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Problem-based learning (PBL): Getting the most out of your students – Their roles and responsibilities: AMEE Guide No. 84

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Abstract

This Guide discusses the considerable literature on the merits or shortcomings of Problem-based learning (PBL), and the factors that promote or inhibit it, when seen through the eyes of the student. It seems to be the case that PBL works best when students and faculty understand the various factors that influence learning and are aware of their roles; this Guide deals with each of the main issues in turn. One of the most important concepts to recognise is that students and Faculty share the responsibility for learning and there are several factors that can influence its success. They include student motivation for PBL and the various ways in which they respond to being immersed in the process. As faculty, we also need to consider the way in which the learning environment supports the students develop the habit of life-long learning, and the skills and attitudes that will help them become competent reflective practitioners. Each of these elements place responsibilities upon the student, but also upon the Faculty and learning community they are joining. Although all of the authors work in a European setting, where PBL is used extensively as a learning strategy in many medical schools, the lessons learned we suggest, apply more widely, and several of the important factors apply to any form of curriculum. This Guide follows on from a previous review in the AMEE Guides in Medical education series, which provided an overview of PBL and attempts to emphasise the key role that students have in mastering their subject through PBL. This should render the business of being a student a little less mystifying, and help faculty to see how they can help their students acquire the independence and mastery that they will need.

Introduction

Problem-based learning (PBL) is an approach to learning that is used to a greater or lesser degree in many medical schools worldwide. PBL is intended to enable students to work together in groups to learn about a subject in the context of a real problem.

Much research has been conducted into the rationale for the use of PBL within the medical student curriculum (Taylor & Miflin 2008). This Guide takes a different view: the perspective of the student. PBL encapsulates the beliefs that learning results from cognitive and social interactions in problem-centred environments (Greeno et al. 1996; Evensen & Hmelo 2000; Savery & Duffy 2001). Students are active partners in their learning, and not passive recipients. The involvement of students in PBL is paramount to achieving the objective of learning. It is their involvement in the process that will help them to learn from each other's experiences, sift, sort and refine ideas, consolidate what they know, and rehearse the arguments that will serve them well in the clinical environment and in passing the inevitable examinations (Taylor & Hamdy 2013).

The aim of this Guide is to describe student involvement within a PBL programme. This will be approached by briefly considering what PBL is (or should be), and then focussing on various aspects of student involvement: how the student feels during the process and how that can affect learning. We will also consider the way that PBL can help students develop as life-long learners, the way it can help them to cross into the clinical community of practice, and what the student needs to do to gain increased benefit from PBL. Finally, we will discuss what faculty needs to know, and do, concerning student involvement in PBL. By understanding the subtleties of student involvement in PBL, we hope to show how student learning can be improved and faculty time best utilised.

Practice points

- PBL is a learning process that requires students to be actively involved in collaborative group work
- PBL is an active and immersive process in which the students must take significant responsibility for their learning
- PBL helps students develop into competent reflective practitioners
- Learning has motivational and emotional components, and PBL groups can foster (or hinder) these depending on the skills of the facilitator
- The key to a successful outcome (achieving educational objectives) is for students and faculty to understand the process of learning and their role in it

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What is PBL and why use it?

There are several theoretical perspectives that are important in understanding adult learning and its application to PBL (Norman 2008; Taylor & Hamdy 2013). In terms of developing the argument within this Guide, we will follow a broadly constructivist approach to learning.

PBL is a method of small group collaborative learning that was first used in medical education at McMaster University in the late 1960s. The move to PBL from the traditional medical curriculum was triggered by concerns that students were disenchanted with their medical education and becoming overloaded with scientific information that did not seem applicable to clinical practice (Barrows & Tamblyn 1980).

In PBL, students in groups averaging eight in number are typically provided with a clinical scenario to work on. A facilitator is present to guide the seven step process (Schmidt 1983), but the facilitator focuses on the interaction and involvement of the students in the process of learning.

According to Schmidt, using clinical scenarios not only increases the intrinsic motivation of the student, but it also facilitates future knowledge retrieval, through encoding specificity, as future knowledge recall is enhanced when the situation in which it was learned resembles the context where it needs to be applied (the contextual dependency of learning) (Schmidt 1993). Wherever possible learning should not be separated from practice, and context of learning should be as authentic as possible (Taylor & Miflin 2008). Following this perspective instructional design focuses on perception and action rather than memory and retrieval.

Students are required to activate their prior knowledge about the constituents of the scenario and then identify knowledge gaps that need to be filled to understand/solve the clinical problems, enhancing their clinical reasoning strategies (Norman & Schmidt 1992). Our understanding of cognitive psychology means that we recognise that a key feature of memory is the way in which new information is linked into existing knowledge networks, and connections between concepts are made or strengthened. Hence, students are better able to construct new knowledge when it builds upon, or is linked to, what they already know (Vygotsky 1997).

Following the first PBL tutorial, the students use their own means and strategies to attain the knowledge required as identified by the PBL session, prior to the next PBL group meeting. In doing this, the student is learning how to become a self-directed learner. It is an important feature of PBL that adequate resources are available to the student and equally important that the student knows how to access them.

At the next PBL session, the group continue their collaboration elaborating on the information that they have learned. The collaboration through PBL is essential from both a socio-behavioural motivational and a cognitive perspective (Hmelo-Silver 2004; Schmidt et al. 2006a). Elaboration of the learning outcomes is a vital component of the PBL process, as elaboration promotes deep learning and subsequent knowledge retention (van Blankenstein et al. 2011), through utilisation of current knowledge while generating new ideas (Schmidt et al. 2011).

Box 1. Research-based conclusions that demonstrate the positive outcomes of problem-based learning.

- Students graduating from a PBL programme have similar factual knowledge but better clinical performance than those from traditional schools (Albanese & Mitchell 1993; Thomas 1997; Watmough et al. 2006b), although they may have less confidence in their knowledge (Watmough et al. 2010)
- The PBL process, and closer interaction between students and faculty is enjoyable (Vernon & Blake 1993; Vernon & Hosokawa 1996; Taylor & Miflin 2008)
- Students from PBL programmes show a greater tendency to use evidence-based medicine (Thomas 1997).
- PBL shows positive effects on physician competency, particularly in the social and cognitive domains, most notably with regards to cultural and ethical issues (Koh et al. 2008; Norman 2008).
- PBL graduates demonstrate an ability to work more efficiently (Schmidt et al. 2006b)

In addition to developing their knowledge and understanding of the subject matter, PBL teaches students to collaborate in a non-threatening way. This also helps the students cross the divide from being outside the learning community to being a member of their PBL group and its community of practice (Lave & Wenger 1991). In turn this appears to be an important preparation for work within the multi-disciplinary team as a doctor (Box 1).

As discussed so far, there are many factors in favour of a PBL course, but the ways in which the student engages with a learning strategy and how it makes the student feel are fundamental aspects of any curriculum design.

Why should a student study using problem-based learning?

Students going to medical school are starting on their professional journey towards becoming a doctor. With this in mind, many students apply for PBL programmes excited at the prospect of learning medical science in the context of clinical scenarios. There is little evidence in the literature about the motivating factors for students to apply to such medical schools, beyond the desire to have more independence and flexibility than they have been experiencing before entry to medical school (Way et al. 2000). In our experience, students only have a hazy idea of what PBL entails, even though most schools using PBL as a main element of their programme are very explicit about what it entails. We think that there are a number of possible reasons that students might opt for a PBL school: They might prefer the independence of study that is possible within a PBL school, they might have a distaste for didactic teaching, they might be attracted by early clinical contact (often a feature of PBL programmes), or they might simply have ended up in a PBL school because they were offered a place. At Liverpool our own, as yet unpublished, data suggest that around a quarter of students on the programme did not choose our institution on the basis of the instructional method. It seems important to accept that students are not equally motivated for the level of independent study called for by a PBL programme. Because of this facilitators need to pay close attention to the extent to which students develop the skills of learning independently and working in groups. Some

students may need rather more support and encouragement than is sometimes offered.

The effect of the PBL approach on the performance of graduating students has been fiercely debated, and will no doubt continue to be debated in the future. One expectation found in the literature is that students have more time to practice professional skills while still at university, and hence are better prepared for their role in professional practice than students graduating from a conventional curriculum (Santos-Gomez et al. 1990). Empirical evidence for these claims shows that PBL not only affects the typical PBL-related competencies in the interpersonal and cognitive domains but also the more general work-related skills such as the ability to work more efficiently (Schmidt et al. 2006b).

Several studies have shown that students from a PBL curriculum felt better prepared in interpersonal skills, such as communicating with patients, co-operating with other health professionals and managing patients with psychosocial problems (Busari et al. 1997; Peters et al. 2000; Antepohl et al. 2003; Watmough et al. 2006a). In addition to these findings, which were based on student self-reports, supervisors who were unaware of the educational background of their trainees characterised graduates from PBL-schools as better communicators with patients (Woodward & McAuley 1983).

In the cognitive domain, PBL-graduates are thought to be better problem solvers. In particular, Dolmans and Schmidt found several cognitive effects of PBL on student learning; increased retention of knowledge, enhancement of integration of basic science concepts into clinical problems, the development of self-directed learning skills and the enhancement of students' intrinsic interest in the subject matter (Dolmans & Schmidt 1996).

The fear that students score lower on basic sciences examination and view themselves as less well prepared in these subjects (Norman & Schmidt 1992) proved unfounded by more recent studies (Verhoeven et al. 1998; Prince et al. 2003), although in our experience there are many people who continue to quote the older study. More generally, work-related skills are studied in the transition from student to junior doctor. Compared with their non-PBL colleagues, the PBL graduates gave higher ratings for the connection between medical school and work, their medical training and preparation for practice (Prince et al. 2003; Watmough et al. 2010). Albanese and co-workers showed that compared with conventional curricula, PBL-students perform better on clinical examinations and faculty evaluations (Albanese 2000). Schmidt and Van der Molen (2001) showed that PBL-graduates considered themselves to have been better prepared than their non-PBL colleagues to run meetings and work independently. This increased confidence may stem from the relationship between emotion, learning and performance, which we discuss next.

How do students feel in PBL?

The relationship between learning and the way students feel

Feeling is a complicated concept, but it relates to the relationship between emotion, motivation and understanding.

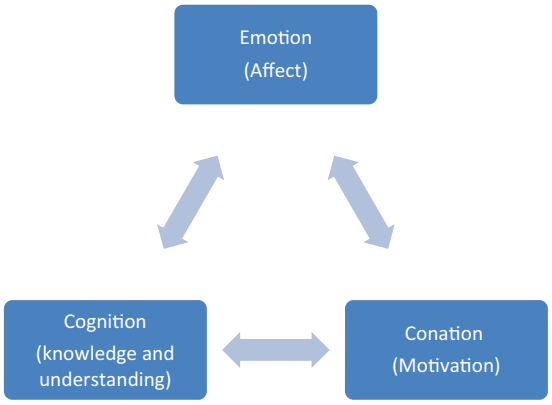

Figure 1. The association between emotion, conation and cognition (Hilgard 1980; Op 't Eynde & Turner 2006).

How the student feels is an important aspect when considering any educational practice. The association between feelings and thinking is well established, having been described over 300 years ago by Descartes (1649). Extensive research has been conducted, investigating the effect of emotion on cognitive and motivational processes. Investigations have included the effect of emotion on the storage, processing and retrieval of information learned, and particularly the influence on intrinsic and extrinsic motivation for learning. Emotion has been described as an integral component of the triad of Cognition (knowledge and understanding), Conation (motivations) and Affect (emotion), required for learning (Op 't Eynde & Turner 2006) (Figure 1).

Despite the complexity of individuals' emotions, the different types of emotions experienced by students can be divided into positive and negative emotions. These can be further classified into activating and deactivating emotions (Pekrun 1992; Pekrun et al. 2002). This helps us to recognise the effect of the four main categories of emotion upon learning. For example, boredom could be described as a negative deactivating affect, while anxiety could be regarded as a negative activating affect, as it may motivate the student to work and learn, while boredom may not (Figure 2).

As demonstrated in Figure 1 motivation (conation) is also important for learning, along with emotion (affect).

Motivation is the construct used to explain the direction, intensity and persistence of behaviour. There are many different factors that can influence a students' motivation to participate in the (collaborative) learning process. Several studies have shown that motivation starts with the basic needs for human functioning (Locke 1991; Ryan & Deci 2000; Pintrich 2003), consisting of the need for autonomy, i.e. the feeling to control one's own behaviour; the need for competence in the interactions with the environment and the need for relatedness, i.e. the feeling of belonging to a group (Baumeister & Leary 1995). A lack in any of these three basic needs will lead to a decrease in motivation, and other cognitive, affective and behavioural "indicators" of adaptive functioning (Pintrich 2003). Academic motivation has been shown to be an accurate predictor of school success and failure (Deci et al. 1991; Vallerand & Bissonette 1992; Pintrich 2003;

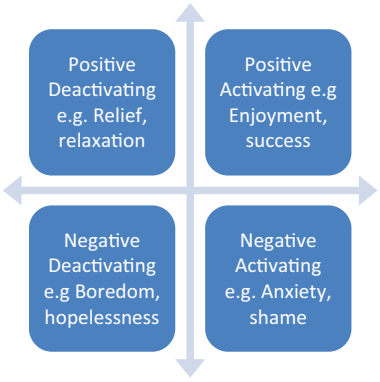

Figure 2. The different categories of academic emotions (Pekrun 1992; Pekrun et al. 2002).

Rienties et al. 2009), illustrating how emotion and academic motivation are required for learning.

It is important when considering the application of this to students to remember that

> 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. (Taylor & Miflin 2008)

Each student is unique, with a different personality. A person's personality can also be associated with their behaviour in a group setting. Isabel Briggs Myers and Katharine Briggs categorised personalities into 16 types but recognised that, depending on the circumstances, people can use all of the eight characteristics (Meyers, 1962). Hence, in an educational setting it may be important to cater towards the learning strengths and preferred environment for each student within the group (Jessee et al. 2006). This is particularly important when students are being expected to work together (Pittenger 1993) as different personality types are thought to have different strengths.

In addition to different personalities, individual students in PBL are believed to have different learning styles, and use different ways to process new information and internalise it. The cognitive, affective and physiological characteristics of a learner specify how that person perceives, interacts with and responds to the learning environment. Learning styles can be defined as:

> personal qualities that influence a student's ability to acquire information, to interact with peers and teachers. (Grasha 1996)

Several instruments have been developed to measure individual learning differences and those most commonly used include the Kolb Learning Styles Inventory (Kolb 1984) or the Entwistle learning styles inventory (Entwistle & Ramsden 1982). There is little published research directly relating learning styles to PBL. However, it seems very important that educators strive for a balance of instructional methods to meet students' learning needs, based on knowledge and understanding of the learning styles concept. Increasing students' self-awareness about learning styles leads to increased understanding of how to improve group function, a greater willingness to help others learn and an increased acceptance of others' learning styles (Hendry et al. 2005).

The way that students feel in PBL can be approached from two different perspectives; the individual students and their response to PBL, and the students' feelings within the PBL group.

The students' response to PBL

Starting at University is a stressful life-event (Dyson & Renk 2006). The work of Land et al. (2008) identifies this state of standing at the threshold of a new career/life, as a liminal state. The student is coming to terms with their new role in society, and is starting to try to understand the language of their new community, as well as access and incorporate a vast body of new knowledge. This is occurring at the same time as a shift from a heavily syllabus- and examination-focussed preparation period, to the much more open ended requirements of a medical degree.

As we mentioned at the beginning of this Guide, PBL is new to most students entering higher education. Collaboration, whereby students share responsibilities for learning, and are mutually dependent on each other and work towards a common goal through open interaction (van Boxtel et al. 2000) is a skill that needs to be learned. Although collaboration is fundamental to the learning theory and motivation for PBL, it can prove challenging.

In addition to this, despite a tutor being present to guide and facilitate the PBL process, the tutor is not present to impart the "correct" answers and learning objectives, which can be seen as frustrating for students, who may be most comfortable in a state of "dualism" (Perry, 1999), relying on the teacher to pronounce between right and wrong. In addition, the use of prior knowledge to direct the formulation of learning objectives may be a shock to the PBL novice, causing anxiety about missed learning objectives and subsequent knowledge gaps (Maudsley et al. 2008).

Not only is the method through which a student's learning is challenged on entering a PBL university course, but so too is the learning approach required of the students. After many years of frequent examinations required to attain a place at university, where a surface or strategic learning approach has often been required, students are now expected to develop deep learning strategies. The essence of PBL, using a scenario as the concrete experience, upon which to activate prior knowledge, reflect and identify learning needs aims to foster a deep approach to learning, defined here as a state in which the learner analyses new information and ideas and links these to previous knowledge, with the goal of long-term retention and understanding.

With time and perseverance, this method of self-directed learning (a process by which individuals take the initiative, with our without the assistance of others, in diagnosing their learning needs, formulating learning goals, identify human and material resources for learning, (Knowles 1975, p. 18)) can build confidence and promote realisation that the student does have a significant degree of prior knowledge. It is important that the students themselves and particularly the tutors are

attuned to the feelings of different members of the group. This enables a balance to be reached which facilitates the positive activating emotion resulting from the autonomy, intrinsic motivation and opportunity for self-regulation, (Sandars & Cleary 2011) while remembering that some students may be becoming frustrated and bored experiencing negative deactivating emotion, because they are not yet able to achieve this degree of self-regulation (Pekrun et al. 2002).

If the latter is the case, then these students can feel that their time is "wasted" by the PBL process – why attend a 2 h tutorial to "guess" the objectives, and then spend a further 4 h talking about what has been learned? The frustration that the tutor cannot provide the "correct answers" can be later compounded by the realisation that different students within the group have identified different answers. While initially the differing views can cause self-doubt and individual insecurity in knowledge, it is precisely this collaborative discourse in PBL that has been demonstrated to result in learning (van Meter & Stevens 2000).

For many, intrinsic motivation, which prompts elaboration and learning as an individual, is successful. However, it is also known that collaborating as a group to identify learning needs further improves this epistemic curiosity and subsequent learning outcomes, and, we would argue, helps students develop into their new community. For this to occur successfully students have to develop both individually and as a group (Khoo, 2003).

Perry describes the stages of intellectual development as a four stage process; dualism, multiplicity, relativism and commitment in relativism (Perry, 1999). Perry recognised that many learners enter higher education with an explicit understanding that there are right or wrong answers to any question, that knowledge is bounded by a syllabus, and that the educator's role is to ensure that the learner is taught the right answers. This is the stage described as "Dualism". Most educators, in contrast, realise that there is more knowledge "out there" than can reasonably be circumscribed by a syllabus. As most answers depend on the actual context, PBL facilitators see their role as being to help learners understand the material in front of them, and think through the consequences for themselves. This is a "commitment in relativism". The aim of University level education is to draw learners from the stage of dualism through to a commitment to relativism, and in an ideal world, helping them recognise that we are all co-creators of knowledge (Belenky et al. 1997). These different views of the educational process can cause tension, particularly in PBL or other student-centred programmes. As we discuss below, the stage of development of a student can be correlated to how they feel in PBL. A student in dualism may find PBL frustrating, as the tutor does not tell them the correct answer and peers express differing views on the same topic. A student that is moving towards multiplicity and relativism may be more comfortable discussing different ideas and questioning others. These students may also be able to apply their knowledge to different contexts.

This intellectual development does not occur at the same rate in each student, and part of the process and rationale for PBL is related to stimulating and challenging students to grow intellectually and question ideas. It must be remembered, however, that as identified by Kloss, even progress and development can bring concomitant feelings of uncertainty and unease for the student (Kloss, 1994), because they are leaving behind the learning style that brought them success in the past, and they see themselves as moving forward into a world of increasing responsibility and uncertainty.

The students' response to the PBL group process

Collaboration is one of the fundamental factors required for learning in PBL, yet it does not just occur if students find themselves in the same room (Roschelle & Teasley 1995; Johnson & Johnson 2002), so why would students collaborate as group members in the PBL process?

We have so far just focussed on the essential elements of collaborative learning: proposing that students need to have the same objectives and have feelings of interdependence among others. To fully understand why and how students interact within a group to gain knowledge in PBL, we first have to understand more about how team interaction (behaviour) leads to knowledge acquisition.

This question has been the focus of many studies (e.g. Roschelle 1992; Dillenbourg et al. 1996; Hinsz et al. 1997; Peterson et al. 2000; Visschers-Pleijers et al. 2006; Jeong & Chi 2007). There are two main components in the interaction process:

(1) *Construction and co-construction* of knowledge, where students discuss what they already know and suggest explanations for the ways in which new facts or understanding can be linked with what is already known *fellow team members are actively listening and trying to grasp the given explanation or build on this given explanation* (Bryant 1982; Stahl 1994; Webb et al. 1995; Barron 2000).

(2) Next, agreement or acceptance needs to be established on the proposed solutions and meanings, in which discussion, debate and *constructive cognitive conflict* is essential to reach further elaboration on the topic (Bryant 1982; Bruffee 1984; Clark & Schaeffer 1989; Traum & Dillenbourg 1998; Bossche et al. 2006).

Co-construction and constructive cognitive conflict are the team learning behaviours that will lead to knowledge acquisition. However, in addition to these processes, there are complex dynamics between group members and between groups within their environments (Forsyth 1983; Sheppard & Gilbert 1991; Argote et al. 2003; Dreu & Weingart 2003; Arrow et al. 2004; Harrington & Fine 2006; Larson 2009), as groups are complex social systems (Hackman 1992), in which beliefs, values, attitudes and motivation, influences the interaction process. In our, and others (Dolmans et al. 2001), experience there are students who dominate discussions, or who remain silent, who do not understand the factors which motivate, or demotivate their colleagues, and a strong facilitator is needed to ensure that students work together. The skill for the facilitator is in engaging with the students in a way that supports the ideal of student directed learning.

Many studies have emphasised the importance of attitudes and beliefs, and their effects on (collaborative) learning. Slavin

has mentioned for example that feelings of *social cohesion* stimulate group members to contribute actively to the interaction process (Slavin 1995, 1996) and as members of the group work together, and their individual emotional behaviours stabilise, group emotional convergence occurs (Kelly, 2008). Three emotion regulation processes have been identified that students use when collaborating with others; self-regulation, co-regulation and shared-regulation. Students use these processes to regulate the emotions of both the individuals within the group, and the group overall, as seen in Figure 1, emotion and motivation are both central to successful collaboration as a group (Järvelä et al. 2010).

One study has investigated the impact of one negative member of a PBL group upon the group's contagion, and demonstrated that one member cannot influence the emotion of the whole group (Bouhuijs et al. 1984).

As the group emotion develops, so too does the motivation of the group. According to the *situative perspective*, motivation emerges through the groups interaction in a social situation; yet the motivation of all separate members in a collaborative group cannot predict the engagement of the (total) group (Hickey 2003, Järvelä et al. 2010).

As mentioned before, Johnson and Johnson (2002; Johnson et al. 2007) posit (social) *interdependence* between group members as one of the most central aspects driving collaboration. *Psychological safety*, the shared belief that the team is safe for interpersonal risk-taking, is acknowledged to facilitate the interpersonal context for team learning behaviour which was found to be important among medical teams performing complex surgery for example (Edmondson 1999, 2003). Finally, *group potency*, "the collective belief of group members that the group can be effective", enhances group performance/effectiveness; in other words, groups that work well together have more successful outcomes (Bandura 1977; Stajkovic et al. 2009).

The social aspects of emotion, motivation, attitudes and beliefs and their impact on learning, show that PBL requires a lot of effort and insight into group dynamics from both the students and the tutors. In addition to this, time is an important factor for the development of group motivational, affective and team learning behaviours.

Group dynamic theorists have studied why and how groups change or develop over time. So far, many models of group development exist, based on studies using a wide variety of methods, such as reflections of observers and experiences, observation, survey research or through literature review (see (Smith 2001) for an overview). Although only one study has focussed on (PBL) groups learning in a team (Hommes et al. 2012b) there is a general consensus that (performance) groups develop and with the higher stage of development, groups perform better (Smith 2001; Wheelan et al. 2003; Arrow et al. 2004; Mathieu et al. 2008). Unfortunately, Wheelan et al. found that fewer groups achieved the optimum conditions than was hoped for (Wheelan & Lisk 2000; Wheelan et al. 2003).

So, what do students feel makes for effective learning? There is no easy answer to this question, besides the observation that every person is unique and will, therefore, differ in their response. Students' perceptions on what group dynamics were important within their groups were investigated by Mpofu et al. (1998) who found that students rated participation and communication as the most important aspects. To the best of our knowledge, there is a general lack of studies defining and researching group effectiveness in education (see Decuyper et al. 2010 for an overview). However, models do exist in organisational or marketing disciplines (see Salas et al. 2007 for an overview), emphasising not only the aforementioned attitudes and beliefs; but also time, communication and group processing which are other variables that increase group effectiveness.

What does the student need to do?

Following our summary on what happens in PBL groups and students' involvement, we will make some recommendations as to what students could or should do (Box 2)

First of all, students *need to understand why PBL is used* in order to apply this method of learning correctly. Many studies have shown that problems with PBL do occur on a regular basis (see (Dolmans et al. 1998) for an overview). The majority of these problems are related to difficulties in the process of collaborative learning. For example in PBL, students are supposed to follow a so-called seven jump procedure (Schmidt 1993). However, Schmidt and colleagues (Moust et al. 2005) identified that students were skipping the brainstorming and elaboration phases which resulted in a suboptimal structuring of their (prior) knowledge. In turn this led to less efficient information acquisition. The main reason for this behaviour was the failure of students to value the necessity of interaction and elaboration for construction of knowledge (Visschers-Pleijers et al. 2005).

Other authors also mention problems in students' social motivation; mainly feelings of anonymity and the occurrence of "free riding" or "social loafing" phenomena which in turn

Box 2. Steps to success, or at least survival, in PBL (after Bate & Taylor 2013).

There are four steps to success for a student in PBL
- *Understand why PBL is used*
- *Be aware of the group dynamics*
- *Learn how to collaborate with others*
- *Build social networks*

And there are twelve tips for survival
1. Try not to panic about PBL
2. Work with your PBL group
3. Ensure that the group activates prior knowledge before forming the learning objectives
4. Recognise that there is no syllabus per se
5. Work to an appropriate depth for you
6. Use PBL to help develop a learning approach that is best for you and study using different resources
7. Encourage equal participation from all group members and ask questions of each other
8. Respect differing viewpoints expressed by other members of the group
9. Ensure that all curriculum themes (e.g. anatomy, physiology, pathology, public health, psychology and ethics) identified by the scenario are studied and applied
10. Do not use notes during the PBL sessions, but do use the board/flipchart to help explain concepts in your own words
11. Reflect and evaluate yourself and each other giving constructive feedback to your peers and tutor at the end of each session
12. Apply the skills that you learn within PBL to other situations

reduced collaboration in these groups (Latane et al. 1979; Salomon & Globerson 1989; Bornstein 1992; Moust et al. 2005; Kelly 2008). Again, beliefs and attitudes towards the group process determined if the actual team learning behaviour within the group stimulated group learning or not. In addition to a true understanding of why PBL is used, students should also *be aware of the group dynamics* that directly influence team learning-behaviour, and know how to change the dynamics in the groups in which they are participating.

Besides the fact that PBL could lead to social and cognitive advantages compared to individual learning, this teaching method also provides students with the *opportunity to learn how to collaborate with others*. This is essential for everyone studying medicine as patient care requires much more than factual knowledge and technical skills, which in turn leads to defining the professional competencies (Leung 2002). For example, the Accreditation Council of Graduate Medical Education (ACGME) included professionalism, interpersonal skills and communication as three of the six areas of competence (Betalden et al. 2002), and the Royal College of Physicians and Surgeons of Canada had developed the CanMEDS, a competency-based framework in medical curricula. CanMEDS also listed "communicator" and "collaborator" as part of their competences to strive for (Frank & Danoff 2007). Similar descriptions of professionalism have been developed in the UK (Royal College of Physicians 2005). Thus collaboration, communication and professionalism are key elements of good medical practice, which can also be learned while collaborating with fellow students. Awareness of the unique "practice field" within the PBL groups, and practice of these competences might increase students' skills. In the end, this should increase the quality of health care they provide later on.

Finally, because PBL provides a natural way of collaborating, for many students it creates an opportunity to *build social networks* (see (Cross et al. 2005) for a practical overview and (Lurie et al. 2009) for an overview of its uses in medicine). These social networks can in turn be beneficial while learning, (Baldwin et al. 1997; Jippes et al. 2010; Hommes et al. 2012a) collaborating in medical practice (Lurie et al. 2009) and also create job opportunities (Rienties et al. 2010).

As the student nears the end of an undergraduate programme they should have transformed into a *self-directed learner*. Elementary, middle and high schools provide the general compulsory education, while university education aims to develop the student's responsibility for their own learning. Consequently, university itself merely provides the learning environment (tutors, mentors, tutorial groups, expertise, and resources) and a framework to help a student transform into a medical professional.

The problem comes when, for excellent institutional and professional reasons, we have to determine whether a student knows enough to be able to practise as a doctor. It is important to recognise that tests of knowledge acquisition are only a first- or second-degree approximation to actually being a safe doctor. Even assessments of clinical skills are only an approximation to what the prospective doctor will actually do in practice, since the student will always be demonstrating what they need to demonstrate in order to progress with their studies. Learning occurs in the mind and behaviour is therefore not *a priori* or a reliable indicator of cognitive processes; which indicates that the current connection between learning and performance is too simplistic (Adams 2006). Since students need to pass tests to become a professional, it's logical that students learn what is necessary to pass the tests, although it is quite unlikely that this makes a student a "good" professional.

The entirety of what a "good" doctor needs to know is unknown. It will depend upon the circumstances in which they find themselves. The only certainty is that one cannot know everything, which some students find difficult to accept. One needs to find one's own practical limits; not only by using tests, tutors, mentors, students in more senior years but also classmates. Most importantly one needs be able to motivate oneself to be a life-long learner because in professional practice there is often no group to support individual learning or teacher that guides and/or provides assessments (Schmidt 2000). PBL appears to many to be an important strategy, because it helps the developing practitioner to recognise the limits of their knowledge, which elements are crucial and need immediate recall, and also where and how to find reliable answers to their remaining questions.

The process of development into a doctor capable of self-directed learning occurs in gradual stages as experience, competence and responsibility are increased. These stages can be categorised into four main transition points (Schmidt & Boshuizen 1993).

- School graduate to a medical student in a PBL curriculum
- The PBL environment to clinical placements
- Medical student to a Junior Doctor
- Junior Doctor to a professional, self-regulated practitioner capable of co-ordinating their learning for the remainder of their career

Student involvement in PBL is an important component of this developmental path, as it aids the student's transition into their future working environment. Students enter into the communities of practice within their PBL groups, where they learn and utilise the PBL process to guide their self-directed learning. During the initial non-clinical phase, the PBL scenario forms the main concrete experience upon which the students derive their learning objectives. This PBL process remains constant when students progress to their clinical placements, forming one of the "boundary objects". This consistency is important as students develop, and enter their new clinical communities of practice (Wenger, 1998). So what is meant by "an individual capable of life-long learning"?

The process of lifelong learning was described by Miflin et al. as a being able to continuously implement the cycle of; evaluation of a clinical scenario, identifying it's components, recognising current knowledge gaps, utilising an appropriate resource to acquire the necessary knowledge, followed by appraisal of the information learned and subsequent application of the learning (Miflin et al. 2000). This process could similarly be likened to both the PBL process itself and the Kolb Experiential learning cycle (Kolb, 1984). Nevertheless, the ability of a student to be a life-long learner could be viewed

from three main perspectives each, arguably, equally important (Evensen & Hmelo 2000; Miflin et al. 2000):

(1) The ability and willingness of a person to identify a gap in their knowledge, and take responsibility for actively seeking the new understanding required,

e.g. in response to a clinical case that provides a diagnostic challenge

(2) The ability and motivation to continuously reflect on and update current understanding and practices, in the context of new research.

e.g. keeping up-to-date with current treatment guidelines, as these continually change according to new research.

(3) The ability to challenge conceptual frameworks further than current understanding, enabling the subsequent identification of new ideas and their applications.

e.g. identifying links between and applications of clinical medical knowledge. Conducting research. Medicine is continually evolving and developing.

The training of students to become self-directed, life-long learners is one of the outcomes of a PBL curriculum that is frequently referred to in the literature. Several studies have attempted to determine the effectiveness of a PBL versus a "traditional" didactic curriculum, in producing students with greater life-long learning capabilities, using a variety of methods (Tolnai 1991a; Shin et al. 1993; Peters et al. 2000; Polyzois et al. 2010).

Tolnai (1991b) used a questionnaire to look at the uptake of Continuing Medical Education (CME) activities in PBL versus traditional curriculum graduates, and no significant difference was identified between the two groups. Another study, using a self-report questionnaire (Peters et al. 2000) showed that PBL and traditional graduates seek new information and access scientific literature with equal frequency; however, they did so in different ways. PBL graduates tended to research and actively learn from clinical (patient) problems, while traditional graduates tended to research and learn to stay up-to-date with the body of scientific research (Peters et al. 2000). This suggests different motivations towards life-long learning and that the PBL curriculum may encourage the implementation of the lifelong learning process in response to a clinical scenario, as described by Miflin et al. (2000).

Interestingly, Shin et al. (1993) approached this issue via a different method and assessed the knowledge of up-to-date hypertension management guidelines in General Practitioners (GPs) who graduated from a PBL compared to a traditional curriculum. This study demonstrated that GP's that graduated from a PBL curriculum had more up to date knowledge about the management of hypertension compared to graduates from the traditional curriculum (Shin et al. 1993).

This illustrates how multi-factorial life-long learning is, along with how difficult it is to find the right methods to study this process and its results. Further research is required to ascertain whether PBL does result in doctors that are capable and motivated to be self-directed, life-long learners. PBL does, however, establish the foundations necessary for students to develop the skills required for life-long learning, as it:

(1) Provides students with a structured and practiced method through which they can identify what needs to be learned and build on their prior knowledge.
(2) Enables students to become familiar with seeking and utilising the vast repertoire of resources available to attain the knowledge required.
(3) Establishes the use of reflection as a method to learn from situations and recognise further improvements that can be made.
(4) Establishes the ability to and importance of collaborating with others when learning and teaching.

What does faculty need to know about student involvement?

The first thing to remember is that students are enthusiastic and willing partners in their education, and they really do want the best possible outcome! From the start therefore it is essential to provide adequate resources and support to enable the students to be proactive in their learning.

The programme needs to be designed (and mapped) in a way that means that both students and educators are clear about what they are supposed to be doing, what has gone before (and what competencies are expected of people already), and what will come later in the curriculum (and so may be safely left for later). Assessment needs to be carefully mapped against the curriculum, so that everyone can be sure that the competencies are being reached at the right stage, and that only those who are able to profit from the next stage are being allowed to progress. The programme management team needs to be certain that there are sufficient individuals, in the right place, at the right time and with the right skills, to help students as they progress through the programme – paying particular attention to the three difficult transition points – the entry to medical school, the first clinical placements and the transition to working as an (partially) independent practitioner. The advantage of a PBL curriculum is that several members of staff will know each student reasonably well, and importantly students will have a good idea of who to contact for help in a given situation. In Liverpool, this has accounted for a very low (around 1%) attrition rate from the programme.

It is desirable to include tasks early in the programme that facilitate academic integration (Krause, 2001). This is partly to familiarise the students with their new learning environment so should include PBL and exercises in academic writing, and partly to overcome the threshold effect (Land et al. 2008). Land and co-workers have shown that it is difficult to enter a new academic field, because of; the use of jargon, the bewildering amount of new knowledge one needs to acquire, and because the newcomer does not understand the rules. A supportive and well-functioning PBL group can provide a safe social space to explore vocabulary, and what appear to be the "rules of the game" that form the professional boundaries within which they will expect to work in the future. It is important that students and staff all recognise that this important social role is played by the PBL group (Stage, 1989). A good PBL facilitator

can help students to articulate what they understand about what they are doing when they enter the profession, and importantly can act as a role model, both in terms of behaviour and also by articulating their own personal thought processes when facing a new problem.

Training is crucial, both for new (Evans & Taylor 1996) and experienced tutors. In Liverpool, there was particular success with engaging students in the process of training faculty (Taylor 2001). The training needs to include the supposed theoretical background for problem-based learning, but also insights into learning theories, learning styles and the impact of PBL on students. It is also essential that staff understand the role of problem-based learning in the curriculum, and the extent and depth to which it is expected to cover specific material. This will help students through the common problem of "how much to learn".

Students and teaching staff all need to understand the nature of the programme, and the evidence, or otherwise, which underpins the methods chosen. This will include actual outcome data about student successes, effectiveness, employability and future career tracks. It is also important to regularly monitor and track the progress of each student through assessment and provide feedback through formal meetings with their personal tutors and advisors.

Promoting clinician confidence in the PBL education is also essential. There is strong evidence that students from PBL programmes are no worse than those from conventional programmes, and are actually better prepared in some areas. Some clinician, without evidence, assert that students from a PBL programme don't know anything (Watmough et al. 2006c) and this can be difficult to counter, since it is easy to ask a question in such a way that the student is cautious about giving an answer. The key to solving this problem lies in ensuring that students and clinicians have a very clear concept of what needs to be known by the student before they start the placement (activating prior knowledge), and what the expected learning outcomes are. This is not explicitly a PBL issue, but relates to the observation that most senior clinicians were trained in an environment that was not explicitly outcomes-based. PBL programmes are typically vertically integrated; this means that in the clinical environment students will be expecting to learn about basic sciences and the other subject areas allied to medical practise, such as sociology, psychology and ethics. The experience of most senior clinicians was that they were expected to "know those things" before they came onto the placement, so the expectations of staff and students need to be carefully managed.

One important way of preparing students for the workplace, and even further ahead, preparing them to take their place as future teachers and leaders, is to encourage and support senior students to take responsibility for running PBL groups, and generally supporting the learning of their junior colleagues. In both Liverpool and Maastricht, taking responsibility for helping others learn is one of the expectations of the programme, and both institutions have a good record of developing clinical academics, who understand both educational process and clinical medicine.

Even for those students who are not able to commit (for whatever reason) to being a PBL facilitator, there are many opportunities to help others to learn. These range from mentoring programmes, through to running teaching or revision sessions. All those of us who are involved in education realise that teaching is the best and quickest way to discover how much we understand a subject. For this reason, it is worthwhile members of faculty being aware of what is going on, and offering support, even if informal, to those who are trying to help their junior colleagues learn.

There are many ways in which students can be involved in a medical programme. Consider enabling senior students to become involved with medical education through training and being a PBL facilitator or helping with and teaching clinical skills. Adopt peer-assisted learning systems either informal, or more formal tutor-tutee/buddying with junior students to provide invaluable support. In our institutions (Bate & Taylor, 2011; Duvivier et al. 2010) we have had excellent results through including students in the quality assurance and the management of our programme.

Finally, just as it is important to ensure a smooth transition into medical school, it is essential to ensure a smooth transition into post-graduate medicine. This is largely through the increasing clinical contact and the additional responsibilities that students assume as they progress through the programme. In the UK there is a move towards student assistantships in the final year of the undergraduate programme, to ensure that students are able to demonstrate that they will potentially be able to practise. In Liverpool, this has been a feature of the programme since the mid-90 s and it has accounted for a remarkable increase in the preparedness of graduates (Cave et al. 2007). It is important however, to maintain high levels of supervision and feedback to ensure that the student graduates as a competent reflective practitioner.

Conclusion

In conclusion, the involvement of a student in the PBL process can help develop the attitudes and attributes expected of a reflective practitioner. It is not a given though, and both students and faculty need to understand what is expected of them. Students and faculty need appropriate training, and a supportive and reflective environment. Although PBL is intensive of staff time, and arguably expensive, it has the great advantage of placing faculty in a position to see, recognise and help students develop from high achieving entrants into motivated, competent and reflective practitioners.

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