Review Articles:

PERCEPTIONS OF EFFECTIVENESS OF PROBLEM-BASED LEARNING

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Introduction:

The start of implementation of problem-based learning (PBL) could conveniently be linked to the McMaster experience, 1969[1], while the present traditional or conventional curricula implementation could be related to the Flexner report of 1910[2].

Since its implementation in McMaster PBL curricula are becoming more and more popular. Since then hundreds of health institutions all over the world have adopted this system and thousands have graduated from these institutions and are professionally actively engaged in the health work force.

PBL is not only applied in medicine, but in many other professions. In this paper we will limit ourselves to undergraduate medical programmes.

Definition

Problem-Based Learning

The issue of definition is complex, PBL is applied differently in different schools, it is not one entity but heterogenous. It is difficult to give a simple single definition, the following is an attempt to give a comprehensive understanding of PBL rather than giving a concrete

definition.

- Problem-based learning at its most fundamental level is an instructional method characterized by the use of patient problems as a context for students to leam.3
- PBL works best when small tutorial groups are used for analysis of the problem, discussion, retrieving previous knowledge, identifying learning needs, self-study and integrating the newly acquired knowledge to the understanding or the resolution of the problems in a comprehensive and integrated manner.
- In PBL the process of problem-solving skills is usually promoted especially so by improving the accessibility to knowledge.
- PBL breeds independent and life-long self-directed learning.
- The student is the centre of learning and the faculty tutor facilitates the learning process.

Effectiveness of PBL shows itself better when applied to a whole curriculum rather than to individual courses.

Effect Size: For comparison the effaced size in used: Standard Mean of PBL out comes.

Minus (-)

Standard means of traditional learning out come.

Divided by: (÷)

Standard Deviation of Traditional learning out come

Traditional learning :

As the definition of PBL is ambiguous and complex, sd~alsois the definition of what constitutes traditional or conventional curriculum (C.C). For most part it is marked by staff-centered teaching, the staff decides on

the leaming objectives and needs, and it is delivered in the form of large - group lectures and structured laboratory experiences[5]. The basic sciences are usually taught in the first two years, discipline based and the clinical in the later years of the programme.

Comparison of PBL and Conventional Curricula:

Naturally questions have arisen as to how do graduates from PBL curricula compare to graduates of the traditional curricula.

This comparison would be very difficult because there are many confounding factors:

1. The complexity of defining PBL and C.C, and the difficulty of sometimes defining the boundaries between the two specially in parallel track programmes.
2. The different ways and circumstances under which PBL is implemented in different countries and colleges.
3. The variability with which students are selected especially in parallel track programmes.
4. The absence of a gold standard to measure and compare the outcome from these programmes.

For these reasons no one single parameter can be used for comparison and there can be *no best evidence,* but only the best *available evidence so far:* this is at best a perception of effectiveness. Most of the studies done have been in schools that have parallel tracks of PBL and C.C, but these have the problems of the differing criteria of admission! and by time the two tracks tend to merge and blend.

With these considerations and limitations in mind, the perceptions

of effectiveness will for convenience and simplicity, be considered under the following headings:-

1. **Students:**
   - 1.1 Knowledge in basic sciences.
   - 1.2 Clinical knowledge and skills.
   - 1.3 Perception of curriculum.
2. **Graduates**
   - 2.1 Clinical knowledge skills, competencies and attitudes.
   - 2.2 Perceptions of the preparatory force of the curriculum.
   - 2.3 Rating by supervisors and self.
   - 2.4 Getting first residency choice.
   - 2.5 Retention of knowledge and continuous learning.
3. Faculty Perceptions
4. Cost
5. Recommendations of International and National Bodies

1. Students:

1.1 Knowledge in basic sciences.

The Macy Conference concluded that the PBL students are more likely to get lower score in National Board Medical Examination, USA (NBME I)[6] which mainly test basic sciences. Some studies did significantly show this, but others either showed no statistically significant difference or significant difference in favour of PBL (Table I)[7"] . Students in PBL were found to study more in preparation for NBME I[19] (P0.01) may be they felt deficient in basic science knowledge. The two extensive meta analysis of Albanese et al[5] and women and Blake[20] both concluded that although jNf there may be a slight

difference *f* in favour of C.C in attaining knowledge in basic sciences but the difference is not really or always true. When the implementation of PBL is more directive, as in Michigan University, PBL is favoured while the compromise of admitting weaker students as in New Mexico for political reasons C.C is favoured .

All these studies are retrospective studies of whole curriculum. Table-2-art(T Fig. 1 show a prospective study but in a course of pharmacology which illustrates the effectiveness and popularity of PBL[21].

1.2 Clinical knowledge and skills.

NBME II tests clinical knowledge and skills. The students' performance in NBME II and other clinical performance examinations showed a different picture. All the studies but one favoured PBL curricula (Table 3)[8'9> 10> n915'17]. Even the schools, notably New Mexico, where the students in the traditional track did better than PBL track in basic sciences the situation was reversed. Both the two meta-analysis referred to above concluded that the trend in clinical performance favoured PBL students - not statistically significant in many but significant in some[5'2C].

The clinical examinations are more of a comprehensive nature, combining the knowledge in basic sciences and clinical subjects with the clinical professional skills, so they are more reflective of the students competencies needed on graduation. So the better performance in these examinations is a better indication of the prepareness of medical students to their medical professional life.

Table 4 shows the performance of both tracks of New Mexico students in NBME I, II and III, the improvement of ES in favour of PBL track can be clearly seen[22].

1.3 Perception of curriculum.

Table 5 shows the perceptions of the medical students in Arabian Gulf University[23] (AGU), College of Medicine and Medical Sciences (CMMS) which follows a PBL curriculum. The surprising things were that the students, especially Year 4 who have been the longest in the programme indicated that they are still worried and less confident of self-study and that they are also worried about gaps in their knowledge - this could be a true reflection, but it could be due to recent changes made in the assessment methods which was not well appreciated by the students.

In a study from Dailhouse, Halifax, Canada the students view on the PBL curriculum were very favourable in comparison to their colleagues from conventional counterparts on their curriculum[24].

Table 6 shows the mean score of a study from Harvard Medial School of the evaluation of the students in the New pathway (PBL) and conventional tracks on self-rated humanistic attitudes, observer - rated interpersonal skills and standardised-patient-rated interactional skills[15]. Of the seventeen items included in these psycho-social skills, the PBL students scored significantly better on 9 items and equal to conventional students on the remaining 8 items. Verhulst and others in Southern Illinois showed that the correlation between the supervisor's ratings and the graduates score in Part II and Part III NBME examinations were substantial than those between the supervisors' ratings and the NBME Part I examination scores[25].

Graduates

2.1 Clinical skills competencies and attitudes.

The higher scores of the PBL graduates in their final clinical examinations, is also reflected in the professional performance of graduates of the PBL curricula. The study done in College of Medicine and Medical Sciences (CMMS), Arabian Gulf University (AGU) in Bahrain (which adopts a PBL curriculum) confirms this[26]. This study compared the performance of AGU graduates with graduates from all other medical schools taking the Bahrain Licensure examination from the year 1991 to 1999. The examination consists of written multiple choice questions (MCQ), objective structured clinical examination (OSCE) and oral examination. AGU graduates did significantly better on all the three types of examination. Table T[6]. The non-AGU group is heterogenous, they are mainly graduates of medical schools in the Arab countries, India and Europe, which follow a C.C. It could be argued that they are the students with a lower higher secondary school certificate grade who did not get admitted to AGU.

In a study in New South Wales, Australia comparing graduates of medical students of Newcastle University which follows a PBL curriculum with graduates from Sydney, New South Wales and other International medical schools graduates which used to follow a C.C.- Table 8, the Newcastle graduates were rated significantly better on thirteen and equal in one of all the fourteen competencies tested, thus showing more competent PBL graduates[27].

2.2 Perceptions of the preparatory force of the curriculum.

Graduates from University of Newcastle, when compared with the

then conventional schools of Sydney and New South Wales also gave a significantly positive perception on how the PBL prepared them for their hospital work. Table 9 .

2.3 Rating of graduates:

Rating of interns by supervisors, nurses and self also showed better rating of PBL graduates Table 10[29].

2.4 Getting first residency choice:

Succeeding in getting the first residency choice in a specialty training is a reflection of many factors, undergraduate medical school records, dean's letter, recommendations, performance in the different hospital rotations, interviews - attitude, motivation, etc. So it is also directly related to the graduate rating. All the studies shown in Table 11[8'1L 15> 17f 309 9 32] have shown them significantly favouring PBL graduates except Tolani 1991, from McMaster, this may be due to the fact that McMaster graduates preferred to work as family physicians in academic posts rather than in rural or sole practice and were so competing among themselves mainly, for a limited number of available jobs.

2.5 Retention of knowledge and continuous learning.

This is difficult to research, but a study comparing McMaster University (PBL) with Toronto University graduates (C.C) in Canada, 8-11 years after graduation, on the management of hypertension, found McMaster graduates are more up to date than the Toronto graduates[33]. Two other studies concluded that knowledge is better retained by PBL students , although Tolani did not find that PBL in the C.C affected the learning habits, of the graduates[32].

3. Faculty Perceptions

Satisfaction of faculty members is essential for the continuation of any teaching programme. PBL learning was the most frequently cited strength of the McMaster programme by a survey of the faculty[36]. When asked about their preference of the type of curriculum 72% of the McMaster faculty chose PBL[31] and 95%, having had the experience11, said they would like to serve as tutors again. The personal contact promoted by the small group tutorials was reported by the Harvard and Hawaii medical faculty as the most satisfying learning experience. These studies do not support the concern of the faculty about the concentrated time commitment PBL requires.

4. Cost

There are many factors to be taken in consideration in making the assessment of the cost of any teaching programme.

1. Faculty numbers and their time commitment to students.
2. Support personnel.
3. Physical support, buildings, rooms, etc.
4. Audio visuals and other instructional material.
5. Library, text books computers, lab tops, journals and learning materials.

Albanase et al concluded that costs for class size of up to 100 in both curricula would not be much different and that PBL schools can reduce the cost by increasing the size of tutorial groups and using non-faculty tutors for some meetings[5].

In New Mexico, Mennin and Martinez found that faculty in the conventional track would spend 3.57 hours per week compared to 4.12 in

PBL, but in PBL track 72% of this time is in direct contact with students while the percentage is only 25 - 30% in conventional tract[40].

Conclusion

The consensus of the so far available evidence definitely goes in favour of PBL. Many international bodies and countries have gone out of their way to support the change in medical education and PBL. The following are examples of the move in the direction of PBL.

Recommendations of International and National Bodies:

1. World Health Assembly Resolution (WHA 48.8) passed May 1995 called for "reorientation of medical education and medical practice for Health for all.

2. World Federation of Medical Education - Edinburgh Declaration - 1989.

- Ensure continuity of learning throughout life, shifting emphasis from the passive methods so widespread now to more active learning, including self-directed and independent study as well as tutorial methods... (World Federation for Medical Education. 1989).

3.American Association of American Medical College Recommendations.

- Training students on how to deal with problems in the future.
- Prepare them to be active learners, independent and problem solvers.
- Integration of Basic Sciences and Clinical Sciences to promote relevance and problem solving.

- Responds to the health needs of the society.
- Ensure continuity of learning throughout life.

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Table (1)

Studies evaluating influence of Problem-Based

Study & School	Effect Size	# Participants
Nolte et al. *(University of Colorado)*	+.62	357
Kassebaum et al. *(University of Colorado)*	+?	78
Moore-West et al. *(University New Mexico)*	+.98	62
Lewis and Tamblyn *(University New Brunswick)*	+.18	42
Vernon et al. *(University of Missouri)*	+.68	163
Vernon *(University of Missouri)*	+.21	82
Blumberg and Eckenfels *(University of Rush)*	+?	52
Dietrich et al. *(University of Dartmouth)*	+?	85
Heals et al. *(McMaster)*	+?	53
Moore *(Harvard)*	+?	120
Nolte et al. *(University of Colorado)*	+?	132
Post and Drop *(Maastricht)*	+?	790

(David, T. A., Vernon & Robert L. Blake, Academic Medicine, July 1993)

Table (2)

Skills & Attitudes:

Mean Scores for Psychosocial Skills of (PBL) and conventional students at the end of their second year. Harvard Medical School, Classes of 1989 & 1990

Scale	PBL Mean Score (n=60)	Conventional Mean Score (n=61)	p
Self rated humanistic attitudes			
Doctor-patient relationship	7.85	7.35	.02
Preventive	=	=	.57
Social medicine	=	=	.71
Empathy	22.56	17.07	.04
Tolerance of ambiguity	54.45	48.53	.04
Comfort with emotion	=	=	.18
Patient-centeredness	=	=	.19

Table (3)

Knowledge & Skills - Clinical:

Summary of studies of Problem-Based Learning (PBL) that used NBME II or other Clinical Examination as Outcome Measures

Study & School	Participants (PBL/ Conventional)	Results Effect Size	p-value
Moore et al.	62/61	+	ns
(Harvard)		+	.02
Saunders et al.	45/243	-.65	.01
(Newcastle)		+.48	.001
		-.37	.05
Verwijnen et al.	565/167	+.68	-
(Maastricht)		+.76	-
		+.49	-
		+.69	-

(Albanase. M.A., Mitchell, S., Academic Medicine, Jan 1993)

Table (4)

Knowledge & Skills - Clinical:

Overall Comparison of Mean Scores on the NBME I, II, & III for Students within the Conventional & PCC (Problem-Based) Tracks, University of New Mexico, 1983 1992

	Conventional Track		PCC Track (PBL)		
Examination	# Stud	Mean	# Stud	Mean	p-value
NBME I	508	504	167	456	.0001
NBME II	447	460	144	469	.29
NBME III	313	491	103	521	.001

(Menin, S.P., et al, Academic Medicine, Aug 1993)

Table (5)

Students Perceptions - AGU, 2000:

Item	% of Students Agreeing with Year 2 (N=68)	Year 3 (N=41)	Year 4 (N=39)	Total (=148)
Advantages & Apprehensions				
Having studied in the PBL system for some time now, what are the advantages of *this method of learning for you?*				
1. Interesting way to study	80	78	74	78
2. Easier way to study than through lectures	27	34	33	31
3. Helps to develop my self-confidence	77	78	64	74
As you became more accustomed to the PBL system, in what ways have your views of the system changed?				
4. Less worried and more confident of self-study	51	56	41	50
5. Worried about gaps in my knowledge	71	71	77	73

Table (6)

Skills & Attitudes:

Mean Scores for Psychosocial Skills of (PBL) and conventional students at the end of their second year, Harvard Medical School, 1989 & 1990

Scale	PBL Mean Score	Conventional Mean Score	p
Observer-rated interpersonal skills			
Biomedical information	=	=	.78
Psychosocial information	=	=	.17
Health behavior information	61.38	39.71	.02
Total information gathered	68.81	58.78	.03
Communication skills	50.79	40.00	.01
Patient education	8.08	6.26	.01
Empathy	6.45	4.85	.04
	=	=	.08

Table (7)

Knowledge - Basic Sciences & Clinical:

AGU & non AGU Graduate Performance in the Bahrain Medical Licensure Examination in 1991-1999

		WRITTEN	OSCE	ORAL	TOTAL
AGU (# 129)	MEAN	32.10	20.18	14.50	66.91
non-AGU (# 370)	MEAN	28.56	18.21	12.04	59.75
	P	0.010	0.048	0.043	0.008
	ES	+ 0.62	+ 0.41	+ 0.52	+ 0.62

Table (8)

Knowledge - Basic Sciences:

Comparison that used NBME I or other Basic Science Examination as Outcome Measures

Study & School	Participants (PBL/Conventional)	Results Effect Size	p-value
Jones et al.	63/138	+.16	ns
(Michigan State University)		-.18	ns
		+.47	.004
		+.31	.05
		-.03	ns
		-.10	ns
		+.09	ns
		+.33	.05
Moore-West et al.	37/41	-.36	ns
(University of New Mexico)			

Table (9)

Interns Perceptions:

Mean ratings of interns from PBL and traditional Medical Schools, on how the Undergraduate Program prepared them for Hospital Practice

	PBL School (n = 52) Mean rating	Traditional Schools (n=87) Mean rating	p value
Interpersonal Skills	4.5	3.7	<0.001
Confidence	4.2	3.8	<0.05
Collaboration	4.5	4.1	<0.01
Management	4.2	4.4	NS
Basic Sciences	4.2	4.4	NS
Prevention	5.1	4.4	<0.001
Holistic care	4.8	4.4	<0.0
Self-directed learning	4.7	4.4	<0.01

Rating Scale: 1 = very inadequately prepared, 6 = very adequately prepared

(Hill, J. et.al., Medical Education, 1998)

Table (10)

Supervisors Rating:

Residency performance rating of graduates from PBL and Conventional Curriculum

Track, number & % of responses	Rater & Mean: Supervisor Mean	Nurse Mean	Self Mean
PCC # 39 (75%)	4.12	4.05	3.92
Conventional # 62 (47%)	3.95	4.12	3.79

(Santos-Gomez, L., et.al.)

Table (11)

First Residency Choice:

Comparison of Graduates of PBL/Conventional Curricula that used as Outcome Measures getting the first Specialty Choices

Study & School	Participants (PBL/ Conventional)	Results Effect Size	p-value
Jones et al. *(Michigan State University)*	357/659	+.19	.001
Moore-West et al. *(University of New Mexico)*	19/19	+.96	.025
Kaufman et al. *(University of New Mexico)*	140/371	+.27 +.58	.05 .05
Neufeld et al. *(McMaster)*	Graduates 1972-1979 (all PBL)	+	.05

Table (12)

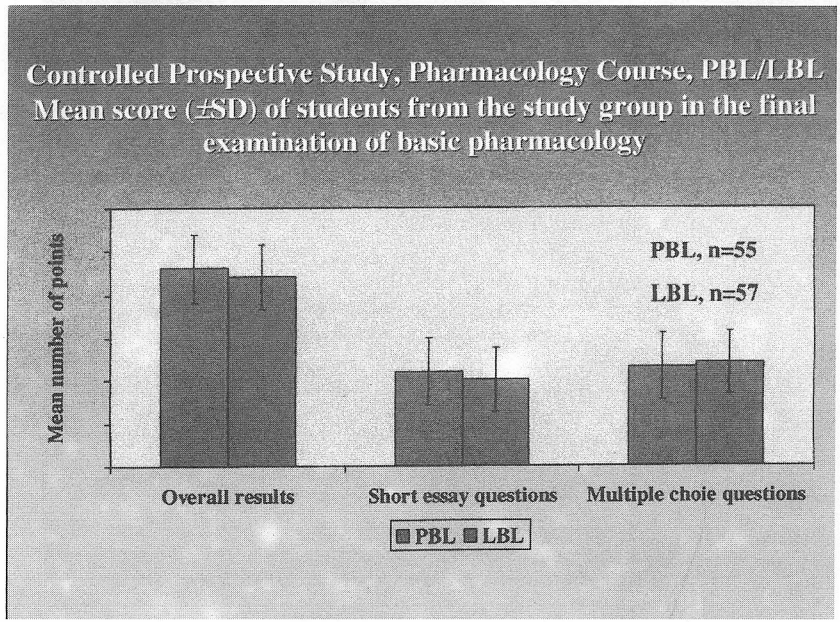
Knowledge - Long-Term Retentions & Updating:

Mean scores on the current knowledge of the Management of Hypertension of graduates of 1974-1985

Component	Total Score Possible	Group: mean score MU Graduates (n = 48)	UT Graduates (n = 48)	p value
Detection methods	15	9.9	9.5	NS
Recommended blood pressures for treatment	10	9.2	8.5	.05
Pharmacologic treatment	26	17.1	15.8	NS
Nonpharmacologic treatment	5	3.6	3.5	NS
Compliance	26	15.7	13.3	.01
Overall	82	55.5	50.6	.01

(Shim, H., Haynes, R. B., Johnson, M. E., Can Med Assoc J. 1993)

Fig (1)


Controlled Prospective Study, Pharmacology Course, PBL/LBL
Mean score (±SD) of students from the study group in the final examination of basic pharmacology
Mean number of points
PBL, n=55
LBL, n=57
Overall results
Short essay questions
Multiple choie questions
PBL LBL