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PROMISE, PERIL, AND POTENTIAL: DEVELOPING, IMPLEMENTING, AND ASSESSING PROBLEM-BASED LEARNING AT THE UNDERGRADUATE LEVEL

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BACKGROUND

In an effort to cope with the vastly expanding body of knowledge in medicine, medical educators in the last 20 years began to realize that not all the facts one needed to know to practice could be 'taught' in four years of medical school. Furthermore, recall of material learned during the 'chock-full-of-facts' early years was discouragingly poor, and learned information went out of date very quickly. Educators came to the realization that producing students who were life-long self-learners was a reasonable solution. Even earlier, a few schools such as McMaster University in Canada began using problem-based learning (PBL) in their medical curriculum. Medical scholars recognized that this technique might also be part of the solution and began implementing it in their curriculum. Now, over 50% of medical schools have a significant problem-based learning component in their curriculum.

Use of PBL is becoming widely accepted and used in various forms. There are many examples of its use now in primary and secondary (K-12) and post-secondary (college) education, and in disciplines such as law, engineering, architecture, social work, optometry, management and administration, economics, nursing, and dentistry, to name a few.

THE POTENTIAL OF PBL

The potential of this method of learning is to produce students who are enthusiastic self-learners. They gain increased depth of understanding, enhanced recall of learned material, greater facility in using knowledge applied to real problems, satisfaction in learning, and confidence in tackling new areas of study. They can learn to work effectively in groups, improve their communication skills, and learn to efficiently locate sources of information when they need it.

PBL AT PENN STATE COLLEGE OF MEDICINE

PBL can be described as a learning technique that starts with a real-life problem in the areas of study. It is a problem with interdisciplinary features that demand integration of traditional disciplines. As it is used in Penn State College of Medicine, students, working in groups of 6-7 with a faculty facilitator, first call on their prior knowledge to begin analysis of the problem (the brainstorming or hypotheses-generation step). Then with sequential disclosure of additional information about the problem, they begin to realize what further knowledge they need in order to understand the problem, and they develop learning objectives to meet these needs. After a period of self-study, they meet again and discuss the new knowledge they gained, reinforcing it, seeing it from others' points of view, applying it to the original problem, and fixing it more firmly in memory (the elaboration-of-knowledge step). The initial problem and the recalled previous knowledge act as a scaffold for organization of the new knowledge. Most PBL methods contain these basic features in some fashion: brainstorming, group collaboration, student-selected learning objectives, self-study, and elaboration.

Penn State College of Medicine began with a self-selected PBL track for medical students in 1992. The track replaced the traditional two pre-clinical years with two years of PBL. There were no scheduled lectures, but students 'processed' 60-70 clinical cases per year, carefully chosen to lead them

to the core material deemed essential for progression to clinical work. The track ran successfully for six years, after which it was combined with the traditional lecture-based track to provide a significant amount of PBL for all students. In the hybrid curriculum, there are fewer lectures and more unscheduled time for study.

A brief review of the outcome of the PBL program shows that PBL students did equally well on the first external exam in the medical licensing procedure (Step I of the NBME, now called the United States Medical Licensing Exams). This result documented the fact that they had achieved the expected knowledge base (Figure 1).

Figure 1. Board Scores As Outcome: Comparison Tracks

Track/Year	N	Mean Score	SD
PBL (Yrs. 1-6)	144	209.44	19.70
Lecture (Yrs. 1-6)	483	209.46	21.14
PBL (Yrs. 2-6)*	113	211.35	19.00
Lecture (Yrs. 2-6)*	388	210.83	21.51

Board scores are scores of the National Board of Medical Examiners exam, Step I.
*Years 2-6 were analyzed separately to allow adjustment for the MCAT covariant, since the method of MCAT scoring changed between year 1 and 2.

In their third-year clinical work, in the six required clinical clerkships, PBL students achieved significantly higher scores for 'Fund of Knowledge' from their clinical preceptors (Figure 2). This difference remained statistically significant after adjusting for covariants such as age, race, gender, year, pre-admission grade point averages, and Medical College Admissions Test scores.

Figure 2. Comparison of PBL and Lecture-based Student Clerkship Scores

Condition	Fund of Knowledge p value	Clinical Problem-Solving Skills p value
Unadjusted	**0.0004***	**0.0182***
Adjusted for all covariants	**0.0316***	**0.3949**

Data unadjusted for covariants or adjusted for base and MCAT covariants by multivariate linear regression models.
* statistically significant

Scores for 'Clinical Problem-Solving Skills' were not significantly different after adjusting for covariants. This was attributed to the fact that these skills are judged by observation of student-patient interactions such as interviewing and physical examination, where PBL and lecture-based students received the same training. Anecdotal information from students and preceptors suggest that PBL students were more comfortable approaching a new clinical problem, asked more questions, and were more active in discussions in the clinical setting. Students also related that they felt their recall was good and that they enjoyed the learning environment.

PROBLEMS OR CHALLENGES OF PBL

From my experiences with PBL, I can relate some of the challenges and pitfalls of PBL, in implementing and administering such a different approach to learning, and perhaps offer some advice to faculty who would like to implement it in their undergraduate courses.

Challenges

Difficulties include these:

1. Lack of students' confidence in their self-learning abilities; they doubt their skills.
   It takes time for students to gain this confidence; they need to engage in PBL for a while to gain this confidence in themselves.
2. Lack of confidence by faculty in students' self-learning ability and self-motivation. It takes time for faculty to change their "if I don't tell them, they won't learn it" approach.
3. Difficulty in designing good problems. It is hard work and takes a lot of creative energy on the part of faculty to design good problems.
4. Decreased breadth of exposure to material in the discipline. Because students are taking more time to go into greater depth in the learning objectives of a case, it is not possible to "cover" as much ground.
5. Competition with courses running concomitantly. A student taking five traditional courses with one course using PBL is unlikely to have sufficient time to get the maximum benefit from PBL.
6. Difficulty in assessment of student performance. Assessment should match the learning, but this is difficult to achieve in many cases.
7. Administrative challenges if PBL is used in an entire program rather than one course or part of one course.

Pitfalls

Traps that faculty can fall into when implementing PBL in their courses are related to the difficulties described above:

1. Not preparing students for the experience. The process and expectations for student performance must be explained beforehand. Some preparations to help students work within groups are helpful. Preparation should include helping students become familiar with how and where to obtain information.
2. Underestimating the workload. It takes significantly longer for students to research the learning objectives on their own.
3. Overestimating the amount of material that can be 'covered'.
4. Using poorly designed problems.

5. Over-populating student groups. The optimum size of groups is in the range of five to eight students. Larger groups do not function well because it is difficult for all students to participate equally and have meaningful input.
6. Involving faculty who have not been trained to function as facilitators. Faculty must allow the educational experience to be student-centered, and to realize that their role is to be guides, not lecturers, directors, or leaders of the group.

FACTORS IN DESIGNING A PBL COURSE

A general checklist of activities that occur during development of a PBL course is given below. It is difficult to generalize an approach when PBL can be used in so many ways, and to various extents e.g., part of a course, as a whole course, as an entire program, and when the problems themselves can be so varied.

1. Develop an overview of the course. Will there be lectures? If so, how many? How many problems will be used? Where should the problems be placed?
2. Design the problems. See below.
3. Prepare the students for the experience.
4. Train the faculty, if more than one (you) will be involved as facilitators of the groups.

Steps in Development of Problems

One way in which to go about developing problems is as follows:

1. Determine the desired learning objectives. List them. This should be a manageable list that is consistent with the time available for study.
2. Choose a real-life problem in which these learning objectives would naturally arise. The topic of the problem should be meaningful to the students and be something they would encounter. Students who can see the relevance in what they are learning become much more enthusiastic learners.
3. Assess the level of development of the students. Design a problem that is within the abilities of the students.
4. Determine where these learning objectives would best fit within the other sequences of activities or lectures within the course.
5. Write out the problem, and determine if additional information should be given to the students, and if so, when in the process it would fit.
6. Decide on the resources (texts, lab equipment, computers, or other) and make sure they will be available. PBL places additional loads on a library, for example, and librarians should be prepared ahead of time.

Resources for Faculty

The references below are good sources to use to get started in developing PBL. An impressive source of information is the Internet, where descriptions of the use of PBL at all levels of education can be found. There are examples of problems actually used in undergraduate education, and descriptions of PBL programs in use at various universities.

CONCLUSION

There are a large number of potential benefits of PBL, many of which have outcomes that are difficult to assess. Traditional assessment methods, such as multiple-choice exams, often cannot detect the skills that are being learned in a PBL environment. They can determine that the PBL student has an equivalent knowledge base, but skills in locating information sources efficiently, working effectively together in groups, communicating more clearly, gaining self-confidence, reasoning through a problem

more effectively, and becoming life-long self-learners are difficult and rarely assessed. An often-stated criticism of PBL is that it has not been shown to produce a better final product (do students become 'better' doctors or administrators, etc.?). Therefore, the question becomes this: is it worth the considerable effort to institute PBL into the curriculum? How important is it that students enjoy their learning? How important are the unmeasured skills that can be developed? Those of us who have become sold on the process and the values would say the potential gains are well worth the effort. My advice is to prepare for the pitfalls, and go for the potential.

HELPFUL REFERENCES FOR PROBLEM-BASED LEARNING

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Carol Whitfield is a faculty member at Penn State College of Medicine. She began her career in medical research in the Department of Cellular and Molecular Physiology. In 1992, she made the transition to concentrate on medical education. She was Co-director of the Problem-Based Learning (PBL) Track for medical students until 1997, at which time a hybrid curriculum containing PBL for all students was initiated. She is the Director of the Multidiscipline Labs, and is Director of Educational and Facilitator Development, Office of Medical Education.