INTRODUCTION

Medical schools in Pakistan, organized on the British model of medical education, have followed a static system in pre-clinical education, led by didactic lectures based on passive learning. Problem-based learning (PBL), ever since its arrival on the international stage, has gathered marked attention in Pakistan. Strong evidence supports PBL in the social and psychological dimensions that include student and faculty satisfaction, self-directed learning skills, communication skills and teamwork.1 PBL has also been considered compatible with the modern theories of adult learning.2 In the wake of the generation of evidence favouring PBL, students and faculty in Pakistan have preferred and prioritized PBL over the existing system of education.3 However, PBL is not bound to succeed in every environment. Success of PBL depends on proper implementation based on political, administrative and logistic conditions.4 Pakistan is a developing country with limited resources. Therefore, implementation of a successful PBL curriculum is a challenge for medical schools.5 Evaluation of PBL programs and comparison with conventional learning is the key to reporting improvements. These analyses can assist in better understanding of workings of PBL in local environment and in the long run may dictate the path for transition in the development of system. Such is the importance of willingness to test and evaluate.

With the same intention, this study was done to systematically review indigenously performed existing research, to evaluate PBL programs, examine outcomes and competencies influenced by PBL, and compare them with conventional learning (lecture based learning; LBL).

METHODOLOGY

Electronic databases including PubMed, PakMediNet and Google scholar were queried. Reference list of editorials and reviews extracted for this review were also searched to identify articles.3,6 Review criteria were applied to all the abstracts searched in the database. If a clear decision could not be made on the abstract, complete article was retrieved. Articles available through the Higher Education Commission (HEC), Pakistan’s digital library service provided at Rawalpindi Medical College, were retrieved as such. Remaining articles were obtained from Pakistan Medical Research Council Library and authors of respective studies.

Only those studies were included that involved undergraduate medical students as study population and only those competencies were considered that were reported as the primary outcome or those found to be present in at least two studies.
Due to heterogeneity among studies in study designs and outcomes assessed, a qualitative content analysis was performed in which studies were classified according to the methods of assessment used in the study (self-assessment, objective assessment). Results were then summarized by outcome and frequencies were calculated for categories of characteristics of the included studies and outcomes that were evaluated.

**RESULTS**

A total of 11 studies were included in the final review. All the articles were identified from electronic databases. Most (n=09, 81.8%) studies were carried out at the Medical Colleges of Karachi. All the included studies aimed to evaluate PBL and used non-probability, purposive sampling technique. They assessed student attitudes and competencies, and compared them with LBL. Four of the 11 included studies (36.4%) had more than one objective. Seven studies (63.6%) assessed student opinions to evaluate PBL and to determine their attitudes. Three studies (27.3%) compared PBL and LBL based on student perceptions. Five studies (45.5%) compared academic performance of student to assess knowledge acquisition. Although few studies (n = 3, 27.3%) did not explicitly report study design, all but one followed observational study design. Remaining studies reported interventional study design.

The competencies assessed by studies resided in cognitive, social, knowledge and research dimensions. All the outcomes were evaluated by self-assessment, except for knowledge acquisition, which was assessed objectively by five studies. Outcomes explored by self-assessment of students were self-directed learning (n = 6), communication skills (n = 3), use of library and online resources (n = 3), group discussion and team work (n = 5), possession and retention of knowledge (n = 4), confidence (n = 3), problem solving skills (n = 4), and research (n = 1).

Mainly two measures were reported: those using direct administration of questionnaires for self-assessment and those using test and exam scores to determine knowledge acquisition. Out of the eleven, ten studies reported use of a questionnaire. Among those, five studies reported using a numerical scale to measure items; the rest relied on simple frequencies. Only one study reported use of a validated questionnaire. Rest of the studies did not give detail on how the items in the questionnaire were derived, and among these some studies (n = 4, 36.4%) did not explicitly define the outcomes they addressed. Moreover, all the studies addressed proposed positive aspects of PBL, whereas possible negative aspects were not taken into account, for example stress was not addressed by any study. Of the five studies that objectively compared knowledge acquisition, four evaluated short-term performance of student in class test and only one study assessed long-term influence of PBL. In three studies, different topics were compared for PBL and LBL. Possibility of a systematic error was not addressed in any study design; demographic variables were not measured, groups of different sizes were compared, and no effort was made to control confounding by any statistical method.

Two forms of PBL programs were identified; course based PBL and curriculum based PBL. A total of six studies investigated different forms of course based PBL. These were; variant of PBL in form of large group session,7,8 single- and multi-course hybrid PBL program,9-11 and single-course pure PBL program.12 All the studies that evaluated knowledge acquisition were course based studies. Three studies reported curriculum based PBL.13-15 Remaining two studies did not describe the PBL program.16,17 The studies did not provide an overview of the foundations of PBL program; only three studies commented on the structure of PBL groups. Student independence, extent of supplementary lectures, availability of resources and facilities, staff support and other practical issues that could influence evaluation were not described.

In cross-sectional studies that evaluated programs (Table I), PBL received high ratings in the competencies mentioned previously. Students reported that PBL encourages self study (n = 4), enhances problem solving skills (n = 4), initiates team work (n = 1), stimulates group discussion (n = 2), motivates to consult various learning resources (n = 1), improves communication skills (n = 3) and increases confidence (n = 3). Studies (n = 3) that compared parameters between PBL and LBL found that students considered PBL more interesting and stimulating and evaluated PBL better than LBL on all the parameters tested i.e. use of library and online resources (n = 2), self directed learning (n = 2) and group discussion (n = 2). PBL students were also found to be more active in research writing and were more confident in conducting research studies as compared to LBL student.

As compared with the rest of the parameters, complete unanimity was not present among the studies that inquired about knowledge acquisition. Although two studies reported that PBL increases the depth of knowledge and helps retain facts for a longer period of time, in one study students reported that some concepts were left behind. Whereas Khan et al. used a validated questionnaire to compare knowledge acquisition between PBL and LBL and demonstrated similar level of knowledge towards health research among LBL and PBL students.

Studies that compared knowledge acquisition between PBL and LBL in terms of test and exam performance used different methodologies (Table II). There was no unanimity among results of all the studies. Of five
studies, two found benefit for PBL. At Dow Medical College (DMC), two consecutive studies were conducted. First study at DMC did not reveal a significant difference in test scores after PBL and LBL. Follow-up study at DMC was conducted after five months to determine knowledge retention and the results significantly favoured LBL. The one remaining study at Jinnah Medical and Dental College also found benefit for LBL students. This was the only study that assessed long-term influence of PBL.

Hybrid form of PBL was favoured by students of Shifa College of Medicine, and Ziauddin Medical University, even after experiencing a program of pure PBL. A student at Aga Khan University also proposed an amalgam of conventional LBL and PBL. He felt that conventional methods were necessary to fill in the void left by PBL.

### DISCUSSION

Students gave high ratings to PBL in assessment and comparison with LBL in the selected parameters that

### Table I: Summary of studies that used student perceptions to assess and compare effectiveness of PBL.

<table>
<thead>
<tr>
<th>Name</th>
<th>Place</th>
<th>Description of program</th>
<th>Objectives</th>
<th>N</th>
<th>Results</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khan et al.7</td>
<td>Dow Medical College, Karachi.</td>
<td>Large group PBL Biochemistry course</td>
<td>To compare students perceptions of PBL and LBL</td>
<td>50</td>
<td>Students rated PBL higher on following parameters i.e. self study, number of books consulted, time spent on internet and in library, interest in method of learning, group discussion and depth of knowledge gained.</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Baig et al.9</td>
<td>Karachi Medical and Dental College, Karachi.</td>
<td>Community Medicine course</td>
<td>To study change in student attitudes after PBL intervention</td>
<td>32</td>
<td>There was a significant change in study trend after PBL course. This included increase in self learning, group study, frequent visits to library and use of internet.</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Zehra et al.10</td>
<td>Isra University, Hyderabad.</td>
<td>Gynaecology and Obstetrics course</td>
<td>To assess the experience of students after introduction of PBL</td>
<td>109</td>
<td>Students liked PBL. Reasons for liking PBL were; better understanding of subject, confidence, knowledge, self learning, communication skills and feeling of independence.</td>
<td></td>
</tr>
<tr>
<td>Haque et al.11</td>
<td>Jinnah Medical and Dental College, Karachi.</td>
<td>Year-long Biochemistry course</td>
<td>To identify attitude of students towards PBL</td>
<td>54</td>
<td>PBL improves problem solving skills, peer discussion and team work. However, it is time consuming and some concepts are left behind.</td>
<td></td>
</tr>
<tr>
<td>Nooruddin et al.12</td>
<td>Ziauddin Medical University, Karachi.</td>
<td>Genetics Course (pure PBL)</td>
<td>Assessment of a pure PBL program</td>
<td>ns1</td>
<td>Pure PBL was favoured over conventional LBL.</td>
<td></td>
</tr>
<tr>
<td>Khan et al.13</td>
<td>Aga Khan University, Karachi.</td>
<td>Curriculum</td>
<td>To compare knowledge and attitude towards research between students undertaking PBL vs. LBL</td>
<td>84/66</td>
<td>PBL students show healthier attitudes towards research. Both groups demonstrated similar level of knowledge about health research.</td>
<td>0.63 0.02</td>
</tr>
<tr>
<td>Jaleel et al.14</td>
<td>Ziauddin Medical University, Karachi.</td>
<td>Curriculum</td>
<td>Assessment of PBL curriculum</td>
<td>65</td>
<td>PBL contributed to the development of critical reasoning, communication and team-linked skills.</td>
<td></td>
</tr>
<tr>
<td>Usmani et al.15</td>
<td>Bahria University, Karachi.</td>
<td>Curriculum</td>
<td>To evaluate the perception of students PBL</td>
<td>186</td>
<td>PBL aids in problem-solving skills, self directed learning, communication skills, depth of knowledge.</td>
<td></td>
</tr>
<tr>
<td>Habib et al.16</td>
<td>Karachi Medical and Dental College, Karachi.</td>
<td>ns</td>
<td>To determine the opinions of students regarding PBL</td>
<td>104</td>
<td>PBL motivates self learning, improves problem solving skills and communication skills. Helps in identifying gaps in knowledge.</td>
<td></td>
</tr>
<tr>
<td>Yawar et al.17</td>
<td>Shifa College of Medicine, Islamabad.</td>
<td>ns</td>
<td>To assess students perception of most suitable method of learning</td>
<td>181</td>
<td>Most students wanted a mix of both lectures along with PBL.</td>
<td></td>
</tr>
</tbody>
</table>

1 ns= not stated; 2 PBL/LBL

### Table II: Summary of studies that used performance assessment of students to assess knowledge acquisition.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description of program</th>
<th>Design</th>
<th>N PBL / LBL</th>
<th>Outcome measure</th>
<th>Result PBL / LBL</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khan et al.7</td>
<td>Large group PBL Biochemistry course</td>
<td>Own control1</td>
<td>141/249</td>
<td>Course evaluation: MCQ test</td>
<td>74.2±10.7/ 73.7±11.4</td>
<td>ns</td>
</tr>
<tr>
<td>Khan et al.8</td>
<td>Large group PBL Biochemistry course</td>
<td>Own control1</td>
<td>43/43</td>
<td>Course evaluation: MCQ test</td>
<td>58.0±14.1/ 68.3±5.6</td>
<td>ns</td>
</tr>
<tr>
<td>Baig et al.9</td>
<td>Community Medicine course</td>
<td>Historical control2</td>
<td>32/47</td>
<td>Annual exam scores</td>
<td>225.1±3.3/ 191.4±3.0</td>
<td>0.000</td>
</tr>
<tr>
<td>Zehra et al.10</td>
<td>Gynecology and Obstetrics course</td>
<td>Own control</td>
<td>105/87</td>
<td>Continuous assessment tests</td>
<td>69.5±8.4/ 58.4±19.3</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Haque et al.11</td>
<td>Year long Biochemistry Course</td>
<td>Historical control</td>
<td>54/74</td>
<td>Annual exam scores</td>
<td>57.8±1.1/ 63.3±1.2</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

1 Own control- A single group experienced both LBL and PBL; 2 Historical control- Previous year class acted as control
resided in social, cognitive and research dimensions. A discrepancy was found to be present in studies that compared knowledge acquisition between PBL and LBL, with results being neutral and favouring both forms of learning.

Numerous international systematic reviews have been conducted on the subject. Graduates of PBL have been found to demonstrate high degree of self-satisfaction and motivation, self-directed study behaviour and better interpersonal skills. Strong evidence in support of PBL was also found for competencies including teamwork, use of information resources, diagnostic skills and communication skills. Little evidence favoured PBL in research and knowledge dimensions. There has been no report of PBL students being better academic achievers in pre-clinical years, and in some cases students taught by PBL method were even found to score less than students of traditional curriculum. Recently, Hartling et al. in their systematic review categorically concluded that “22 years of research shows that PBL does not impact knowledge acquisition”, although they acknowledged methodological weakness in literature. Apart from knowledge acquisition, results of these reviews are somewhat similar to what was found by the present review. Only that studies conducted here lack rigour and that evidence for better research and problem solving skills is weak in international literature. Possible shortcomings of PBL reported were that it was stressful and costly.

In this review, authors from various studies assessed a range of outcomes resulting in a comprehensive evaluation of PBL. However, the present review has a number of limitations. First, considerable heterogeneity was present among studies as they differed in study design, respective PBL models, practical foundations and implementation. Heterogeneity is highly prevalent in PBL studies. The phrase problem-based learning has an imprecise meaning and is often not used for a fixed pedagogical technique, therefore, its definition and implementation varies widely. Second, five studies that compared knowledge acquisition were significantly weak in methodology and were vulnerable as none of them addressed systematic error in both study design and statistical analysis, thus limiting validity and authenticity for justifiable inference. Third, all but one outcome were assessed by self-assessment using cross-sectional surveys. Surveys have limited validity and data based on subjective assessment is prone to inaccuracy. Fourth, interestingly, no study assessed possible merits or shortcomings of PBL. Therefore, weighing merits of these studies and considering heterogeneity among them, analysis of results in this review permit only tentative indicator of experience with PBL.

Although there are no clear guidelines regarding PBL research, it has been argued that education takes place in a complex and changing network of social interactions. In these complex and multi-factorial environments, effects are inevitably diffused by a myriad of unexplained variables that can adversely affect the validity, and obscure the findings of a study. In these circumstances, to overcome the obstacles, researchers should make every attempt to improve the methodological quality of the studies and provide more detail on the educational programs. In case of PBL, future studies need to provide adequate and precise information of the PBL programs and outcomes need to be carefully chosen that learning strategies seek to influence; otherwise authentic results cannot be obtained. Studies that evaluate knowledge acquisition should make stringent attempts to prevent confounding and systematic error. Further, as compared to short-term programs, evaluating long-term influence of PBL, and comparing with conventional methods can provide more meaningful and organic results.

In this review PBL curriculum was reported at private medical colleges only. In fact, most studies were conducted at private medical colleges with number of students averaging a hundred. The results, therefore, do not represent the state of PBL in the whole of Pakistan. Many public schools still follow conventional curriculum based on didactic LBL, and face a daunting task to implement PBL, as the resources are limited and number of students is way more than that of private medical colleges.

A decade of research in Pakistan shows that apart from knowledge acquisition, based on subjective assessment of students, PBL has many advantages. PBL was also rated better than LBL on selected outcomes. However, the results are limited due to heterogeneity. Studies that assessed knowledge acquisition by comparing exam scores provide equivocal evidence, and the results of these studies were marred by methodological weakness making them incapable for any justifiable inference. Further, studies undertaken in the future should take rigorous measures to improve the validity of the results.

CONCLUSION

Based on student perceptions, PBL has many advantages. However, the results of this review are limited due to heterogeneity and methodological weakness of studies, specially the studies that compared exam scores to assess knowledge acquisition.

Acknowledgment: The authors would like to thank Prof. Dr. Aqeel Safdar, Paediatric Surgeon at Military Hospital, Rawalpindi, for providing valuable advice and comments on the manuscript.

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