PROBLEM-BASED LEARNING

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II. What is PBL?

A. A brief history

1. Developed in 1965 at McMaster in Hamilton; it was copied by the University of Limburg at Maastricht in the Netherlands. Howard Barrows, one of the originators, moved to Southern Illinois University. It has since spread through the US, the UK, Australia, and a number of other countries. It is now used in a variety of educational settings.
2. PBL's developers at McMaster had little formal training in education. They had, as a group, been unhappy with their experiences in medical school and content with their experiences as residents. They sought to put the emphasis on learning, not teaching, by
   a. Making the student an active partner in the learning process.
   b. Increasing the perceived relevance of what was being taught.
   c. Focusing more on concepts and deep learning rather than rote

memorization.

d. Freeing up curriculum time in order to furnish students with more control over their education.

3. In 1992-3 there were 22 American and Canadian schools that were utilizing PBL.
   a. Canadian schools were more likely to be pure PBL (4/6 programs that were utilizing an exclusively PBL format.
   b. Another eight schools (all American) offered both PBL and conventional tracks.
   c. The remainder offered some PBL courses--hybrid curricula.
4. Since then the numbers have been steadily mounting. "There is scarcely a medical school that has not thought seriously about implementing PBL. " (Shatzer)

III. What is the rationale for PBL?

A. What do we want medical students to take away from medical school?
   1. Acquisition of an extensive, usable, integrated knowledge base.
   2. Development of effective and efficient clinical reasoning skills.
   3. Development of effective and efficient self-directed learning skills.
      a. This must include internal motivation for learning and questioning as well as the ability to accurately diagnose holes in one's knowledge base.
   4. Development of effective patient interaction skills.
      a. History taking
      b. PE
      c. Basic communication skills necessary to motivate behavioral change.
   5. Development of the ability to work effectively with colleagues.
   6. Development of skills in life-long learning.

B. Theoretical underpinnings of PBL. It is based on adult learning theory.
   1. Realize that the two models listed below are stereotypes and not totally age-dependent. Thus, a good grade school will use many adult learning techniques. Adults, when confronted with a totally alien experience where previous life experience does not serve, may be better served by relying on a child learning model.

Adult and Child Learning		
	Child	**Adult**
The Learner	Dependent	Self-directed

Adult and Child Learning		
The Teacher	Full responsibility for decision making.	A guide
Teaching Technique	Information transmission--lecture, assigned reading, audiovisual presentations. Passive learning.	Active learning.
Role of Learner Experience	Learners are tabula rasa.	If experience is ignored or not valued, it feels as if the person is ignored or not valued. Previous experience may beget closed mindedness.
Readiness to learn	Open to learning. Mature from grade to grade. Readiness is largely a function of age.	Adults are ready to learn when there is a need.
Orientation to learning	Subject oriented	Life centered, task oriented, or problem centered
Motivation for learning	External pressures.	External pressures also applied, but internal motivation is a far more powerful motivator.

2. While adult learners may indeed be self-directed in all other aspects of their life, there is often a primitive reflex when they enter into a setting that is labeled "educational" whereby they return to their previous mode of learning and to a dependent role.

C. There is an important review by Norman and Schmidt. They took the various rationales for PBL and examined each in terms of experimentally derived data. They use Barrows' goals for PBL to organize their discussion.

1. Fostering clinical reasoning or problem solving skills. The problem here is that there are few data to support the concept of generalizable problem solving skills; they tend, instead, to be situation and discipline dependent.
2. Enhancing the acquisition, retention, and use of knowledge. There are several key principles here
   a. Activation of prior knowledge facilitates the subsequent processing of new information--those who know baseball will recall more of an account of a game than will those who do not know about the game.

b. Elaboration of knowledge at the time of learning enhances subsequent retrieval.
   (1) Thus, taking notes at a lecture helps.
   (2) Using knowledge to understand a problem and the discussion that takes place in a small group will both help.

c. Matching contexts facilitate recall.
   (1) Royal Navy divers who learned word lists on land recalled them better when tested on land; those learned in the water were recalled more readily when tested in the water.

d. Note that PBL is closer to meeting these criteria than is a traditional curriculum. Material learned in a clinical context with small group discussion and the working through a problem before going to the literature activates prior knowledge.

e. Multiple tests of this area have been consistent. PBL students' immediate recall of material is worse, but long-term testing (periods have ranged from six months to four years) have consistently found better recall by PBL students.

3. Use of prior examples and pattern recognition. The idea here is that learning is situation dependent. Learning in the PBL setting may enhance retrievability when similar difficulties are seen in real clinical situations. This is, of course, pattern recognition.

a. There are good data in the education literature which indicate that activation of prior knowledge facilitates the subsequent processing of new information. The small group discussion seen with PBL should force students to articulate prior knowledge in this area.

b. New knowledge has to adhere to prior knowledge. Thus, if you know nothing about baseball, you will have a harder time recalling the number of homeruns that Sosa and McGuire have.

c. Elaboration of knowledge facilitates later recall. Thus, discussion about this topic will facilitate later retrieval. Again, the group will help in this regard.

d. One would argue that PBL by virtue of increasing the student's clinical base would enhance this, but this is largely untested.

4. Narrowing the gap between basic and clinical sciences; the transfer of principles and concepts.

a. All of the literature points towards a rather narrow window of transferability. Thus, very comparable reasoning is not invoked unless the environmental cues are the same.

b. They argue that successful transfer requires:
   (1) That the domain not be identified. If it is presented as a problem about hypothalamic regulation, the chances of students transferring the information will decrease.
   (2) Problem solving without feedback does not work. There

must be corrective feedback immediately upon completion of the problem.

(3) There was an experiment where students from a PBL curriculum and another group from a conventional curriculum were asked to solve a clinical problem and then integrate three passages of basis science knowledge into the case.

(a) Students from the PBL curriculum advanced many more causal explanations.

(b) Students from PBL were able to integrate basic science and clinical problems; conventional students did not do nearly as well at the clinical end.

5. Enhancing self-directed learning skills and life-long learning.
   a. PBL students check more books out of the library than do conventional students.
   b. Exams years out on clinical material are performed better by PBL students (limited data).
6. Students' intrinsic interest in subject matter may be enhanced by PBL.
   a. Much of learning in our educational system is extrinisically motivated, e.g. passing an examination. The problem with this is that the depth of learning is limited by passing the exam.
   b. PBL students who have discussed a topic are more likely to follow it up and to read more on their own than are students from a conventional curriculum.

IV. Use of PBL

A. A PBL session

1. The tutorial room should have a large table, many blackboards, a medical dictionary and a medical text.
2. Introductions are made, emphasizing background that may be pertinent to the case at hand.
3. Ground rules are reviewed.
   a. Silence means assent. If you are quiet, then you understand.
   b. Expression of ignorance is encouraged. We want students to figure out what they do not know, to acknowledge this, and then to work at correcting the deficiency. There is no point in showing off knowledge unless it is helpful to others in the group.
4. A student reads the first part of a case.
5. A scribe divides the board into four areas. A secondary scribe writes it down, since someone will erase it prior to the next session.

Hypotheses	Facts	Learning Issues	Action Plan

Hypotheses	Facts	Learning Issues	Action Plan
Brain-storming about causation	Syntheses of information obtained through hypothesis guided inquiry.	List of what needs to be learned in order to complete the problem task. (This commits students to work, so they may need to be pushed on this one.)	Things that need to be done in order to complete the problem task.

6. Terms or concepts in the case that are unknown are clarified.
7. Explain the problem--rank order the hypotheses. Go out on a limb, listing the explanations proffered from most likely to least.
8. Assign the learning tasks to members of the group.
9. Self-study. Return to report on what was learned.
    a. What resources were used and a critique thereof.
    b. A summary of the problem
    c. Reassess the problem. Change the table noted above.

Hypotheses	Problem Information	Learning Issues	Action Plan
Revise in light of new information	Apply new information. Inquire for additional information. Summarize problem and its possible resolution.	Identify new issues, if necessary, or redefine old issues.	Actions need to complete performance and/or presentation.

10. Return for a second or third session. Share the results of self-study, trying not to inflict a lecture on your colleagues.
11. Self- and peer-evaluation
    a. Reasoning through the problem.
    b. Digging out information and using appropriate resources.
    c. Assisting the group with tasks.
    d. Gaining and refining knowledge.
12. Tutor and group evaluation.
13. The tutor's role
    a. Faculty are there to function at a metacognitive level, not to give answers, but to help in figuring out learning strategies.
    b. The primary job is process, not content

(1) Encourage the group to make sure that all students are involved.
(2) Modulate the flow of the group so that students are neither overwhelmed nor bored.
(3) Monitor/manage interpersonal dynamics.
(4) Encourage group responsibility.

c. Make educational diagnoses
(1) Attend to problems of:
(a) Knowledge/understanding.
(b) Reasoning/critical thinking
(c) Self-directed study.
(d) Initiative/diligence
(2) Ask students to reflect on these areas.

d. Model, support, then fade from the process by encouraging the students to:

e. Take responsibility for the PBL process
(1) Interact with each other
(2) Become independent learners.

f. When in doubt:
(1) Opt for student centered action
(2) Let the process work (hold back)
(3) Ask for problem synthesis
(4) Ask "Why?"

B. Construction of a case. A good PBL case:
1. Should grab you, for, if you can convey why this got to you, it will get to students.
2. The student is grabbed. They may identify with the patient or with the physician. The case should represent a compelling real world problem. It should be as true to real life as is possible.
a. In the presentation
b. In the students' role
c. In the information that is available to the student at any point in the process. In the product demanded at the end of the process.
3. As in real life, the case unfolds slowly with a vague beginning.
4. The students' role is clear.
5. It encourages detective work. It demands inquiry to solve problems.
a. Students should never be able to solve a case based exclusively on previous information. If so, they are not learning.
(1) Information is provided only as it is asked for. The usual tendency is to give out too much up-front.
(2) Students have access to information as in the real world. To learn, they have to ask.

6. It encourages creativity. It demands higher order (metacognitive) thinking.
7. There is a way for the student to assess if they are done.
    a. Good cases assign students a task. A product arising from the PBL gets them more involved.

C. The evolution of a PBL group
    1. Kalaian reported on a survey of PBL students that was performed when they were first using PBL and then repeated later after they had become more sophisticated learners. There was an expectable evolution. Initially the tutor was seen as of paramount importance. Later the importance of the tutor faded and the importance of group interaction increased as did the learning materials utilized.

D. Do PBL groups adhere to faculty-defined learning objectives?
    1. This is largely a function of how well crafted the case is.
    2. Kennedy and Wilkerson reported on Harvard PBLs in the early days of the New Pathway.
        a. They ran cases and then furnished students with a list of questions for post-case consideration. These did not tie directly to the case, but to the organ system that was being studied.
        b. For the study students and faculty in the Human Body block were asked to list the major issues discussed by the group.
        c. This was required since HMS students were inconsistent at listing learning issues studied.
        d. They did well at covering the major anatomy issues. They did less well with histology and only rarely discussed the psychosocial issues buried in each case.
        e. In sum, they followed the goals of the course. The interesting question would be if the same cases presented in another course would have led to different results.

V. What makes for a good tutor?

A. The subject expert vs nonexpert debate
    1. There are data which suggest that subject experts tend to be more active as tutors, that they guide the discussion more, and that there is more student ←faculty and less student←student interaction with expert tutors.
    2. Some argue that this is an irrelevant debate, that faculty will not volunteer to tutor in areas where they are inexpert. That has not been the case in Rochester. My own experience would suggest that while tutoring in an area where I am not a subject expert is considerably more anxiety provoking, it is also in many ways more gratifying.
    3. Others argue that one of the primary determinants is the degree of structure

that the cases provide. (e.g. a highly structured case over-rides subject lack of expertise.)

4. It also gets complicated by the question of the degree of expertise. Davis writes about "hyperexperts".
5. Eagle found that students in groups led by content experts defined twice as many learning issues as students in groups led by nonexperts and spent twice the time in self study.
6. Maastricht (Dolmans) asked tutors to rate themselves as subject experts or nonexperts. They then looked at data for 119 tutors involved with 135 tutorial groups. Students were asked to rate their prior level of expertise with the cases and there was an assessment of how structured the clinical material was. Cases were analyzed for the amount of structure provided. Students were then administered 150 T-F questions at the end of each unit.
   a. There was no difference in the scores of groups led by subject experts and nonexperts.
   b. There was no relationship with structure or lack thereof.
7. Another Maastricht paper looked at the impact of a subject expert on how students' approached a problem. Students taught by subject experts spent more time on self-directed study and defined more learning objectives. Their achievement was very slightly superior to that of the other students. Both effects washed out over time, being most dramatic in the first year of the curriculum, suggesting that rookie students were more dependent on the faculty for guidance.
8. Another question revolves around how well a non-subject expert tutor can assess student performance. Kaufman (1997) looked at the correlation between tutors' evaluations of students and their performance on written short answer examinations in the basic sciences.
   a. There was a statistically significant but weak correlation between tutors' rating of students knowledge acquisition and integration with performance on the examination. Asking the tutors to predict students' exam performance yielded similar results.
   b. Subject experts and nonexperts were equally inept at predicting exam perfromance. There were three of thirty one tutors who did rather well at predicting--all were experienced teachers. One tutor was equally good at predicting performance (albeit in a negative direction--if he asserted that a student would do well, they did poorly). He was a relative rookie.
9. How to reconcile the apparently conflicting data? Possible explanations include:
   a. Differing definitions of what constitutes expertise.
   b. Students' differing status in the curriculum
      (1) Students just entering medical school and without PBL expertise or expertise in researching learning issues may

have different needs than more experienced students.

(2) Students with some background in an area may have differing needs from those who have a solid underpinning.

(3) Thus, Schmidt (1994) compared student tutors, non-expert faculty tutors, and expert faculty tutors in terms of student performance on examinations. If students had low prior knowledge of the area being studied, tutor expertise mattered. Tutor expertise was also important in cases which were relatively unstructured, but largely disappeared with more structured PBLs. Interestingly students did relatively well as tutors in situations of low structure and in cases where the tutees had relatively little background. The most logical explanation is probably that they were most able to translate for the learners when they really needed it.

c. The degree of structure afforded by the case. Davis' first study found that subject experts were associated with students who were happier about PBL and who learned more. A second study by the same authors with more structured cases made any difference disappear. They did find that subject experts were more likely to direct interactions than were nonexperts. The latter finding echoes previous findings of Silver.

10. What conclusions can we draw? Luann Wilerson reached the following conclusions:

a. Whenever possible, recruit tutors who are familiar with essential course content. If you are going to use nonsubject experts, make the cases highly structured. If you have a limited number of content experts, use them for beginning students.

b. Provide resources for increasing relevant content knowledge among tutors, including case preview, clear objectives, and readings. Make sure that there is a content expert available as a consultant to students and faculty.

c. Provide training in group-process facilitation that includes the appropriate use of knowledge and experience to promote student-directed discussion.

d. Craft problems that provide substantial cues for faculty and students about what is essential to be learned when students are new to PBL, when students' relevant prior knowledge is minimal, or when other curricular activities are unstructured.

e. Take time to study PBL in your own institution.

B. Role functioning of the tutor. Moust has written (admittedly in Dutch, so more accurately, is reported to have written) that there are six key behaviors for the tutor:
   1. Use of subject matter expertise
   2. Use of authority
   3. Achievement orientation
   4. An orientation towards cooperation in the tutorial group
   5. Role congruence--"the willingness of the tutor to be a student among students"
   6. Cognitive congruence--"the ability to express oneself in the language of the students, using concepts that they use and explaining things in a way that is easily understandable by students". This is regarded as a sine qua non for tutors.
      a. It also involves the ability to be sensitive to the difficulties that students may come across.
      b. It assumes a genuine interest in the students.
      c. It assumes sufficient subject matter expertise as to be able to follow students' reasoning.

VI. How do students feel about PBL?

A. In 1992-3 at the University of Toronto they tested student and faculty attitudes towards PBL before implementing a new curriculum and again after the first five week block.
   1. Prior to PBL 38% of the students favored PBL over their traditional curriculum as the more effective manner of learning. Post-PBL this increased to 52%.
      a. PBL was rated superior for developing teamwork, for relating to patients, and (post-PBL, but not pre-) for clinical skills.
      b. Traditional teaching was rated more positively for knowledge acquisition.
      c. They ended up favoring a hybrid curriculum.
      d. Faculty results were quite consonant with those of the students.
   2. At Dalhousie (Kaufman, 1996b) they surveyed classes from the last year of a conventional curriculum and contrasted them with those from the first year of a PBL curriculum.
      a. As the only medical school in the Maritime Provinces, they represent the only real option for most of their students. They therefore felt that there would not be any real differences between the two classes. Demographic data, etc. seemed to support this

view.

b. Students from the PBL class rated their curriculum as provoking more enthusiasm about learning, and as higher for democratic decision making. PBL students thought that there was more vigorous class discussion, that faculty were more enthusiastic, and felt that there were more outstanding course offerings. PBL students were less positive about student interactions, apparently reflecting the development of cliques. PBL students saw faculty as more likely to provoke students' curiosity. They saw the material (basic sciences) as more fundamental to their experience as a physician.

c. There was no difference between students from the two curricula in terms of attitudes about social issues in medicine.

d. A second report (1996a) compared responses on 12 items. 11/12 favored PBL. The only exception was on learning details. The other items included understanding principles and how to apply them, integrating across subjects, articulating previous knowledge, stating learning objectives, making decisions, independent thinking, problem solving, gathering and analysing information, stimulating and enjoyable, stimulated to learn more, and stimulated to read medical literature.

3. Lancaster and Lieberman looked at students' perceptions of the medical school environment prior to matriculation and after the first year. They looked at cohorts from two medical schools and compared students in lecture based and PBL oriented tracks at both schools. They found that both groups started with the same expectations, but that PBL students clearly viewed the school more positively on 6/7 scales than did the grads of the lecture based courses. This was true for the school as offering a more meaningful learning experience, as more flexible, as allowing exploration of special interests, as more nurturing, as encouraging more student-student interaction, and as providing a more positive emotional climate. The lecture based format was better in terms of organization.
4. Both of these reports are in contrast on one study which found student-student interactions to worsen with PBL. This is clearly an atypical finding.

B. How do students see themselves learning? Martha Regan Smith asked students at conventional and PBL schools whether they learned by rote.

STUDENTS' PERCEPTION OF PERCENTAGE OF LEARNING THAT IS BY ROTE			
		>50%	p
Years 1 & 2	Traditional	49%	<.0001
	PBL	6%	
Years 3 & 4	Traditional	9%	NS
	PBL	4%	

VII. How do faculty feel about PBL?

A. Vernon surveyed 1287 faculty tutors from 22 US and Canadian schools which utilized PBL during 1992-3.
   1. 69% response rate. They were given a series of nine questions with a series of Likert questions favoring conventional or PBL teaching. There were, in addition, a series of open-ended questions.
   2. They were an experienced group, averaging 11.4 years of teaching experience in the traditional curriculum and 3.75 years with PBL.
   3. They averaged about ten weeks of PBL teaching and nine cases in the preceding year.
   4. 77% tutored on a voluntary basis; the remainder were required to do so.
   5. 4% said that they would definitely not tutor in the following year; 20% said that they might; 75% said that they would definitely do it the

following year.

6. Each item was scored from 1 (traditional approach perceived as much better) to 3 (both PBL and traditional the same) to 5 (PBL much better).

Item	Mean	SD
Student interest and enthusiasm in the material	4.31	.85
Factual knowledge of basic science	2.63	.97
Understanding of general principles	3.56	.95
Faculty interest and enthusiasm overall	3.70	.98
Own personal satisfaction	4.16	1.00
Efficiency of learning	3.16	1.16
Student reasoning ability	4.24	.75
Preparation for clinical rotations	3.86	1.00
Overall value to students	3.94	.87
Total (mean of all items)	**3.73**	**.66**

7. The greater the faculty member's experience with PBL, the more robust was their support.
8. There were several open-ended questions about what they liked most and least.
   a. Most liked aspect of PBL:
      (1) Tutor-student relationship

(2) Student motivation for learning
(3) Group atmosphere
(4) Student-directed learning
(5) Student problem solving

b. Most disliked
(1) Time required
(2) Poor student motivation
(3) Student evaluation problems
(4) Lack of faculty control over student-directed learning
(5) Basic science knowledge problems.

VIII. What are the outcome data?

A. There are two large metanalyses of PBL (Albanese and Vernon, 1883) published within six months of one another. They draw similar, but decidedly different conclusions.

METANALYTIC STUDIES OF PBL		
Variable	**Albanese**	**Vernon**
NBME I	Mixed data with trend favoring conventional students.	Same, but notes marked heterogeneity.
NBME II or other clinical exams	Trend effect favoring PBL	Same
Study behaviors	PBL students study for understanding; conventional students for short-term recall. PBL students are more likely to use the library.	Same, PBL students also more likely to go online. PBL students were more likely to use self-directed resources.
Learning environment	PBL students are less stressed, except at Harvard where the opposite was the case. Students generally favor PBL.	
Student satisfaction	Clearly higher with PBL.	Same

METANALYTIC STUDIES OF PBL		
Graduates' perception of their training	Solidly favor PBL.	Same
Residency selection	PBL graduates do well in the Match	
Clinical evaluations of graduates	Clear trend towards higher ratings for PBL graduates by their clinical supervisors.	Same
Specialty choice	Greater tendency to opt for family medicine.	
Faculty satisfaction	Faculty find PBL a satisfying way to teach, particularly the personal contact.	Same
Costs of PBL	If class size is <40 PBL is cheaper. If >100 it is more expensive. In between is harder to gauge. The longer retention of material by PBL students might mean that there would be less need to reteach over the long-term, thereby lowering costs, but this has not been calculated.	

B. Examination results
   1. It can easily be argued that conventional MCQ examinations are biased in terms of conventional curricula simply by emphasizing memorization and factual knowledge rather than clinical reasoning.
      a. Richards reported data from Bowman Grey which had parallel PBL and traditional tracks. They argued that USMLE was an inappropriate measure since it emphasizes recall to a significant extent and that a standardized patient clinical performance examination would be a better means of assessment.
      b. Students were observed as they worked up each of fifteen patients. This was an examination developed by a NC statewide consortium

and also used several NBME developed cases.

c. Students elected either the PBL or traditional curriculum, so there is some real bias in the results. More women opted for the PBL track. MCATs were comparable. The PBL students rated somewhat more extroverted on an introversion/extroversion scale.

d. PBL students outperformed traditional students on every item on this exam on a statistically significant basis. Step II of NBME, and third year medical school GPAs all favored PBL as well, though this was only a trend effect.

C. One of the aims of PBL should be the development of enhanced self-assessment skills.

1. Hay reports on an interesting experiment from an allied health program at McMaster.

a. They compared self-assessment with faculty assessment over a series of cases.

b. Students initially rated themselves more highly than did the faculty.

c. At the end of the six cases students were more self critical than the faculty were.

d. Inter-rater reliability between faculty- and self-assessment increased going from .49 on the first evaluation to .84 by the sixth.

e. Their interpretation was that this was more of a case of students being trained to come close to faculty than it was of enhanced self-assessment.

D. Much of the data emerge from the University of New Mexico which has run two parallel curricula.

1. From 1979-93 there were two tracks for the first two years. The Primary Care Curriculum was a PBL based experience. Theirs has been a relatively unstructured form of PBL, close to McMaster's, with students setting their learning priorities. There has been a well articulated emphasis on community medicine and on primary care.

2. They have published data with careful analysis of NBME perfromance for students from the conventional and PBL tracks.

a. First something about how students were selected. There were six admission subgroups. All students were asked to express a preference for one of the two tracks prior to matriculation.

(1) 439 students who asked for the conventional track got it since there was a clear excess of students requesting PBL

given that there was only room for twenty students per year.

(2) 34 students requesting PBL were randomized into the conventional curriculum

(3) 85 were randomized into PBL.

(4) 82 students who requested PBL were thought to have extraordinary qualities including a high probability of returning to medically underserved communities, broad life experience, or a superior academic record. These students were not randomized but placed directly into the PBL group.

(5) 18 students requested PBL but judged unacceptable.

(6) 17 students requested PBL but changed their minds before starting the curriculum.

Comparison of Mean Scores on NBME I, II, and III for UNM Classes 1983-92					
	Conventional Track		PBL Track		
Exam	No.	Mean	No.	Mean	p
I	508	504	167	456	.0001
II	447	460	144	469	.29
III	313	491	103	521	.001

(7)

Students' Failure Rates on First Attempt By Admission Subgroups				
	NBME I		NBME II	
	No.	% Failing	No.	% Failing
1. Chose Conventional Track	439	9	392	3
2. Randomized Into Conventional Track	34	3	27	0
3. Randomized Into PBL Track	85	18	67	0

Students' Failure Rates on First Attempt By Admission Subgroups				
4. Selected Into PBL Track	82	21	77	5
5. Unacceptable to PBL Track	18	33	14	29
6. Declined PBL Track	17	12	14	7

(8) They looked at the influence of MCAT scores on NBME performance and found those who entered with low MCATs did poorly on NBME irrespective of track. Curiously GPA for undergraduate science course was a strong predictor of NBME performance in the conventional track, but not in the PBL track.

b. They point out that NBME performance was emphasized in the conventional, but not in the PBL, track.

3. They have looked at their graduates.
   a. Santos-Gomez looked at their graduates performance as residents.
      (1) Self ratings did not differ overall, though PBL grads did rate themselves higher on patient communication skills.
      (2) Residency training directors gave higher evaluations to graduates of the PBL track.
   b. Mennin (1996) is a survey of graduates from the first four years of the curriculum after they had been in practice and had completed their residency training.
      (1) PBL graduates were more likely to work in medically underserved areas, to practice in publicly funded settings, and to care for non-paying patients.
      (2) They were more likely to identify patient problems and curiosity as driving their learning.
      (3) They were more likely to study clinical medicine and community health topics and to spend time in community activities.
      (4) They felt better prepared for practice by their medical school than did their conventionally trained colleagues. They felt better prepared than conventional students in terms of clinical reasoning, coping with uncertainty, diagnostic skills, doctor-patient relationship, follow up care, health economics, history taking skills, interviewing skills, continuing education, patient education, PE skills,

preventive care skills, service for medically underserved patients, self-assessment, teamwork, therapeutic management, and overall preparation for medical practice. *Conventional students did not rate their preparation more favorable on <u>any</u> item.*

(5) There was no difference in the degree of satisfaction attained from their work (though there was a trend favoring PBL grads) or in their likelihood of asking for consultation.

(6) Both groups were very likely to be practicing as PCP's (67% conventional; 79% PBL).

(7) PBL graduates were far more likely to spend time as faculty preceptors.

(8) PBL graduates were more likely to use library resources on a regular basis, though in all other respects they seemed to use the same resources.

E. Southern Illinois (the home of Howard Barrows and therefore an international training site for PBL) has run parallel tracks as well.

1. Cautions here include:
   a. PBL students may attend conventional lectures, labs, etc. It should be pointed out that very few actually elect to do so.
   b. Tutors are extensively trained with a f/t one week training period required. There is no comparable training requirement in the conventional curriculum.
   c. Students opted into the PBL track.
2. Distlehorst reported data on the first three classes. All measures favored PBL though many failed to reach statistical significance.
   a. The two tracks' students were comparable in terms of underrepresented minorities, age, gender (slight excess of _ in PBL), overall GPA, and Science GPA. Differences in the >.01 <.05 level were found for MCAT (PBL 8.64; Conventional 8.22) and rural background (29% PBL; 16% Conventional.
   b. USMLE Step I scores were comparable (means 201 vs 198)
   c. USMLE Step II was 208 vs 199; p .0197
   d. Clerkship grades were 4.12 vs 3.90 p .0028.
   e. Clerkship OSCE both in terms of examination and interview checklists again favored PBL on all measures, though statistical significance was not obtained.

F. Moore et al reported data from the New Pathway at Harvard.

1. This represented a move to a hybrid PBL curriculum, though there were other changes. It is therefore hard to unbundle the effects of PBL from other changes (more interdisciplinary teaching, an ongoing mentoring relationship with a faculty member, etc.)
2. They looked at the students who applied to the New Pathway track. Applicants were randomized to either traditional or NP tracks and, thus, served as a good control group. They were comparable at baseline in all respects (age, gender, GPA, MCAT, etc.)
3. NBME performance--no statistical difference between the two groups on NBME Part I with the exception of improved perfromance in behavioral science for NP students.
4. When tested after year four on material learned in year one from preventive medicine and biochemistry, there was no difference.
5. There were several attempts to test clinical reasoning and no difference was found in perfromance.
6. Attitudes towards social issues in medicine were not different. NP students expressed greater appreciation of the centrality of the doctor-patient relationship, but there was no difference in terms of prevention related issues. NP students were more tolerant of ambiguity and were more empathic than conventional students.
7. Their interpretation was the NP curriculum was, across all measures, more effective in teaching interpersonal skills during the first two years.
8. NP students endorsed a preference for discovery style or student-directed learning. NP students were less likely to memorize, they crammed less, and they retained material better after three months.
9. NP students saw themselves a having greater autonomy, more innovation and involvement with their education. They had less clarity about their work. Work pressure was felt to be higher after the first year for the NP students, but was equivalent after year two. NP students felt more responsible for their own educational experiences. They were also more anxious and frustrated than their conventional colleagues. They were more likely to describe their curriculum as “stressful, engaging, and difficult”. Traditional students were more likely to use “nonrelevant, passive, and boring”.
10. NP students were three times as likely to form a close relationship with a faculty member.

G. McMaster has several interesting outcome studies.
   1. Their was a survey comparing McMaster graduates with others in Ontario. They were asked about the extent to which medical school prepared you

to practice.

a. 66% or McMaster graduates were satisfied or very satisfied with their preparation compared to 40% of the graduates of other schools.
b. 10% were dissatisfied vs 26% of the graduates of other schools.

2. They reported on the practice patterns of their generalist graduates and contrasted them with graduates of other, more traditional, Ontario medical schools.
   a. As with the New Pathway, it is difficult to parse out the effects of PBL.
   b. None the less they found that McMaster graduates matched by gender, year of graduation, and practice location were more likely to see fewer patients, to offer more psychotherapy and more prenatal care, and to be Board Certified.
   c. Their graduates were more likely to teach, to engage in research, and to be involved administratively.

H. PBL vs integrated curricula.
   1. Schmidt (1996) reports data from three Dutch medical schools--one traditional, one PBL, and one that integrates basic sciences and clinical sciences throughout the curriculum with a combination of lectures and small group teaching that is not PBL. They looked at students' ability to generate accurate differential diagnoses from a series of case histories representative of the most common disorders seen in the Netherlands.
      a. Students from the integrated and PBL schools outperformed those from the conventional curriculum during the latter half of the curriculum.
      b. Students from the conventional curriculum outperformed the others during the first half of the curriculum.

I. Discipline based approaches
   1. Yates describes the use of what is alleged to be PBL on a psychiatry C/L service. It clearly was not, but did represent an EBM seminar.

J. Demands on faculty
   1. One course in Norway (Martenson) found a 24% increase in faculty time.
   2. The better study is Mennin who found that faculty at UNM spent 3.57 hours/week/student in preparation and teaching in the conventional curriculum. 25-305 of this time was spent in direct student contact. With PBL this increased to 4.12 hours/week/student, but 72% of this time was

spent in direct student contact.

3. Another way of looking at this is that the conventional curriculum required 189 faculty hours/week. PBL required 20.6 hours/week/small group. The key issue is one of class size.

IX. Holes in the literature

A. Cost of PBL

1. Given the importance of this topic, the scant references noted above are surprising. My guess is that the start-up costs are high, but that the costs in terms of maintenance are not unlike other small-group teaching.
2. Our experience is that it takes something like 20 hours to write a good case with detailed tutor guide.
3. The time required is probably higher for basic scientists and lower for clinicians as one of the main stumbling blocks is getting a hold of appropriate clinical material.

B. Use of PBL beyond the preclinical years

1. I could find remarkably little that was written.
2. There is one article, reportedly about PBL, that was about the use of EBM on a psychiatry c/l service.
3. I have been using a PBL approach in teaching about psychopharmacology to psychiatry residents.
    a. It has been remarkably successful. The residents seem excited and are working for the seminar in a fashion unlike their predecessors.
    b. I had not appreciated how much labor saving would be involved for me.
    c. I have a series of topics that I want to cover
    d. I pull the records of a patient who fits the description--e.g. one where I struggled with the appropriate treatment for acute mania. I disguise the patient.
    e. During the first session I present the case and we proceed as we would for any other PBL case.
    f. The residents' role is to act as a consultant to me.
    g. Other faculty are now asking to present, seeing it as way to get good, free consultation.
    h. I am impressed that PBL in this sort of format requires much less preparation than teaching in the first two years of medical school.

Problem-Based Learning
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