal for many teachers because it captures 'the spirit of the times', embodying 'the democratic ideal, the ideology of individualism, the concept of egalitarianism, the subjective or relativistic epistemology, the principles of humanism, and the construct of adulthood.' It therefore has emotional appeal and can inspire more liberal interpretations that confuse self-direction with self-directed learning. Boud (1988) argues that the effect of the faulty double-assumption that students are adults and that adult learners are self-directed is that self-directed learning in universities in general:

> . . . has come to mean independent of classes, independent of other students, or independent of faculty. Acceptance of any one or even all of these as essential would be missing the most important aspect of the whole process which is that the student becomes capable of self-directed study.

The misconception is also a product of the conflation of self-directed learning with adult learning and the notion of self-direction associated with adults (Miflin 2004c). Miflin and Price (2000) propose that these concepts should be clearly distinguished for teachers. Self-direction for lifelong learning is more appropriately conceived as a goal (one product) of a problem-based curriculum rather than the entire learning process by which it is achieved. In PBL, students 'direct' their own learning by identifying what they need to learn from 'problems'. When they are able to address their learning deficits effectively by accessing, *inter alia*, the expertise in content and in teaching that resides in the faculty and the profession, they become confident in their own decision-making about learning, and the final curricular goal of self-direction for lifelong learning is well on the way to being achieved.

Problems

The core of the PBL curriculum is patient problems, designed and written by faculty, and presented to students as staged scenarios. Davis & Harden (1999) provide a comprehensive overview of the nature of problems and their presentation, and present Dolmans et al's (1997) seven criteria for effective problem design. The Schools that provide training for PBL (for example, Harvard, New Mexico, Newcastle) also provide training in problem design and have printed materials available. They also provide a comprehensive discussion of the forms in which problems can be presented.

The two features of problems that deserve reiterating here are:

The problem comes first. The feature that distinguishes PBL from problem-solving, is that, as Barrows (1984, p. 22) says, 'the problem comes first'. Arguably, this feature of PBL causes students of all ages and backgrounds most angst as it is the antithesis of the traditional learning style encouraged in all education but especially in the natural sciences.

Barrows (PBLC 2000) also insists that problems for PBL must be those that are prevalent and important in practice. Classical diseases and disorders are not generally suitable as they 'rarely occur in reality' (Barrows & Tamblyn 1980), and are difficult for students to access and confirm in their

own experience, especially in the preclinical curriculum. Barrows (2000) says that, in reality, patient problems range from the 'complex' to the 'vague', 'undiagnosed' or 'simple'. Finally, Barrows emphasises the importance of early clinical contact.

An example of how these three principles of problem design are able to be applied faithfully and effectively without causing students undue distress students comes from the PBL curriculum at the University of Notre Dame Australia. One of the core resources provided by the Clinical Skills Domain to support student learning was scheduled visits to General Practitioners, approximately one per week from the third week of the course. By this means, students were able to experience that 'complex, vague, undiagnosed or simple' problems are the reality of general medical practice, giving them greater comfort with the problems they encountered in the classroom. As well, these GP sessions provided students with experience, if only as observers in the early part of the course, with the realities of dealing with patients across the spectrum that they had or would meet in classroom problems, such as children, the elderly, the reluctant, the aggressive, the upset, and the like. Students welcomed their GP visits and stated that these invigorated classroom-based problem-based learning. This was as true for the experienced health professionals in the cohort as it was for students fresh from a biological science degree.

Research elsewhere serves to confirm this as yet unpublished data. O'Neill et al. (2006) show that students are prepared to confirm, extend or disconfirm ideas on the basis of clinical experience.

Scenarios should encourage students to consider all aspects of the problem. Following from the previous point, problem scenarios should present patient problems as whole, and encourage students to consider and follow up with learning, as pertinent to any given problem, in aspects of basic biomedical sciences, psychosocial aspects of medicine, concepts connected with public health or epidemiology, clinical concepts and skills required to access and understand the problem, and professional and ethical issues. This is commonly referred to in the literature as horizontal integration but is a simple concept. It is relatively easy to identify resources in all domains relevant to a given problem. These support student learning and reinforce for students from the beginning of learning medicine the importance of acquiring and applying a range of knowledge, skills and attributes to both understand and evaluate clinical problems and to be able eventually to diagnose and manage them.

It is important to note that Barrows did not separate clinical learning from learning in the other domains. When students consider a problem, they naturally identify clinical learning issues/objectives such as how to take a good history, how to examine a knee, how to approach a child patient, and the like. These learning objectives are as intrinsic to discussion and further study in relation to problems as, for example, the anatomy of the knee. Sometimes, dis-integration occurs because clinical learning objectives, that arguably help students to see the purpose of all the other knowledge and keep them motivated, are treated as separate from the process, for example, as a separate syllabus in clinical skills laboratories. As Barrows intended and Margetson (1999) argues, the problems in PBL should encourage whole learning of medicine from the beginning of a course, even if this is at a 'rudimentary' level in the early stages of the curriculum, and not simply as 'convenient pegs' on which to hang knowledge acquisition in basic science in preparation for later use. He argues that this conception of PBL suffers from the same 'knowledge first, application later' feature of the traditional curriculum–and its consequences are that learning is no more effectively remembered than in the traditional curriculum.

The desire to address these consequences was a primary stimulus for Barrows' development of PBL. He observed that students to whom he had taught neuroscience in the preclinical course could not remember it when they came back to him for their neurology clerkship. He also noted research that supported his own experience with the inability of students in clerkships to think in any systematic way (Barrows & Tamblyn 1980), not only in terms of the application of science but also in synthesis of the other aspects of problems. While his initial thought was to ensure science was learnt in a clinical context, he makes it clear that the clinical context is much more than the application of science knowledge to a problem. The problem scenarios provide the 'engine' for learning across the spectrum of knowledge, skills and attributes required for clinical competence. As noted above, problem-based learning for him was not just a matter of learning discrete parcels of knowledge in a clinical context; it was learning all that was relevant to clinical practice in the clinical context of patient problems, including learning to think about the problem as a clinician. It is also important to note that, because Barrows intended PBL as pertaining to the pre-clinical curriculum only, he defined this thinking as

> 'the analytical or evaluative process aimed at determining the cause or nature of a patient problem (as contrasted to therapeutic processes concerned with management or treatment). It does not refer to arriving at a specific or refined 'diagnosis' or 'differential diagnosis' (Barrows & Tamblyn 1980).

The latter objectives are the province of the clinical years. It may be argued that the lack of enthusiasm that students' exhibit in tutorials in some instances reported in the literature is in part due to problems being presented as requiring a unidimensional understanding, that is, the mechanics of the body. As Margetson (1999) found, students were frustrated when they came into the course to learn medicine but were confined to learning basic science in the first year of the course, especially when the problems were designed as 'convenient pegs' for learning large amounts of science that were not always relevant to the problem at hand. The same difficulties arise when horizontal integration is taken to mean using problems as 'convenient pegs' on which to learn knowledge in any domain without encouraging students to synthesise knowledge from the different domains and apply all of it as relevant to the problem at hand. In Liverpool it has proved to be necessary to emphasise to the students that the knowledge gained in different domains should be applied to the problem in the case scenario (Maudsley 1999b).

Structure of the PBL curriculum

As for any curriculum, the sequencing of the content in a PBL curriculum is crucial, and more complex because all domains of knowledge require appropriate sequencing. Because all domains of knowledge, skills and attributes are introduced in the horizontally integrated way in the PBL curriculum, all domains also need to be vertically integrated, that is, they are presented for learning in all phases of the curriculum. An individual subject area (for instance anatomy) is taught in each year of the programme, including the clinical years, and examined at each diet of examinations, up to and including finals.

As Davis & Harden (1999) point out, problems need to be consistent with the stage of student learning. The difficulty of the scenario relative to what individuals in the PBL groups already know is important. A scenario that covers ground which is totally unfamiliar to the students is unlikely to be successful. If constructivist hypotheses are taken into account (Vygotsky 1978) then it will be necessary for the required concepts to be within the zone of proximal development of at least one of the group members. Conversely, a scenario that rehashes old ground is unlikely to have many benefits, unless something new is added. Since one of the roles of scenarios in problem-based learning is to help students construct their own cognitive knowledge structures (Dolmans et al. 2005; Loyens et al. 2006), it is important that the scenario is sufficiently accessible.

At the same time, the sequencing of problems should allow students to build upon their acquired knowledge in a structured and logical way; retracing their steps over areas they have previously poorly understood, and extending both the breadth and depth of their knowledge; and for the duration of the curriculum.

To be able to gauge the depth of learning required at any given time, students need guidance. Giving the students a list of intended learning outcomes is one way, but students will use cues such as any self-assessment questions (or formative examinations), previous students, and any reading list, to divine the learning outcomes (Lloyd-Jones & Hak 2004). Davis & Harden (1999) argue that 'external' support such as this is necessary for students lacking prior learning, and suggest that it come from the PBL tutor or a study guide.

Barrows & Tamblyn (1980) were unequivocal about the need for guidance to learning objectives. They insisted that students need a framework to ensure that learning objectives are appropriate for any given phase of the course. In following this principle, McMaster (MD Programme, McMaster University 1993) uses the *Vade-me-cum* series of booklets to all students at Orientation. These provide an overview of each Unit, the objectives, resources and assessment for the Unit, advice on 'troubleshooting' and feedback, and the place of the Unit in the overall structure of the course. This is especially important for students in the early stages of the curriculum so that they develop confidence in their own ability to define appropriate learning objectives and to provide parameters so that they do not overload themselves.

Indeed, Barrows, conscious of differences in the emphases in students' backgrounds (for example, major in anatomy versus a major in biochemistry), recommended, as noted above, that tutors design 'educational prescriptions' tailored to the needs of individual students. With support such as this, especially in the early stages (Dolmans & Schmidt 1994), students learn with confidence to assume personal responsibility for their own learning and therefore to be confidently self-directed in the sense of pursuing self-identified learning objectives (Miflin et al. 2000). Recent reseach suggests that students develop these attributes as quickly as possible to ensure optimal learning (Dolmans & Schmidt 2006; Verkoeijen et al. 2006).

Resources for learning

Just as problem scenarios need to be staged to accommodate the stage of learning, so too resources provided to support students in pursuing their learning objectives must be appropriate to the stage of learning as designed into the problem sequence. This requires careful planning on the part of faculty to ensure that resources are matched to the objectives of the problem. As described in all published material on PBL, resources may take many forms.

Different opinions about how resources should be delivered in a PBL curriculum were discussed above in the section on teachers' beliefs and values. As noted there, some teachers consider that PBL curricula should be characterised by as few lectures as possible, in fidelity to the understanding of the concept of self-directed learning that prevails in their schools. Others (as shown for example in the revised PBL curricula at Harvard and New Mexico) believe that 'more structured teaching' is appropriate.

As noted above, Barrows expected students to be 'taught' by experts. What he eschewed was the concept of pre-planned lecture programs in the traditional sense where teachers decide what is to be learnt and when it is to be learnt, and without regard to what students are learning in other lecture programs in other disciplines at the same time.

It is interesting that, in developing PBL curricula, many schools tend to provide ample teacher-based resources for clinical and communications skills learning and yet, the learning of basic science and other domains (factual knowledge) is often devolved to students. There is an unidentified contradiction in criticising traditional lecture-based curricula for failing to promote student learning on the one hand but expecting students who learn in these types of courses to learn sufficient to guide their own learning in the PBL curriculum. It is especially important to provide up-to date information (not readily available in text-books) in the basic sciences given the rapid expansion of basic science knowledge, and the increasingly short time in which knowledge in biology becomes obsolescent or at least replaced by new understandings flowing from further research.

While access to all expertise is vital, access to 'contemporaneous' expertise in the basic sciences is crucial, given the exponential growth of knowledge in these areas (Barrows 1988). It is interesting in the light of the earlier discussion of the negative effects of misconception of self-directed learning on the interpretation of PBL that Norman (2000) perceives an overly liberal understanding of student-centredness vs.

teacher-centredness as one of the greatest difficulties for effective PBL. He especially criticises the proposition of constructivist interpretations that imply that students should discover basic science for themselves. He argues that, if basic sciences have a role in providing prior knowledge to facilitate understanding and learning of clinical knowledge, the role of the teachers of basic science is crucial.

It may be argued that it is not the mode of delivery (lectures) that cause 'curriculomegaly' in traditional courses but more the amount of content that is delivered in lectures, requiring more lecture time. The fundamental difference between lectures in the problem-based learning approach and lectures in the traditional curriculum is that students know why they are being given a lecture, and are keenly attuned to taking the best from it to address their current learning objectives. Those who design problem scenarios have a responsibility to design the resources including lectures they require to support the learning objectives that they expect students to generate during problem analysis; and a responsibility to brief lecturers carefully and to monitor lectures that are delivered.

There is no contradiction to the objective of having students take responsibility for their own learning; students remain self-directed in that they have to make sense of and apply what they hear in a lecture in terms of the problem on which they are working at any given time. One proviso is that lectures are not compulsory, so that students may attend if they need to according to the nature of their academic preparation. It may well be that a student with an advanced degree in anatomy would spend his/her time better in other areas of learning while his colleagues without specific anatomy need to attend a lecture on the structure of the knee.

Lectures have arguably another important role in a PBL curriculum: they provide structure and parameters for student learning from other resources at any given time. Without these parameters, students are arguably as likely to overload their own learning agenda as lecturers were in the past. They are also an efficient and, because students attend with specific learning objectives in mind, they are an effective resource mode for large cohorts. This can also ease the resource strain that adoption of PBL often entails, especially when lectures that provide parameters are supported by electronic resources gauged to different levels of student need.

The PBL process

Again, several worthwhile guides to the PBL process have been published in the last forty years. We will not repeat them here, but recommend critical consideration of the processes described by Barrows (above), Davis & Harden (1999), the Harvard and Maastricht guides reproduced by Davis & Harden (1999), and the Liverpool model (Maudsley 1999b); and the evaluative studies pertaining to these. As Davis & Harden (1999) note, different approaches have been devised in different medical schools. The cognitive elements common to all approaches are shown in Box 3. The main difference is in expression rather than substance, arguably to describe the process in terms that best suit local teachers.

Box 3: Cognitive elements of PBL

- The problem comes first; no specific preparation precedes it.
- Students activate and articulate existing knowledge as the starting point of discussion of possible causes.
- Students engage in systematic reasoning about the problem, including applying new learning.

Figure 1 (Miflin et al. 2000) provides a simple overview that emphasises that the essence of problem-based learning is a process of evaluation, learning and action that is familiar to experienced professionals. When deliberately taught through analysis of problems in the undergraduate preclinical curriculum, it is a learning process that, as Barrows says, students can and will use for further learning in the clinical curriculum, in vocational training, and in learning for the rest of their careers.

Group size

The type of individual 'educational prescriptions' that Barrows recommended for students are arguably more possible for tutors to devise and monitor when groups are small. As noted above, Barrows implemented his PBL curriculum at Southern Illinois with groups comprising 5 to 6 students. Based on the research evidence, Miflin (2004c) argues that genuinely small groups (up to 8 students) in the earliest stages of a PBL curriculum are crucial for good function and therefore the development of problem-based learning processes that support the achievement of sound knowledge, skills and attributes, including confident self-directed learning abilities and productive collaboration with others. The findings of more recent research concerning the provision or not of learning objectives (Dolmans & Schmidt 2006; Verkoeijen et al. 2006; Cunningham et al. 2006) as argued above, support this argument.

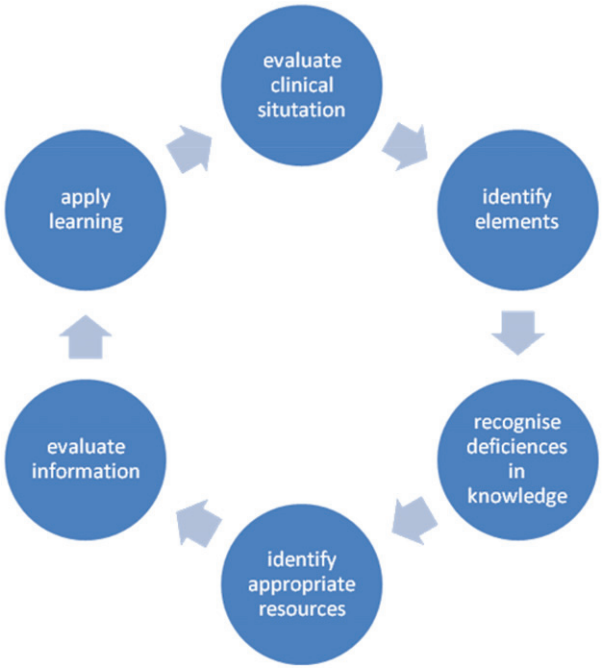

Figure 1. Overview of the PBL process (after Mitlin et al. 2000).

PBL tutors

When PBL is conceived as the 'convenient peg' model, it is logical to appoint tutors who are experts in the bodies of knowledge the learning of which is stimulated ('hangs on') the problem scenarios. Research shows that, in this conception of PBL, students learn better when their PBL tutors are experts. For example, when the problem is focussed on anatomy, the tutor is an anatomist; when the problem is focussed on a preventive medicine issue, the tutor is an epidemiologist. The alternative conception presented by Barrows is that problems are always whole in the sense of stimulating learning in many domains. The question arises as to the level of expertise that such subject matter experts have in the other areas of learning that should presumably be inspired by a patient problem. For example, how to take a history, the influence of social circumstances on the presentation and expected resolution of the problem, the difficulties with reluctant patients, and we could mention many more. Miflin et al. (1999, 2000) also identified the difficulties that arise in keeping students interested in the PBL process when it seems to them that they might just as easily be given the learning objectives as bother with 'going through the motions'. As Walton & Matthews (1989) found in consulting a wide range of PBL practitioners, non-clinicians have difficulty in facilitating the development of clinical reasoning skills – applying knowledge learnt to the clinical problem. One may assume that there are concurrent difficulties with ensuring that students make sense of learning in other non-science domains in the clinical context. Good facilitation, as well as requiring skills in group dynamics, prompting and challenging and holding one's tongue, also arguably requires skills in synthesis of separate bodies of knowledge and their application to the clinical problem. While it may be assumed that scientists are capable hypothetic-deductive reasoners and that they could therefore make good PBL tutors, their knowledge is generally and legitimately limited to their field of expertise. While the same limitations may apply to specialist clinicians, at least they have practised at a more generalist clinical level. Given that undergraduate medical education in total is designed to graduate generalist clinicians, perhaps generalists are appropriate PBL tutors, especially when PBL is conceived as belonging to the preclinical curriculum, and problems in this phase are conceived as preparing students for intensive clinical learning in clerkships.

The ideal individual, who has the required broad expertise in these areas, is the qualified medical practitioner, which is arguably why Barrows (as above) did not feel he had to define the qualification for PBL tutors. Although Barrows weighed into the debate about the qualities of tutors, it has been argued elsewhere (Miflin 2004b) that his concept of 'expert' vs. 'non-expert' PBL tutors refers to the differences between clinical disciplines; that is, 'a doctor who is a good facilitator is, regardless of his/her discipline (non-expert), a better PBL tutor in, for example a renal problem, than a doctor who is a renal physician (expert) but a poor facilitator'. Although an assumption, it is based on evidence from Barrows & Tamblyn's (1980) explanation of PBL. For example, they emphasise the tutor's role in facilitating the development of clinical reasoning skills, and defend the hypothetico-deductive reasoning model that they recommend for the PBL years in terms that experienced clinicians can understand, arguably so that they can understand the new role of PBL tutor. It is also based on the fact that the initial assumption at McMaster (Neville 1999) was that clinicians would constitute the PBL tutor workforce.

While full-time practising clinicians and academic clinicians may not be able to find the time to dedicate invariable numbers of hours each week to PBL tutoring in the preclinical curriculum, there are alternatives. For example, the School of Medicine at the University of Notre Dame Australia was able to recruit general practitioners with flexible hours as well as several clinicians who were intermitting from either vocational training or clinical practice for a variety of reasons, including having children. Recently retired clinicians also relished the chance to be involved. Not only were such recruits able to afford the time but they were also dedicated to this type of teaching only. It is important to note that, given the arguments above about the power of the existing beliefs and often unrecognised presuppositions of individuals, such clinicians also need initial training as well as continuing support and confirmation, that is, attention to preparation for the role as is provided by schools who use tutors from a variety of backgrounds. There has been no formal evaluation of the comparative effectiveness of this strategy as the medical course began only in 2005, and in a newly founded School of Medicine. However, anecdotally, these clinician-PBL tutors have shown an enthusiasm for the role that is infectious and unanimous which, in turn, has assisted further recruitment of their colleagues.

This analysis suggests that the first principle of PBL tutor training should be that the 'trainers' have a very clear understanding of the curriculum model in context, and are able to articulate and defend it clearly. Because teachers like their students are individuals, the second principle we recommend is that mass production models of PBL tutor training tend to imply that individuality and individual needs and beliefs are not important. 'Trainers' should work with individuals by monitoring their development in both the pre-service phase and when they begin teaching; and providing support at all times. Feedback should be individual and frequent rather than only evaluative. PBL tutor programs, such as those reported at Harvard (Wilkerson & Hundert 1991), Dalhousie (Kaufman & Holmes 1996), and Newcastle (Rostas & Rolfe 1997), provide ample time for teachers to interact with and reflect on their experiences, and a recommended as a starting point.

Space

Small, appropriately appointed rooms are essential for PBL groups to meet for the tutorial process. These rooms can also be used for the conduct of other small-group work such as communication skills. Other facilities will vary depending on the approach taken to providing resources and the size of the cohort. Most schools find that they need facilities for large group presentations (such as conventional lecture halls),

as well as dedicated facilities for clinical skills teaching. Students also need access to the growing number of electronic resources, which are often marshalled through a virtual learning environment.

Students

Again, as noted above, Barrows designed PBL for and McMaster implemented PBL with students who had completed a pre-medical degree mainly as conceived in North American universities. Students entering the PBL undergraduate medical curriculum in this setting had a sound background in basic science, albeit with different emphases for different individuals. It bears reiterating that Barrows and McMaster also required certain qualities in the students that were accepted into their programmes, namely 'self-motivation, ability to cope with ambiguity, effective interpersonal skills, and self and peer assessment skills'. Understanding this context may assist those who employ PBL in a different context to understand at least some of the difficulties experienced with student attitudes to the PBL approach.

Research has shown that student views of what is appropriate education differ with age and background, and these differences can have a powerful effect on the way a PBL curriculum is implemented and on its success or otherwise (Dolmans & Schmidt 1994; Bernstein et al. 1995; Walton 1997; Miflin et al. 1999; Dolmans et al. 2001, Norman 2001; Cunningham et al. 2006; Maudsley et al. 2007b). Several studies highlight the differences between the learning approaches of different age groups within the student body (Newble & Entwistle 1986; Feil et al. 1998; Aaron & Shakun 1999; Virtanen et al. 1999; Perry 1999), and the effects of differences on the way the small group functions in PBL (Miflin 2004c). Graduates behave differently (McCrorie 2001) which means that the way PBL is practised in a graduate entry school is likely to be different from the way it is practised in a school with school-leaver entry and practised differently over time as the composition of a cohort changes (Miflin et al. 2003). MacDonald (1991) at McMaster found that: 'In a school where students have at least gained an undergraduate degree, (the) process is easier to implement than in a school where learners are accepted from secondary school. In the latter situation, much more initial guidance will be necessary for students to acquire self-directed learning skills'.

On the other hand, Wilkinson et al. (2004) find that age more than a prior degree influences the way students approach study because age brings 'certainty and motivation about career choice'. Miflin et al. (2003) found that, as the composition of the cohort changes from a higher proportion of older, differently-qualified students to a higher proportion of students with a single, biological science degree, the character of the PBL curriculum changed in a negative way, especially in regard to effective group work and, in turn, effective problem-based learning.

Schmidt & Moust (2000) explain the use of a more structured PBL in Year 1 at Maastricht to cater for school-leavers who are 'less well-equipped with self-directed learning skills' than their graduate equivalents at McMaster.

From the discussion above about self-directed learning, we question the notion of lack of self-directed learning skills as the limiting factor in this adaptation. Miflin (2004c) points out that, even when students entering medical courses are mature and have some of the attributes of self-direction, they have not studied medicine before. For these students, the objective may be conceived as 'developing in persons who have not practised medicine before but who are committed to taking responsibility for their own learning, the wherewithal to do so, and to do so for the rest of their working lives'. The limiting factor with younger students, especially those with a comparatively narrow academic background, is that, in general, they have not had the experience of assuming responsibility for their own learning.

When these differences are acknowledged, it is eminently possible to use PBL as conceived by Barrows with both school-leavers and graduate students as well as with various definitions and combinations of these. The proviso is that students are perceived and treated as individuals with different learning needs; that these differences are conceived as a positive rather than a negative for collaborative learning; and that the needs of some do no override the needs of others. In this regard, Barrows' concept of individual 'educational prescriptions' recommends itself, as does limiting group size. As Miflin (2004c) points out, it seems more possible, although not automatic, to understand and meet the needs of individuals, all of whom regardless of entry requirements have different needs, and assist them to work effectively with each other in a group when the group comprises five or six students.

Whether school-leavers or graduates are the preferred candidates, it seems worth considering including more than academic achievement in the criteria for selection for medical schools in the 21st century. There is little doubt that, whatever type of medical course is offered, medical graduates will need the skills and the motivation to continue to self-direct learning throughout their careers. While Barrows believes that these skills and attributes can be learnt by problem-based learning as defined in this Guide, time is finite in a medical course, and medical education is expensive for both schools and students. It seems sensible to ensure, as far as this is possible, that students who are accepted already possess the types of attributes that will make them motivated and committed learners. As Miflin et al. (2003) found, while all students in their graduate entry course were more enthusiastic than students were in the traditional lecture-based course, not all graduate students bring the same level of commitment to learning nor do all graduate students adopt a mature, confident approach to their studies.

PBL in preclinical and clinical settings

When PBL is practised in this way in the preclinical curriculum, students enter the clinical years as fully-fledged problem-based learners who will use each clinical situation to follow the evaluation, action and application cycle. In this conception, there is no need for a structured PBL tutorial process to support problem-based learning as it continues in the

clinical years. It is important, however, to continue to support students' learning with resources. The major resource for students, as it has always been, is a clinical teacher who, like the PBL tutors before him/her, guides students to consider all aspects of patient problems and of other problems that they encounter in the clinical setting. Arguably, good clinical teachers have done this for time immemorial.

However, like PBL tutors before them, clinical teachers need to know about and students need to have access facilitated to the same types of external resources that provided support for learning in the preclinical years. This is particularly important because students will have gaps in some areas of knowledge and skills as a result of the horizontally integrated PBL preclinical curriculum. This specific characteristic of PBL is the basis on which in some schools (for example Liverpool and Manchester, have extended structured PBL facilitated by clinicians, into the clinical years). Resources may still need to include lectures. For example, McCrorie and Cushing (2000) recommends a variety of presentations from the resident clinical biochemist, the clinical pharmacologist, the pathologist, surgeons for anatomy, endocrinologists, and the like, as well as Grand Rounds and intercalated exercises. These types of resources are relevant to the clinical years whether structured, tutorial-based PBL is continued or not, and obviate the need for basic scientists to travel to teaching sites, although their contribution is welcome.

Rather than continuing PBL as such in the clinical years, some schools use the teaching experience of clinical teachers in a task-based, small group tutorial approach (see Harden & Davis 1998), and/or case-oriented learning based on cases seen on the wards and in clinics to support clinical teachers *in situ* in ensuring that students are reminded of gaps and remain acutely aware of the need to fill the deficits. Time should be available for these 'extra' resources because students entering clerkships from an integrated PBL preclinical curriculum have had more extensive preparation in clinical skills, clinical reasoning, population health and professionalism than students coming from a traditional preclinical curriculum. It should be noted that faculty have to plan the clinical years' resources as carefully as they do for the PBL years to ensure effective vertical integration. As well, the resources which are commonly available for clerkships need to be readily accessible to experienced problem-based learners.

Arguably, the case- and task-based approaches are those with which clinical academics have experience, a factor which can ameliorate the angst related to change to an entirely new way of teaching, especially for the voluntary teaching workforce. It also should mean savings on resources. It is important to remember that Barrows had never intended PBL to be used in the clinical years but, instead, it was intended to provide a good preparation for them.

Other professional education

Barrows recommended his 'curriculum' to other professional courses (Barrows 1988). For education in other health professions, the three core objectives to be achieved simultaneously might be expressed in the same terms as Barrows used for his approach to medical education. In other professions, these core objectives may be equally appropriate for simultaneous achievement. For example, they might be expressed as:

1. That students acquire an essential body of knowledge in all domains that are required to effectively address engineering (architectural, teaching) *tasks*, that is retrievable and usable.
2. That students develop the ability to use this knowledge effectively in the evaluation and execution of tasks (reasoning; problem analysis and resolution).
3. That students develop the ability to extend and improve knowledge to keep up to date and cope with new problems that may arise in their professional lives.

It is assumed that other health professional education would retain the concept of patient problems. Although we use the term 'task' for professions other than health professions, it should be noted that this suggestion differs intrinsically from the concept of task-based learning as proposed by Harden & Davis (1998). These authors define task-based learning in the sense of the real world of medical practice, for example, in junior doctor and perhaps continuing medical education. We use the term 'task' here in lieu of the term 'problem' simply to distinguish the essential nature of the work of different professions. The work of other professions is not always conceived as addressing problems although undoubtedly, education in these professions can present tasks as problems for the inherent motivation that the presentation of problems brings to the study of basic knowledge in the first years of curricula. It is to be remembered that PBL was designed for the pre-clinical years of a medical course in preparation for clinical apprenticeship. The same principle can be applied to other professional courses. In this pre-professional phase, engineers, dentists, architects, nurses as the case may be would be PBL tutors.

Conclusion

This review of PBL has shown that, while educational principles are legitimately unconstrained by contexts, curricular models are not independent of context. Context is an essential ingredient in both the inspiration for curriculum and its effective implementation because 'educational contexts and circumstances inform particular meanings' (Schwandt 1998), and PBL is a conception of curriculum designed for a specific context.

This may well mean that PBL as originally conceived may be impossible in some situations. At the same time, the educational principles underlying PBL are not limited to particular contexts. The caution from this analysis, however, is that those who adopt such principles, either in part or in total, are clear that they are using principles rather than PBL as a whole-of-curriculum concept designed for, and dependent for success on, a particular context.

We reiterate that the confusion that surrounds PBL is a natural and expected result of its wide dissemination, and confusion is more than likely to continue despite our best

efforts. However, we hope that we have managed to clarify the sources of confusion for readers, and that their enthusiasm for PBL is renewed and may eventually be rewarded.

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