Problem-Based Learning: A White Paper & Primer

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Contents

Problem-based learning is "a curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem-solver confronted with an ill-structured problem that mirrors real-world problems" (Finkle and Torp, 1995)

Problem-Based Learning (PBL) Origins

PBL is often associated with pedagogues such as Dewey (1938) and Kilpatrick (1918, 1921) who emphasized the importance of engaging in actual experiences when learning, rather than just passive receipt of information and knowledge from an instructor. What Dewey and Kilpatrick were speaking of was not actually what we today would define as PBL, but the idea that learning most effectively occurs when interacting with other learners, engaging in authentic learning experiences, performing research, and being active participants in the classroom, are all certainly cornerstones of the PBL experience.

Today, PBL has evolved from North American medical curricula, specifically at McMaster University, and to a smaller extent, Case Western Reserve University (Boud & Feletti, 1997). These early implementations focused on "structuring an entire curriculum promoting student-centered multidisciplinary education as a basis for lifelong learning in professional practice" (Boud & Feletti, 1997; adapted from Neufeld & Barrows, 1974).

PBL has continued to grow and develop, largely due to some core tenets of the PBL process that have broader pedagogical importance; these are features that educational experiences should ideally inhabit, and which PBL does very well:

- Knowledge is situated in meaningful contexts, taking into account how students ultimately learn by being actively involved in the learning process
- The confines of a single program at a higher education institute cannot possibly teach an individual everything required to be successful in their chosen career; students need to learn quickly, effectively, and independently when tasked with a new problem
- Individuals need to be able to respond to change due to the rapid changes occurring in professional practice and the emergence of new technologies
- Effective educational programs need to be adaptable to the logistical parameters of higher education institutions, which PBL does very well (adapted from Boud & Feletti, 1997)

Three paragons of PBL success exist at McMaster University (Canada), Maastricht University (Netherlands), and Newcastle University (United Kingdom), each adapting PBL for their own educational contexts in ways that best suit their institutional contexts. Each institution will be referred to throughout this document when necessary to demonstrate how a leading-PBL institution understands and supports problem-based learning.

Defining PBL

While there is no single agreed upon definition, PBL can be very succinctly defined as "an active learning method based on the use of ill-structured problems as a stimulus for learning" (Hmelo-Silver & Barrows, 2006; taken from Barrows, 2000). Of note in this definition are two features: firstly, PBL requires active contributions from all learners, constructing meaning and engaging in authentic research. Secondly, the use of ill-structured problems that present

learners with some information, but with intentional gaps that the learner is required to fill in, are key to guiding the learner to a better understanding and, ideally, better learning.

Barrows and Tamblyn (1980) originally defined PBL as:

> The learning that results from the process of working toward the understanding or resolution of a problem. The problem is encountered first in the learning process and serves as a focus or stimulus for the application of problem solving or reasoning skills, as well as for the search for or study of information or knowledge needed to understand the mechanisms responsible for the problem and how it might be resolved (pg. 18).

This definition, in light of the other myriad possibilities of PBL implementation, is now often referred to as *pure* PBL (Hung, 2011). It must be noted that just like many other educational approaches, there are many different (and equally valid) approaches that can be taken to implement what we would still call *PBL* into the curriculum. These can be seen in Figure 1 below, which illustrates a spectrum of PBL approaches as described by Hung (2011).

Hung (2011) also proposed six representative approaches to PBL classified according to how well- or ill-structured the problem is and the level of self-directedness required in the learning. His approach attempted to synthesize PBL classifications proposed by Barrows (1986), Harden and Davis (1998) and Hmelo-Silver (2004). See Table 1 for a description of the different approaches.

Table 1. Descriptions of six representative approaches to PBL (from Hung, 2011, pg. 535-537)

PBL Type	Description
Pure PBL	Learning initiated by a need to solve a real world, ill structured problem, no lectures
Hybrid PBL	Pure PBL supplemented with a few lectures
Anchored Instruction	Students possess basic content knowledge before engaging in the problem solving activities, which comprise the major portion of the course
Project-based Learning	Learning initiated by lecture or students possess basic content knowledge before engaging in the project; project activities comprise the major portion of the course
Case-based Learning	Learning initiated by lecture, companied with case analysis/study (using solved problem)
Lecture-based with problem solving activities	Learning initiated by and comprised with lectures, accompanied with a few problems for practice at the end of the course

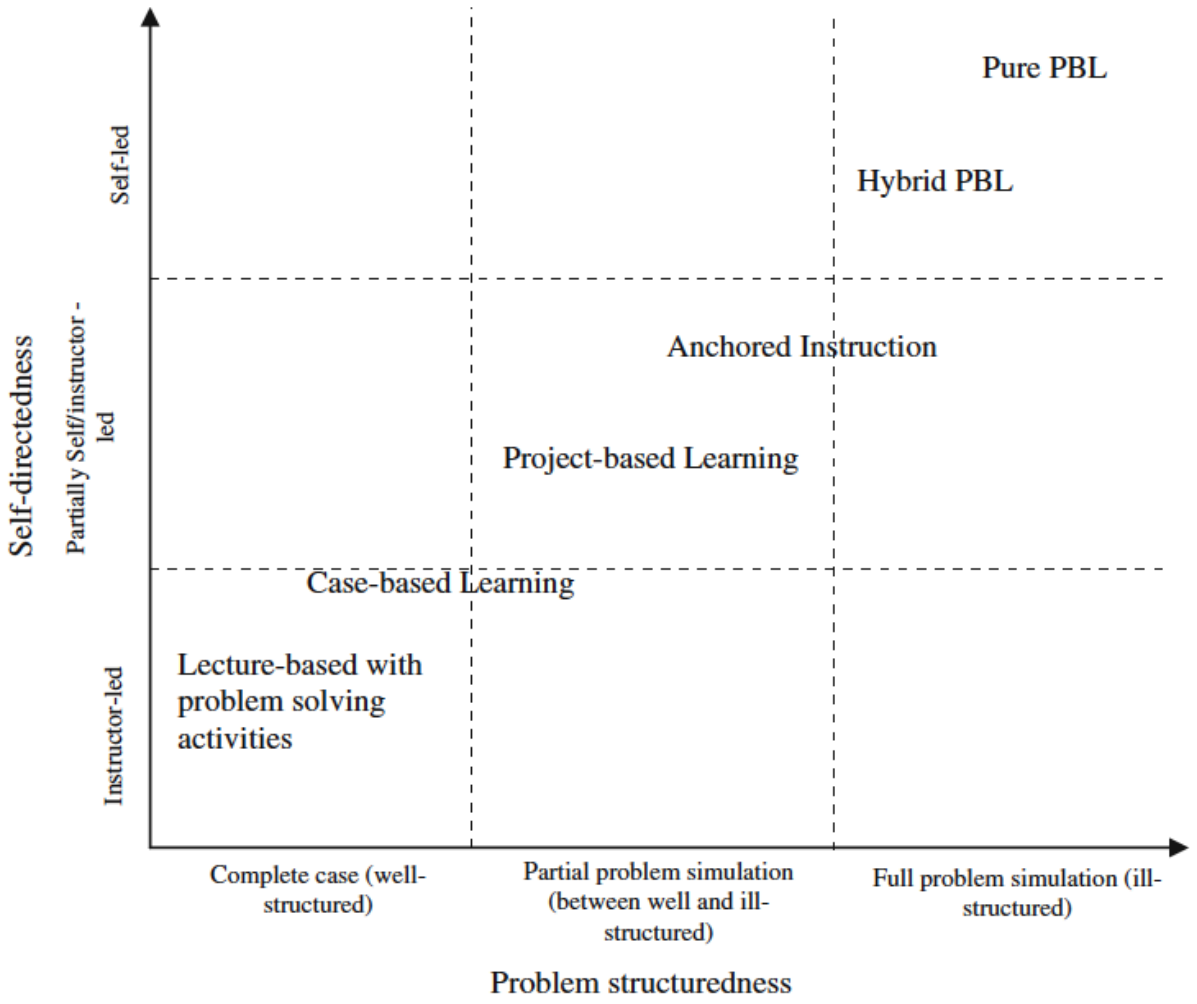

Figure 1. Six representative approaches to PBL (Hung, 2011, p. 534)

At the bottom left of the figure is the closest to traditional instructional methods, where the instructor uses lecture supplemented with some problems or cases for illustration and practice. As the problem or case becomes more ill-structured, and the students become more self-directed in their learning, the PBL experience progresses to "Pure PBL" or what Barrows (1986) referred to as "Closed-loop or Reiterative Problem-based Learning". Closed-loop PBL is the model initiated and championed at the medical school at McMaster University. In Closed-loop PBL students are asked to evaluate the resources they used and reconsider the problem to identify how their reasoning could be improved and evaluate prior knowledge (Barrows, 1986). As a group, they evaluate themselves and one another after the completion of the PBL experience, considering what went well and where they could make improvements individually and for the group process.

Figure 2 below illustrates the PBL process used at McMaster in the Closed-loop model of PBL.

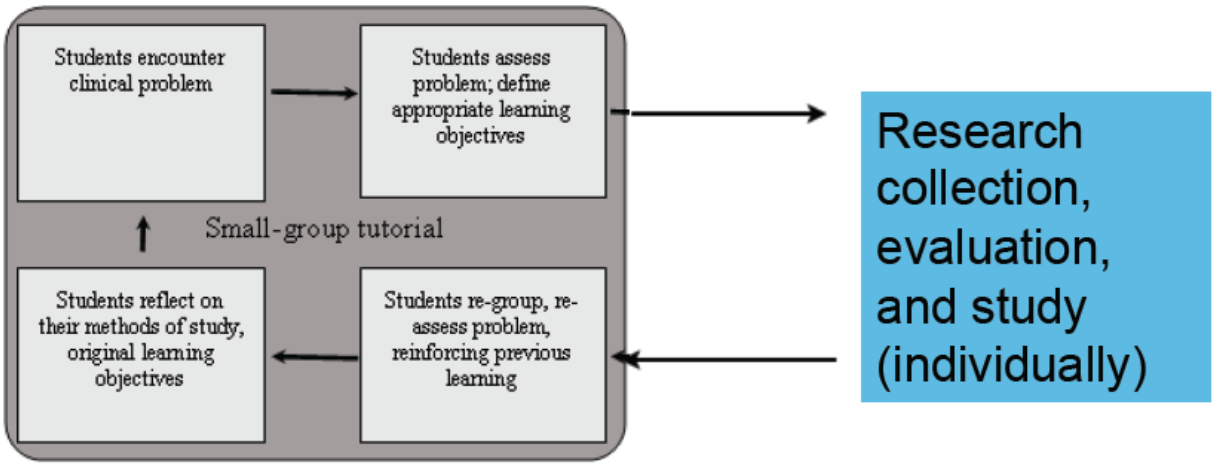

Figure 2. Illustration of the Closed-loop model of PBL (Adapted from Atrie et al., 2008)

Schmidt (1983) outlined the general steps of the PBL process:

1. Identify the Problem
2. Explore pre-existing knowledge
3. Generate hypotheses and possible mechanisms
4. Identify learning needs / outcomes
5. Self study (individual, outside of tutorial)
6. Re-evaluation and application of knowledge to the problem
7. Assessment and reflection on learning

With these varied approaches to implementing PBL in mind, there nevertheless exist a set of key features or characteristics that many PBL scholars agree upon. These include the following:

- A problem, question, or issue must exist that students can discuss, and ideally, *want* to discuss
- The problem should be authentic
- Students should be working together (either cooperatively or collaboratively) in a group
- As students work through the problem, they should be guided to think critically about how to address the problem and use the resources that they have available to begin to work through the problem by a tutor
- This tutor should both know the problem well, and also be able to facilitate the learning process
- Learners should be encouraged to identify what their learning needs are, and in turn, what the learning objectives of the problem should be
- Time spent on the problem should span both classroom time and out-of-class time, as time spent away from the classroom should be used to do further research and prepare to discuss the problem in greater detail

- When returning as a group after having conducted individual research, learners should pool and apply new information/findings/knowledge and apply it to the problem, coming to some form of a solution
- As the problem cycle closes, learners should evaluate their own learning processes (adapted from Boud & Feletti, 1997; Neufelt & Barrows, 1974).

It must be finally noted that the Maastricht University model does differ from what many would describe as *traditional PBL theory.* In particular, and as expanded upon by Moust, van Berkel, and Schmidt (2005), Maastricht University elects to have students act as tutors through a rotational system, provides the problem definition to students instead of encouraging them to discover it on their own, limits brainstorming by students, and provides course readers to students to work through, instead of having students conduct their own independent research (Moust, van Berkel, & Schmidt, 2005, p. 674). While the Maastricht University PBL model has clearly elicited success, as evident by its continued implementation, there are some signs of its challenges, primarily rooted in poor educational habits being formed in PBL groups that are not reverted by experienced tutors, such as limiting self-study time and skipping phases of the PBL process which would elicit self-directed learning (Moust, van Berkel, & Schmidt, 2005, p. 670). Other researchers implementing PBL in large classes have used techniques such as having graduate student tutors, peer tutors, floating facilitators, and even no tutors to varying levels of success (Woods, 1996b; Duch, 2001; Shipman & Duch 2001).

Curricular Considerations

> *"The implementation and institutionalization of such a large-scale educational innovation as PBL in institutions of higher education is an evolutionary process" (Moust, van Berkel, & Schmidt, 2005)*

The decision as to whether or not to implement PBL needs to be made with the curriculum or program in mind; individual course level implementations of PBL can be successful, but there is great value in broader, program-wide implementations of PBL where students learn the basic tenets of PBL early in their academic careers and can be expected to gradually become more autonomous in the PBL process.

Woods (1996a) proposes a four-stage model to PBL implementation that may lead up to a program-wide implementation: *nibble*, *enrich*, *develop*, *extend*

Nibble: first exploration into PBL; what issues might exist; try some aspect related to PBL

Enrich: analyzing the element of PBL already incorporated and deciding what else may be helpful to add to the PBL experience

Develop: Using self-directed, small-group PBL

Extend: Broadening PBL to other situations; may involve more specific assessment-related practices of program-wide implementation

There nevertheless exist evidence of successful PBL implementation on a curricular level, with the experiences of the programs providing valuable insight into the considerations that must be made when deciding to implement PBL on a program-wide scale. Jonassen and Hung (2008) observed that "PBL is becoming increasingly popular in graduate business programs, where students primarily solve case analysis problems that are fairly ill structured" (Jonassen & Hung, 2008). Azer (2001) notes the following as factors that must be considered when determining the extent to which PBL is implemented into a curriculum:

- Time commitments of faculty and staff;
- Requirements for support personnel;
- Cost of instructional materials;
- Buildings and rooms (Azer, 2001)

Some of these factors have been researched more intently; varying figures have been offered when discussing the time required to develop strong problems for PBL. For each semester, Azer (2001) suggested needing approximately 50 hours of time to develop the requisite materials for each course utilizing PBL. Albanese and Mitchell (1993) analyzed faculty effort required to be invested into PBL vs. conventional curricula, finding that faculty members typically invested 8.6 hours per week into teaching in a traditional lecture-based course, whereas they spent 20.6 hours per week for a PBL course.

Other factors, such as the time commitments of tutors, are more pragmatic, logistical concerns; depending on how tutors are chosen to lead the small group discussions, faculty and staff will either need to be trained and receive teaching relief in some capacity to act as tutors, or paid facilitators will need to be hired and trained with their sole purpose being to act as facilitators across a variety of varied PBL courses.

An additional component of curricular PBL approaches that should be considered is the time required for students to adequately prepare for their PBL classes. In particular, Boud and Feletti (1997), when discussing the appeal of the PBL philosophy, suggesting that:

> "these curricula feature regular small group 'problem solving' sessions at which students discuss simulated but true-to-life problems, and a weekly schedule which facilitates integration of learning across disciplines, with very few lectures and **more 'protected time' for electives or self-directed studies**" (pg. 3, emphasis added).

Just as we see examples of establishing protected time directly in the student's course calendar at UW, similar protected time should be considered for any course that is categorized as PBL; Jeff Nagge's PBL course (PHARM 422) is a 1.0 credit course that also dedicates 6 hours per week for student self-study time. This is designed so that students are aware of the expectations to prepare sufficiently and to demonstrate the program's commitment to the students.

A final note: due to the time investment that students invest in the PBL process, assessment of the process that students undergo is recommended; how they interact as a group, the research

they do outside of class, the brainstorming process, should all be dutifully assessed and students should be credited for the substantial time commitment to PBL. Continuing to use traditional assessments (such as MCQ or fact-based examinations) will not necessarily assess students on the multitude of skills they develop by participating in PBL (Woods, 1996b).

Experience Level of Tutors

The role and experience level of the tutor is contentious in the literature (see the meta-analysis below). Opinions vary between whether the tutors should be primarily context experts, and secondarily facilitators, or primarily facilitators with some context knowledge. Are faculty members best positioned to be tutors, or should upper-level/graduate students assume this role, or even individuals from the industry? Barrows (1996) noted "it seems generally agreed now that the best tutors are those who are expert in the area of study, only they must also be expert in the difficult role of tutor" (pg. 6).

Azer (2001) recommends junior tutors, or senior students, be utilized more so than senior staff/faculty to act as tutors due to the benefits for professional development. This angle may be one to explore to help off-set the requirements of a full PBL administration. Fourth-year students could potentially enroll in a course that has them act as tutors for a first or second-year PBL course, and their class time is then spent as a tutor, and study time is spent preparing for tutoring.

Azer (2001) also argues that the ideal tutor is one who is familiar with teaching techniques that are applicable to small groups. He also suggests, however, that knowledge of the problem is important, as well as the learning issues that may arise when attempting to solve the problem. Tutors will too much subject-knowledge may be overly directive with their guidance and inhibit the learning potential of the PBL process.

McMaster University suggests that the tutor should be an expert at both content and process facilitation, and therefore is likely a faculty member trained in facilitation, rather than a trained facilitator who becomes relatively knowledgeable in the discipline. Furthermore, the tutor needs to find the right balance between dominating a group's discussion and completely removing oneself from the discussion. To do so "requires considerable insight on the part of the tutor, and a willingness to reflect on tutorial process and actively invite feedback from the students" ("Problem Based Learning: A Novice's Guide", pg. 10).

Maastricht University incorporates students throughout the entire PBL process; students will act as scribes, chairs, regular group members, and indeed, even the tutor of their small groups.

PBL Group Size

The appended meta-analysis below lists a number of studies and the group sizes that they have implemented. The typical group size in PBL is 5-8 students (Barrows, 1996; Wilkerson, 1996; Lohman and Finkelstein, 2000; Moust et al., 2005; Dangerfield et al., n.d.; McMaster University, n.d.). To add to this, however, and returning to the three paragons of PBL success, we find that

Newcastle explains in their guide to PBL that "the number of students in a group should be limited, so that all members can actively contribute to the group's discussions and the tutor/facilitator can give sufficient attention to facilitating the many interactions accordingly. Seven students per group are frequently adopted as most appropriate" ("A Whole System Approach", pg. 17).

McMaster University adopts a similar group size as Newcastle, stating that "Problem-based learning occurs in a tutorial-style setting and includes 7-8 student participants" (Education Methods, McMaster University). Barrows and Tamblyn (1980) of McMaster University, argue as well that groups of 6-8 are optimal. Maastricht University adopts a larger group size, stating "You work in small tutorial groups, engage in hands-on training and attend (far) fewer lectures. Under the supervision of a tutor, you team up with ten to fifteen students to tackle real-life challenges" ("Problem-Based Learning", Maastricht University).

Lohman and Finkelstein (2000), studied the impact of group size on the development of problem-solving skill, self-directedness, and technical knowledge. They studied groups of the following sizes: small (n=3), medium (n=6), large (n=9) using an approach akin to "Pure PBL" as described above. They found the level of self-directedness increased with small and medium groups but decreased significantly with large groups. In addition large groups rated their experience of PBL significantly lower than small and medium groups. Interestingly, there was no significant difference between groups in terms of problem solving skill or development of technical knowledge, but the authors note that the short amount of time (3 weeks) doing PBL may have been a factor in this result.

Group size will likely have an impact on how much experience a tutor needs in facilitation; smaller groups are inherently easier to facilitate, ensuring that each group member has opportunities to speak and to generally control how the group functions, whereas larger group sizes can be challenging to interact with and ensuring equal speaking time; Dolmans, Hurk van den, Wolfhagen, and Vleuten van der (1996) argue that "decreased participation, as well as the difficulty presented by large groups of providing timely and appropriate feedback, might undermine the development of the self-regulation that enables students to reflect upon and control their own activities" (p. 4). Of course, tutor facilitation training can make this much more manageable, and regardless, some form of training for tutors is advisable.

PBL Question Design Considerations

As just one element of the preparation required for PBL implementation, consideration must be placed as to how best to design questions that are sufficiently "ill-structured" while also promoting the necessity to conduct independent research and share findings. Hung's (2009) 3C3R problem design model (Figure 3) is a good starting point to understand one approach to follow to design strong questions for PBL.

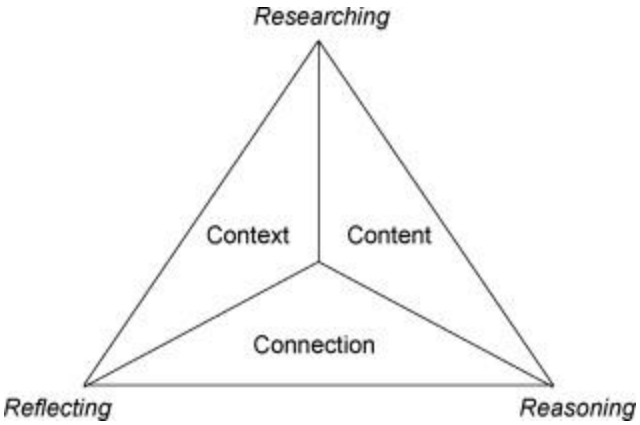

Figure 3. 3C3R Problem Design Model.

Hung also outlines a 9-step process to follow that then relates to the 3C3R model.

1. Step 1: Set goals and objectives
2. Step 2: Conduct content/task analysis
3. Step 3: Analyze context specification
4. Step 4: Select/generate PBL problem
5. Step 5: Conduct PBL problem affordance analysis
6. Step 6: Conduct correspondence analysis
7. Step 7: Conduct calibration processes
8. Step 8: Construct reflection component
9. Step 9: Examine inter-supporting relationships of 3C3R components (Hung, 2009).

McMaster has an online resource dedicated to problem writing for PBL (located here: http://www.fhs.mcmaster.ca/pbls/writing/contents.htm). This resource contains both helpful tips for writing problems, as well as numerous example problems that can be consulted when designing one's own problems. McMaster also links to a resource on case design to assist PBL problem writers in creating their own problems (which can be located here: http://cll.mcmaster.ca/resources/pdf/How_do_you_Design_a_Case.pdf). The intention behind case writing is perhaps broader than a specific problem for PBL, and indeed, the situations do differ, but this too may be a useful starting point for writing a PBL problem.

The University of Leicester provides a number of helpful tips to consider when writing problems, beyond just a list of steps to follow when doing so. Specifically, they state that PBL problems should:

- Pose a stimulating question
- Be based in a realistic context
- Be open-ended and/or multi-pathed and encourage debate
- Be complex (answers should be unable to be Googled)
- Encompass new areas of knowledge

- Give each student a role or point of view
- Require professional working habits
- Engage students ("A Short Course in Problem Based Learning", University of Leicester)

Resources Needed

A final aspect to consider pertains to some of the basic resources needed to make PBL work effectively. This goes beyond ensuring there is a sufficient number of tutors for each small group, and more to classroom design and space considerations. Scholars emphasize the 'technology-free' nature of PBL, relying primarily on whiteboard usage to collect and organize thoughts (see Hmelo-Silver, 2004), suggesting therefore each break-out room for small-group discussions be equipped with some manner by which to record thoughts for public discussion.

McMaster touches on this briefly, writing that "PBL is very resource intensive. Increasing student enrollment entails a great deal more than adding another row of seats to the back of the lecture theatre. Many faculty members are required, and all must be well prepared for the role of tutor" ("Problem Based Learning: A Novice's Guide", pg. 8).

Albanese & Mitchell (1993), having conducted an analysis on many of the earliest implementations of PBL, outlined a number of *implementation issues*, which again speak to the types of resources required to effectively integrate PBL. They list items such as the time efficiency (taking 22% more time to cover a similar unit in PBL vs. traditional lecture), faculty effort (spending time interacting with students and preparing resources), and additional space and materials (classrooms, writing spaces, print resources) as all being aspects to consider when deciding on how to implement PBL.

The Buck Institute for Education has an entire webpage dedicated to resources related to PBL: articles, books, sample problems, and rubrics (http://www.bie.org/resources).

Meta-Analysis

The following table details a number of articles selected from the 1980s to present. They are analyzed with the following criteria:

- **How is PBL defined?** If the article attempts to establish its own definition of what PBL is, it is listed here
- **PBL Process**. What does the PBL process look like for this specific article? Does it follow the standard process as outlined above, or does it deviate in some way from the 'traditional' model of PBL?
- **Group Size.** If there is any mention of the size of group employed in the tutor-led, small-group discussions, it is listed here.
- **Role of Tutors.** When the role of the tutor is explained in detail, it is expanded upon here. This may also be more theoretical than simply a descriptive of the tutor's exact role in the small group.

- **Tutor Training & Expertise.** When the article speaks of the type of training a tutor has, or what his or her expertise is, it is detailed here.
- **PBL Outcomes.** If the article attempts to make a statement about the efficacy of the PBL process, or provides commentary on successes/challenges, it is expanded upon here.

Article	How is PBL defined?	PBL Process	Group Size	Role of Tutors	Tutor Training & Expertise	PBL Outcomes
Hmelo, C.E. (1998). **Problem-based learning: Effects on the early acquisition of cognitive skill in medicine.**	Hypothesis-driven learning; learning situated in authentic problems;	Facilitator provides students with small amount of information; group evaluates and defines different aspects of problem by asking facilitator questions to elicit key information, generating hypotheses and learning issues; learning issues divided up, researched independently, then shared; finish with reflection on what was learned	5 to 7 plus a facilitator	Help students' learning process by modeling hypothesis-driven reasoning for students and encouraging them to be reflective; facilitator as expert model and coach; facilitator can fade later as students internalize the facilitation role by asking each other justification quesations	Facilitator acts as expert learner, so must know the material in order to model the questions that students should be asking themselves	PBL students score lower on MCQ but higher at task-based evaluations; PBL explanations may be more error prone, but are more elaborate;
Hmelo-Silver, C.E. (2004). **Problem-based learning: What and how do students learn?**	"focused, experiential learning organized around the investigation, explanation, and resolution of meaningful	Students are presented with a problem scenario; formulate and analyze problem by identifying relevant facts; generate hypotheses and possible solutions;	Small	Teacher helps students learn cognitive skills needed for problem solving and collaboration; cognitive apprenticeship model; primarily	Facilitator is an expert learner, able to model good strategies for learning and thinking, rather than an expert in the content itself;	Same as Loyens, Magda, and Rikers (2008)

Article	How is PBL defined?	PBL Process	Group Size	Role of Tutors	Tutor Training & Expertise	PBL Outcomes
	problems"; uses 'wandering' facilitation model, rotating from group to group	identify knowledge deficiencies; engage in self-directed learning; share new learning; reflect on abstract knowledge gained		facilitation; students acted as tutors sometimes as well	scaffolds student learning through modeling and coaching with questioning strategies; monitor group process and moves students through the stages	
Hung, Jonassen & Liu (2008). **Problem-based learning.**	Self-led, pure problem simulation	Students encounter problem; define the problem; set learning goals; self-directed learning to complete goals; share learning with group; summarize and integrate learning at end	5-8	Facilitators, not knowledge disseminators, who probe students but never interject	Tutors must be communicate with students informally while maintaining empathetic attitude	Students needed at least 6 months to adapt to new method;
Kilroy, D.A. (2004). **Problem based learning.**	Self-led, pure problem simulation	**PBL 1:** Clarify terms and decide the problems; analyze the problems; identify study	Unspecified	Empowering learners; students need reliable access to facilitator;	Expertise in group dynamics and supportive enthusiasm	Each group member contributes to learning process at every stage;

Article	How is PBL defined?	PBL Process	Group Size	Role of Tutors	Tutor Training & Expertise	PBL Outcomes
		priorities for scenario; formulate learning objectives; individual study; **PBL 2:** group shares findings (presentations, lead discussion, create handout); identify areas for improvement		enthusiasm; provides encouragement and guidance as learners tackle problems; suggest useful resources to consider; interject with thought provoking comments	more valuable than deep subject knowledge	learners become more confident and self-aware as professional learners
Kwan, A. (2009). **Problem-based learning.**	Self-led, pure problem simulation (combination of pure and hybrid PBL)	Explore problems; identify learning issues; solve the problem with existing knowledge; identify learning needs; set learning goals and allocate tasks; study individually; share and teach; assess and reflect on whole process (some steps may need to be repeated)	Unspecified	Instructor as coach; fades in the background by facilitating and modelling at appropriate points; arranges assessment and ensures students receive feedback	Facilitation ability most important	Students are allowed to construct their own understanding and apply prior knowledge; can be stressful for students and staff at beginning of process

Article	How is PBL defined?	PBL Process	Group Size	Role of Tutors	Tutor Training & Expertise	PBL Outcomes
Loyens, S.M.M., Magda, J., & Rikers, R.M.J.P. (2008). **Self-directed learning in problem-based learning and its relationships with self-regulated learning.**	Self-led, pure problem simulation	Small groups learn collaboratively by discussing meaningful problems that describe observable phenomena; students discuss problem with fellow students; propose solutions; students select literature to do further research; students meet again and share and critically evaluate findings; PBL tutorials held twice a week, lasting 2 – 3 hours	Studied self-directed learning in groups of 3, 6, and 9 students; 3 & 6 performed better	Stimulate discussion, provide students with relevant content information, evaluate progress, monitors each group member's contributions	Unspecified	Students construct extensive and flexible knowledge base; become effective collaborators; develop problem-solving skills; intrinsic motivation to learn
Maudsley, G. (1999). **Roles and responsibilities of the problem based learning tutor in the undergraduate**	Philosophically, problem based learning is centred on the student and on problem-first learning, whereas in subject based	Look for phenomena requiring explanation; investigate previous knowledge and experience; volunteer shared learning objectives; explain the essence of the	'small group'	The tutor facilitates the group's self directed generation of learning objectives from triggers in successive case	Tutor should have expertise in group facilitation (process expertise) rather than in a subject area (content	Focused moreso on the role of the tutor and less on the value of PBL itself, so outcomes-wise, most important is to balance empathy with

Article	How is PBL defined?	PBL Process	Group Size	Role of Tutors	Tutor Training & Expertise	PBL Outcomes
medical curriculum.	learning teachers transmit knowledge to students before using problems to illustrate it. Problem based learning aims to enable students to acquire and structure knowledge in an efficient, accessible, and integrated way.	case scenario by sharing, applying, and synthesising prior and new knowledge; reflect and evaluate by discussing the group process and learning, and personal contributions and achievements (including those of the tutor)		scenarios that set the context	expertise); most new tutors in problem based learning are challenged by the "where necessary" (deciding when and how) part of intervention	content expertise when trying to encourage discussion
Strobel, J. & van Barneveld, A. (2009). **When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms.**	Unspecified (meta-analysis of meta-analyses)	Unspecified	Unspecified	Unspecified	Unspecified	PBL students outperformed traditionally taught students in performance and skill-oriented assessments; greater satisfaction with PBL over traditional learning

Article	How is PBL defined?	PBL Process	Group Size	Role of Tutors	Tutor Training & Expertise	PBL Outcomes
						methods; MCQ style exams favored traditionally-taught students; works best with focus on skills and long-term retention

Annotated Resources

[7 Must-Have Problem Based Learning Apps, Tools and Resources]

Focusing primarily on educational technologies and online resources, this webpage introduces strategies that can help facilitate your own undertaking of PBL.

[Buck Institute for Education's PBL Resources]

A leader in thinking through approaches to problem-based learning, the Buck Institute for Education has amassed an impressive set of resources, both print and digital, as well as tools to help with the assessment of PBL practices, such as rubrics, planning forms, and handouts.

[Centre for Teaching Excellence's Problem-Based Learning Video Series]

These are videos from a recent workshop by CTE staff and faculty members on how they have employed PBL in their teaching. The website also has other useful resources in the sidebar that can help spur PBL-thinking.

[Miami Dade College's PBL Educator's Resource]

An excellent library guide that contains videos, readings, "PBL Stories", and explicit examples as to how Miami Dade College integrates PBL into the curriculum.

[University of Delaware's Resources for Problem-Based Learning]

Another set of excellent resources, including specific links to sample syllabi, group evaluation forms, sample problems, and videos to help assist in facilitating effective discussions as a tutor.

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