BJMHR
British Journal of Medical and Health Research
Journal home page: www.bjmhr.com

Comparing The Effectiveness Of Problem-Based Learning To Traditional Teaching In Medical Education: Systematic Review

Maryam Naser*[1], Ali Ebrahim[1], Salim Fredericks[1]
1.Royal College of Surgeons in Ireland - Medical University of Bahrain

ABSTRACT

Problem-based learning is a well-established model in medical education that was developed by McMaster university in 1969. Several studies have been conducted since then to evaluate its effectiveness on several learning domains. However, unequivocal evidence supporting its superiority over the traditional teaching is not established due to contradicting results. To evaluate recent studies comparing problem-based learning to traditional teaching, focusing on medical students' academic performance, satisfaction and motivation, and knowledge retention and recall. An electronic search, limited to the last 10 years, was conducted through PubMed, Academic search complete, Medline, CIANHIL and PsychInfo. A manual search of the references of the selected papers was also carried. Quality assessment of studies was conducted to establish the level of evidence supporting the individual outcome variables. The search yielded 109 articles for title and abstract screening, 5 of which met the inclusion criteria. One more article was identified through the manual search of the references yielding a total of 6 studies. No evidence was established to support the superiority of PBL over didactic teaching in terms of improving medical students' academic performance and satisfaction and motivation as the studies reported contradictory outcomes. Limited evidence was established to support the superiority of problem-based learning in improving medical students' knowledge retention and recall as it was derived from a single low quality study. More research into this area is still required to establish an objective assessment and to overcome the inherent limitations of research in problem-based learning.

Keywords: problem-based learning, medical education, traditional teaching.

*Corresponding Author Email: maryamnasser.mj@gmail.com
Received 04 April 2017, Accepted 24 May 2017

Please cite this article as: Naser M *et al*., Comparing The Effectiveness Of Problem-Based Learning To Traditional Teaching In Medical Education: Systematic Review. British Journal of Medical and Health Research 2017.

INTRODUCTION

Problem Based Learning (PBL) is a well-established model in medical education in which students play a central role in directing the learning process [1,2]. It is defined as an "instructional method that uses patients as a context for students to acquire knowledge and understanding of the basic sciences and the clinical sciences" [3]. Students are expected to engage actively in acquiring knowledge, establishing judgments and drawing conclusions with relevance to the topic being studied [4]."Triggers" from the problem scenario are used by students to set their own learning objectives. Subsequently, each student is responsible for carrying an independent, goal-directed studying before discussing and refining the knowledge they acquired in small groups. According to the data reported by the World Health Organization, PBL is being used currently in more than 1,700 medical schools globally and the number continues to grow [5].

Since its development by McMaster university in 1969 and subsequent adoption by the Association of Medical Colleges and the World Federation of Medical Education, it has been a subject of several studies to evaluate its efficacy in developing medical education. However, despite the replete literature, the results are conflicting [6,7]. While several studies report favorable outcomes in terms of improving students' academic performances [8], satisfaction [9], and in promoting critical thinking skills [10], other studies have questioned its efficacy, particularly in developing a theoretical knowledge base [11, 12].

Several systematic reviews have been conducted comparing PBL with traditional curricula, nevertheless, unequivocal evidence supporting the superiority of PBL has not been established [4,13,14]. This is important because such evidence is needed to provide a scientific basis for evaluating the necessity and the feasibility of applying such model in medical education[5). As such, this qualitative systematic review aims at evaluating the most recent evidence reported in the last 10 years comparing PBL to didactic traditional teaching methods in medical education. The review's focus is on studies evaluating medical students' academic performance, satisfaction and motivation, and knowledge retention and recall since they are commonly reported variables [15]).

MATERIALS AND METHOD

This systematic review was conducted in accordance to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. [16]

Search Strategy

Initially, an electronic search through PubMed, Academic search complete, Medline, CIANHIL and PsychInfo was conducted. The keywords used are "Problem based learning" and "didactic teaching" combined with "medical students", "competency" and "medical

education". The search was limited to the last 10 years and to articles published in English. No restrictions were placed on country or study design.

Upon review of the papers selected for final synthesis of data, a manual search of the references of the selected papers was carried.

Eligibility criteria

Inclusion criteria

Population

Medical students

Intervention

Use of problem based learning that resembles that adopted by McMaster University or the University of Maastricht[17,18] .

Comparator

Use of a control group from a traditional, non-problem based learning curriculum

Outcome

A study reporting outcomes on one or more of the following:

- academic performance (grades)
- knowledge retention and recall
- students motivation and satisfaction

Study design

Randomized Controlled Trials (RCT) or Controlled Trials (CT). Controlled trials were included as most educational research has methodological limitations and "purity of curricular change and random assignment of students are rarely possible" [19].

Exclusion criteria

- population of non-medical students
- control or PBL group was not from the same medical school
- studies implementing a modified PBL model
- qualitative, descriptional or comparative studies

Data Extraction

With the use of a prepared data extraction sheet, the following data were retrieved from individual studies:

1. General information of the study

Name of the first author

Country at which the study was based

Year of publication

2. Characteristics of the study

Study design

total number of participants

number of participants in the control and the PBL group

Course name

Description of the intervention process

Duration of the intervention

3.Outcomes

Outcomes and their assessment tools

Quality assessment

As majority of tools used to assess RCTs and CTs are developed for clinical interventions, the only validated tool found suitable for this study was developed by Smits P. et al [20]. The author was contacted for permission and the tool was adopted for quality assessment.

The tool consists of five indicators of quality (randomization, follow up and response rate, objective assessment, blinding, and statistical correction). Each criterion has a maximum of 10 points with a total possible score of 50. Studies with a total score of greater than or equal to 25 points were considered of high quality. A score lower than 25 points indicates a low quality.

Quality assessment was conducted independently by two reviewers (MN, AE).

Data Analysis

For each study, three outcome variables were assessed: students' academic performance (grades), knowledge retention and recall and students' motivation and satisfaction.

The evidence of effectiveness of problem based learning was assessed in a similar manner as to that by Smits P. A et al[20]. Outcomes were recorded as positive if they were found to be superior to the control, negative if control was superior and no difference if the control and the PBL group showed no difference, all being assessed in terms of statistical significance.

The evidence was strong if there was a positive outcome in two high quality studies, moderate if there was a positive outcome in one high quality and one low quality study, limited if there was a positive outcome in one high quality study or one or more low quality studies and none if there was a contradictory outcome or no outcome [20].

A meta-analysis was not conducted because of the wide heterogeneity in outcome measures and study reporting making it difficult to quantify the effect size.

RESULTS AND DISUCSSION

Study selection

The search strategy yielded a total of 206 articles (Figure 1). The prime source of articles was from PubMed (n=76) with additional articles being retrieved from the other databases (n=130). Following removal of duplicates, 109 articles were available for title and abstract screening. 87 articles were excluded and 22 were assessed for full text eligibility. Out of the 22 articles, 5 met the inclusion criteria. A manual search of the references of the 5 articles yielded a single eligible study making the total of the studies included in the final qualitative synthesis of data to be 6.

Study characteristics

Six studies were included in the final review [21-26] reporting on a total of 1126 medical students. Three of the studies were conducted in Iran 24-26), with the other three being from Spain [21], Hong Kong [22] and India [23]. The studies were published between 2012 and 2016 with only one study being published in 2009 [22]. Most studies adopted RCT design with the only exception being by Jaminez-Mejias et al [21] conducting a CT. The PBL approach was applied to different courses as detailed in Table 1, which included but was not limited to Physiology, Pediatrics and Evidence-Based Medicine. All studies compared PBL to the traditional teaching methods, which ranged from a lecture-based approach to traditional bedside teaching. The duration of the intervention process differed between studies from a minimum of 7 weeks to a maximum of 2 years with one study [22] reporting the duration as that of the course. Outcome assessment tools were variable and ranged from researcher-developed tests and questionnaires to final course examinations or a validated assessment tool and focus groups.

Table 1: Study Characteristics

Author	Country	Year of publication	N	N Control	N PBL	Study type	Course name	Intervention process	Duration of intervention	Assessment tool(s)
Jimenez-Mejias E et al (21)	Spain	2014	527	272	272	CT	Epidemiology and Health and Social Demography	PBL: instructor facilitated practical sessions in a small group. Control: traditional teaching of the module to the whole group.	2 years	1- MCQ examination 2-validated questionnaire to assess students' satisfaction
Johnston J. et al (22)	Hong Kong	2009	129	59	70	RCT-cross-over trial	Evidence-based medicine (EBM)	PBL: small group using a PBL case format and facilitated by a faculty tutor Control: whole class teaching format led by a faculty member	Duration of the EBM course (not reported)	1- locally validated, standardized knowledge, attitude and behavior questionnaire. 2- purposely-selected focus groups to assess students' satisfaction and perceptions
Joseph N. et al (23)	India	2016	273	77	196	RCT	Community medicine	PBL: tutor-facilitated sessions in small groups	1 month	1- generic skills of students were assessed using a standard validated checklist

								Control: LBL		2- feedback on using a modified version of the standardized feedback form 3- two written MCQ examinations to assess problem-solving and critical thinking skills
Khoshnevisasl P. et al (24)	Iran	2013	40	20	20	RCT	Pediatrics	PBL: teacher-facilitated clinical sessions in small groups Control: LBL	6 months	1- 10 question exam to assess academic performance 2- validated questionnaire to assess students' satisfaction and perceptions
Pourshanazari A. et al (25)	Iran	2012	39	26	13	RCT	Respiratory physiology	PBL tutor-facilitated sessions in small groups Control: LBL	7 weeks	1- end of term examination 2- researcher-developed tests after 1 and 4 years
IMANIEH MH et al (26)	Iran	2014	118	59	59	RCT	Pediatric Gastroenterology	PBL: tutor facilitated clinical sessions Control: traditional bedside teaching	4 months	1- pre and post-course test to assess students' academic performance

Outcome variables

Most studies reported two outcome variables (Table 2) except for Imanieh Mh. [26] who reported one outcome variable.

Academic performance in the form of grades was the most commonly reported outcome and was assessed in all studies following PBL implementation. Although the general trend is positive with three studies [21,23,26] favoring PBL over the traditional non-PBL approach, Johnston J. et al [22] and Pourshanzari et al.[25] reported negative results while Khoshnevisasl P. ([24]) reported no statistical difference between the PBL and the control groups. The results are therefore inconsistent.

The second most commonly reported outcome was students' satisfaction and motivation, which was reported in four [21-24] out of the six studies using variable assessment tools (Table 1). Johnston et al [22] was the only one to report a negative result where students conveyed negative impressions regarding PBL as compared to the traditional teaching methods.

One study [25] only assessed students' retention and recall using researcher developed-tests after one and four years following the intervention. The outcome was reported to be positive.

Table 2: Outcome variables

Author	Number of outcomes assessed	Outcomes		
		Academic performance (grades)	Students' satisfaction and motivation	Knowledge retention/recall
Jimenez-Mejias E et al (21)	2	Positive	Positive	N/A
Johnston J. et al (22)	2	Negative	Negative	N/A
Joseph N. et al (23)	2	Positive	Positive	N/A
Khoshnevisasl P. et al (24)	2	No difference	Positive	N/A
Pourshanazari A. et al (25)	2	Negative	N/A	Positive
IMANIEH MH et al (26)	1	Positive	N/A	N/A

Quality Assessment

Quality assessments revealed that majority of studies were of high quality scoring between 25 and 40 out of a total of 50 points. The only exception is that of Pourshanazari et al[25] which scored 20 points indicating low quality. Results are detailed in Table 3 below. Of note, none of the studies described information on blinding which was defined by Smits P. et al [20] as "educational methods offered to participants were described as equally effective ".

Level of evidence

No evidence can be established to support the superiority of PBL in improving medical students' academic performance or in increasing their satisfaction and motivation. This is attributed to the contradicting results reported in the studies evaluated (Table 4).

The evidence supporting PBL's role in improving students' knowledge retention and recall as compared to traditional teaching is limited. This is because only one low quality study reported a positive outcome with no other study assessing this outcome variable.

This systematic review compared the effectiveness of problem based learning to didactic teaching on developing medical students' academic performance, knowledge retention and recall, and their satisfaction and motivation. A total of five RCTs and one CT were included to address the review's objective. The qualitative analysis have shown that no evidence can be established to support the superiority of PBL over didactic teaching in terms of improving medical students' academic performance and satisfaction and motivation as the studies reported contradictory outcomes. Limited evidence was established to support the superiority of PBL in improving medical students' knowledge retention and recall as it was derived from a single, low quality study.

The findings are consistent with other studies [1,7,27,28], which have shown that PBL students' performance is not different or slightly worse than students of traditional teaching methods. On the contrary, other studies [4,5] have reported positive outcomes that favor PBL to traditional teaching particularly in excellence rate and examination scores.

Hejine-Penniga M. et al [29] proposed multiple reasons as to explain the negative effects of PBL on knowledge level. They speculated that students from PBL systems have difficulties in retrieval of information because they need certain retrieval cues that correspond to the problems discussed during sessions. In addition, traditional curricula students are adept at preparing for tests and outscoring their PBL counterparts since they receive isolated knowledge that is not context-dependent and are better able to retrieve information from short-term memory.

On the other hand, studies reporting favorable outcomes of PBL attribute these results to several factors. For example, Zahid et al [4] explained the findings of his study using the "situational interest" hypothesis, which suggests that the brainstorming session involves activation of prior knowledge and identification of knowledge gaps. This results in a "knowledge-seeking" behavior. Moreover, Jimenez-Mejias E. et al [21] suggested a causal relationship between increased satisfaction following PBL and increased academic performance. Increased satisfaction was proposed to be due "clearer direction, closer engagement with the lecturer and the work with small learning group"[21].

However, the contradictory findings in the various studies could be explained by multiple factors inherent to research in PBL. First, PBL curriculum is heterogeneous and is not a uniform curriculum intervention. The definition and implementation varies between medical schools and among medical educators [17.] Second, there are number of factors that are difficult

to control and quantify, which may affect the PBL process and success [30,31]. These factors include tutor, educational materials and lecture rooms [20]. Furthermore, the variability of the tools in assessing the outcome measures and evaluating the efficacy of PBL makes it difficult to draw conclusions and make comparisons with the traditional curricula [32].

The limitations of this review should also be acknowledged.

- Limited number of studies was included in this review, which in turn might lead to inadequate sample size. This might have lead to differences in outcome.
- Other outcome variables like reasoning, critical thinking, diagnostic accuracy and continuous medical education were not evaluated. While it is important to do an extensive review on such variables to establish a more thorough and objective evidence, inadequacy of data collected on these variables lead to their dismissal from the review.
- Search of grey literature was not carried which might lead to some information bias.
- Heterogeneity in implementation, assessment and in environmental and cultural media of conducting PBL was not accounted for.

CONCLUSION

Evidence supporting the superiority of problem-based learning over traditional teaching during medical school has not been established due to contradicting results from multiple studies. More research into this area is still required to establish an objective assessment and to overcome the inherent limitations of research in PBL.

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