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Problem-based learning (PBL) is a student-centered teaching method that uses real-world problems as the motivation of a self-directed learning process. There are many variations that can be classified as PBL such as guided design, case-method, games/simulations (McKeachie, 2006), and project-based learning. PBL can also be classified under more general teaching methods such as active-learning, constructivism, and student-centered teaching. One of the key elements that sets PBL apart from other methods is that the problem comes before instruction on the knowledge needed for the problem. Typically, the student applies new knowledge covered through instruction to solve a problem. In PBL students use the problem to direct them to research and learn the new knowledge needed (Erickson, Peters & Strommer, 2006). This unique sequence is the foundation of PBL and the main source of the positive and negative attributes of this teaching method. McKeachie (2006) writes of the abundant research conducted on PBL,

My summation of the results is that, compared with traditional methods of teaching, problem-based learning may sometimes result in less acquisition of knowledge but typically shows little, if any, decrement. However, retention, application, and motivational outcomes are generally superior to those in traditional methods of instruction (p. 202).

Overall, PBL is currently a popular teaching method that all teachers should be aware of as professional educators.

The impetus for PBL is the real-world requirement to work in a group to solve ill-defined, complex problems. Current educational research has shown that typical lecture methods and end-of-chapter questions do not require students to reach higher cognitive levels. Many students faced with similar questions but in different context fail to make the connection of the questions’ similar underlying principles. Using Bloom’s Taxonomy of Educational Objectives (1956) a typical end-of-chapter question may require the first three cognitive levels; knowledge, comprehension and application. To achieve higher cognitive levels of analysis, synthesis, and evaluation requires a different approach to learning. PBL is one teaching method that attempts to achieve higher cognitive levels and to develop life-long problem solving skills. “Cognitive theory provides good support for the idea that knowledge learned and used in a realistic, problem-solving context is
more likely to be remembered and used appropriately when needed later” (McKeachie, p 202).

History
PBL was formally introduced in the 1960s at McMaster University in Canada for a medical course, but many agree that the underlying concepts have been in use much longer. Karen Goodnough (2006) makes connections to J. Dewey’s 1944 work that “emphasized the connections amongst doing, thinking and learning.” Original applications of PBL focused on medical and other professional studies and its large expansion in the 1970s and 1980s brought PBL to other disciplines including the sciences and more recently to the humanities. PBL, in its many different forms, is now used at all grade levels in many diverse educational environments.

Practice Variations
PBL has been used to describe a wide range of methods and techniques and careful consideration of educational objectives is required when integrating PBL into a curriculum. Over twenty years ago Barrows (1986) proposed a taxonomy of PBL methods and determined three major variables that distinguish different methods; “the design and format of the problem,” “the degree to which learning is teacher-directed or student-directed,” and “the sequence in which the problems are offered and information is acquired” (p. 482). To achieve the highest educational gain the problem is presented with minimal background information, the students acquire the information needed to solve the problem independently, and they revisit the problem when new information is gained until an acceptable solution is achieved. The wide spectrum of variations possible causes the educational outcomes also to be varied.

Beneficial Attributes
Two primary advantages of PBL are student motivation and problem solving skills. Student motivation is a critical component of PBL. Carefully crafted problems that are linked to the students’ personal interests, to their community, or to current real-world issues can improve student motivation to ask questions and learn. Encouraging this inquisitiveness can develop life-long problem-solving skills that are highly sought after in most industries. More complex problems require a methodical approach that includes identifying known information, identifying needed information, and developing a detailed research plan for the group. This process develops the skills needed to effectively work in a group and present verbal and written information.

Controversial Aspects
The controversial aspects of PBL come from the effects of the many variations in executing a PBL curriculum. Some aspects that are commonly discussed are the complexity of the problems, the role of the facilitator, and the assessment of students. Key to the PBL process is the problem statement. The topic of the problem and the complexity of the problem will significantly affect the students’ motivation and the achievable cognitive levels. Although databases of problem statements in many disciplines continue to grow, finding the correct balance of topical interest and
complexity for a specific course with specific learning objectives can be difficult. Problem choices will significantly alter the educational outcomes of the course. Also challenging for many educators is the role as facilitator, not teacher, in the PBL process. The role of the facilitator varies throughout the PBL process and throughout a given course. The skills of a facilitator vary and again significantly affect the students’ motivation and the achievable cognitive levels. In larger courses that require multiple facilitators this issue is compounded. The facilitator must balance the amount of directing they do to the importance of content coverage in the course. Allowing students to develop their own learning requirements can result in key topics not covered. Directly related to content knowledge is student assessment. The main focus of PBL is problem-solving skills in a group environment, which does not lend itself to traditional individual exams focused on content knowledge. Innovative and clearly published assessment techniques are required to maintain a positive educational environment.
References


Barrel uses modern examples of situations, including the attacks on 9/11, that may have been avoided if questions were asked, as the motivation for educators to develop inquisitiveness in students. *Chapter 8, Inquiry- and Problem Based Learning* starts with the same inquisitive approach and answers the question why should we use problem based learning. He then discusses techniques to implement problem-based learning through examples. Most other resources focus on science-based courses but Barrel includes a high school social studies class studying Africa demonstrating the flexibility of problem-based learning.

Barrows has published many articles on the use of problem-based learning in medical education and is widely referenced. This article would be very useful for an educator establishing a problem-based learning course as he or she weighs the objectives of their course against different problem-based learning techniques. The article establishes four educational objectives of problem-based learning and six categories of problem-based learning methods. Each method is then methodically evaluated in each objective. Although Barrows focus is medical education the educational objectives and methods can be easily modified for any field of study.

The implementation of problem-based learning requires the teacher to take the role as a facilitator. The role the facilitator plays can significantly change the problem-based learning experience for the students involved. This chapter, one of a collection of accounts covering a wide range of higher education topics, provides background information on problem-based learning then focuses on students’ perceptions of facilitation styles and skills. Based on students’ feedback, Clouston establishes three aspects to describe facilitation style and three aspects to describe facilitation skills.

This text takes problem-based learning, originally developed for medical students, and simplifies it for K-12 students. Although the sample problems are developed for primary and secondary education levels, the simplistic approach and frequent checklists makes it a useful resource for someone new to problem-based learning. Delisle develops a simple six-step process that provides the necessary structure for teachers and students to effectively implement problem-based learning.

An overall teaching resource, this text provides a short summary of problem-based learning and includes a detailed example of problem-based learning used in a writing course. Finally, a summary of current problem-based learning assessments is presented.


A short article written by one of the leaders in active learning, Felder stresses that the transition to an active learning curriculum (problem-based learning) will not be easy, but it is worth the effort. He makes an interesting comparison of what students first exposed to a problem-based learning environment experience and the experiences associated with trauma and grief. He then presents strategies to help students and educators make the transition.


In this article Goodnough analyzes the effects of executing a problem-based learning curriculum on her development as a teacher and specifically her pedagogical content knowledge. Although the focus is the self-study of an educator, many useful insights into the use of problem-based learning are presented as she discusses her experience executing the pre-service science education course. These include concerns about the appropriate support of students, equity among groups working on different problems, the amount of the course that was problem-based, appropriate assessment, group dynamics, and students’ learning of required content.


McKeachie’s text is a well known reference that covers a wide range of higher education topics. Several chapters cover different aspects and techniques of active learning including one on problem-based learning. This chapter highlights three specific variations of problem-based learning: guided design, case studies, and simulations. McKeachie provides a short description of each variation then provides a useful list of supplemental reading for each variation.


A very useful resource, it provides many details on the different models of problem-based learning, what constitutes a good problem, the role of the facilitator, and assessment methods. Included are many case studies that present different teaching scenarios as motivation to implement problem-based learning, develop plans to implement, predicts outcomes and then performs a cost-benefit analysis for each case. Finally, ten contributors detail their experiences in implementing problem-based learning.

This 362-page text is highly researched and is the most comprehensive resource on problem-based learning found. The details of problem-based learning are examined using major educational theories; clearly developing the strengths and weakness of problem-based learning. The key components of executing a course using problem-based learning is covered in detail including the role of the tutors and the tutorial process, the development of appropriate problems, and individual and group assessment. The final chapters provide useful information learned from direct experience executing problem-based learning courses.


Woods has developed three separate text covering problem-based learning. This text is the primary source for teachers as they consider problem-based learning and begin implementation in their courses. Unique is the details presented to implement problem-based learning in incremental steps. This process allows an educator to gradually make the transition from a traditional course to a problem-based learning course, a common hurdle. Also unique is the presentation of the complex options in problem-based learning in tabular form. Woods’ other text are cross-referenced throughout the text. *Problem-based Learning: resources to gain the most from PBL* is another teacher resource that provides more specific details on the implementation of problem-based learning. *Problem-based Learning: How to gain the most from PBL* is a student resource designed to introduce students to problem-based learning.
WEB Resources

The Problem-Based Learning Network at Illinois Mathematics and Science Academy in Aurora, IL. http://www2.imsa.edu/programs/pbln/tutorial/intro/
Problem-Based Learning at the University of Delaware. http://www.udel.edu/pbl/
Problem Based Learning and the McMaster Problem Solving Program at McMaster University in Hamilton, Ontario. http://chemeng.mcmaster.ca/innov1.htm
The PBLI is a group of teachers and researchers involved in PBL and active in faculty educational development. http://www.pbli.org/pbl/pbl.htm
The Interdisciplinary Journal of Problem-based Learning (IJPBL). http://docs.lib.purdue.edu/ijpbl/
Learning Initiatives website of the Penn State College of Information Sciences and Technology. http://pbl.ist.psu.edu/
The University of Medicine and Dentistry of New Jersey’s Center for Teaching Excellence. http://cte.umdnj.edu/

Other Resources


A Protocol to Assess the Curricular Validity of Cases for PBL. Teaching and Learning in Medicine, 9(3) 215-220.


Comparing Students' Attitudes in Problem-based and Conventional Curricula. Academic Medicine, 71(10), 1096-1099.


An Introduction to Reiterative PBL. Issues and Inquiry in College Learning and Teaching, Spr/Smr, A156, 19-36.


Analyzing the emergence of a learning issue in a Problem-Based Learning meeting. Medical Education Online, 2(1) [electronic serial: http://www.utmb.edu/meo/res00003.pdf, also to appear in Evenson, D. and Hmelo, C. (Eds.), Problem-Based Learning: A research perspective on learning interactions. Mahwah, NJ: Lawrence Erlbaum Assoc.].


