

## Original Research Article

# Comparison of cognitive domain scores after lecture-based and problem-based learning in community medicine

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### ABSTRACT

**Background:** Problem-based learning is a student-centred, problem-based, small-group method of learning that emphasizes use of scenarios. The objective of this comparative descriptive study was to determine the difference in cognitive domain scores after lecture-based learning and problem-based learning.

**Methods:** This comparative descriptive study was conducted at a municipal medical college in Thane, Maharashtra, India. After approvals, the study was explained to third-year MBBS students and written informed consent was obtained from willing students. After delivering lectures on five topics in environmental health in the subject of Community Medicine, a pre-test was conducted, which comprised five short-answer questions (ten marks per question; maximum 50 marks). Scenarios pertaining to the same topics were devised for problem-based learning. To enable small-group discussion, the students were randomly assigned to two groups. The post-test questionnaire was identical to that used for the pre-test.

**Results:** A total of 61 students (males=26; 42.62% and females=35; 57.38%) participated. The overall mean pre-test scores increased from  $26.44 \pm 3.58$  (95% CI: 25.55-27.34) to  $32.74 \pm 4.46$  (95% CI: 31.62-33.86). The difference between the overall pre- and post-test scores was highly significant ( $Z=8.604$ ;  $p<0.00001$ ). However, the gender differences in pre- and post-test scores were not statistically significant.

**Conclusions:** Since problem-based learning offers a standardized method of teaching wherein the knowledge can be applied, it can be used as an adjunct in educational settings that focus mainly on lecture-based learning.

**Keywords:** Community medicine, Problem based learning, Cognitive domain scores

### INTRODUCTION

Since its origin at McMaster University, Canada, in the mid-1960's, Problem-based Learning (PBL), a student-centred, problem-based, small-group method of learning that emphasizes use of realistic scenarios, has been progressively implemented in many medical colleges.<sup>1-3</sup>

The suitable setting for successful adult learning ought to include a learning environment characterized by physical comfort, mutual trust and respect, mutual support, freedom of expression, acceptance of differences, learner-perception that the goals of the learning experience are

their own goals, learner-acceptance of a share of responsibility for planning and operating the learning experience and therefore having a commitment to it, active learner participation with a self-awareness of progress toward their own goals.<sup>4</sup>

PBL is consistent with current views of human learning, which presupposes that "knowledge" is not an absolute, but is "constructed" by the learner based on prior knowledge.<sup>3</sup> It has been postulated that interactions with one's environment stimulates learning and that knowledge evolves through social negotiation and assessment of the viability of individual understandings.<sup>5</sup>

The pre-requisite for PBL is the critical reflection on evidence and utilization of this evidence for working on the problem.<sup>6</sup> PBL places the responsibility for learning in the hands of the students, and is concerned with both what students learn and how they learn it.<sup>7,8</sup> Though the medical teacher is freed from the task of having to update lectures periodically, PBL needs different teacher skills, chiefly those of group leadership and ability to engage students in small group work and self-directed learning.<sup>9</sup>

The tutorial discussion is at the core of PBL. The method uses small group discussion in addition to traditional teaching methods to stimulate active learning by students.<sup>10</sup> The selected problems are derived from clear course objectives and are customized for students at different stages of training. The facilitator, who need not be a subject expert or resource person, is expected to guide the progress of the students through the discussion and decision making that is necessary to find a solution to the problem at hand. The students learn how to obtain information from a variety of sources. During the first session, a note-taker, elected by the group, records the focal points of the discussion. These focal points are utilized to define the learning activities that the group will subsequently undertake before the next meeting. At the second session, the students are encouraged to reflect on what they have learned by answering the questions recorded by the note-taker during the previous session. They delve into each others' answers to the questions and consequently, teach themselves and compare their own performance with that of their peers. The new knowledge and understanding acquired in this process is applied to solving the original problem. In the early part of the course, finding a solution to the problem is not necessary.<sup>9</sup>

The success of PBL is determined by the quality of the devised scenarios.<sup>11</sup> By working on the problems, students reflect on the nature of the problem, generate ideas and have better knowledge retention.<sup>11,12</sup> PBL increases in-depth training, and helps students to perform better in examinations.<sup>13</sup> PBL, a very useful teaching strategy for integrated undergraduate teaching due to opportunities for integrating knowledge and skills across multiple disciplines, works best within a planned curriculum with learning stage-specific clear learning objectives.<sup>9,14</sup> Though the introduction and development of PBL requires time and coordination, the use of small group work, self-directed learning, peer support and feedback and the cultivation of critical thinking assure long-term gains.<sup>9</sup>

One of the features of medical education in India is the excessive emphasis on lecture-based learning (LBL). LBL is apparently more beneficial for students preparing for a written examination though it is disapproved of for creating information overload with insufficient critical thinking.<sup>15</sup>

The objective of this comparative descriptive study was to ascertain the difference in cognitive domain scores after LBL (by pre-test) and after PBL (by post-test).

## METHODS

This comparative descriptive study was conducted between August and September 2017 at Rajiv Gandhi Medical College in Kalwa, Thane, Maharashtra, India. This municipal medical college has an intake capacity of 60 students per year for the Bachelor of Medicine and Bachelor of Surgery (MBBS) course. After obtaining approval from the Institutional Ethics Committee, the purpose of the study was explained to third-year MBBS students. Written informed consent was taken from students (n=61) who were willing to participate in the study.

At the outset, LBL sessions were conducted on five topics pertaining to Environmental Health mentioned in the syllabus prescribed by the Maharashtra University of Health Sciences for the Community Medicine course – water, sanitation, entomology, radiation and ventilation. The pre-test, conducted after the LBL, comprised five short-answer questions (ten marks per question; maximum 50 marks) pertaining to these five topics.

For PBL, problems pertaining to all the above-mentioned five topics were devised. The students were randomly assigned (using lottery method) to two sub-groups comprising 30 and 31 students, respectively, to enable small-group discussion. Both authors acted as facilitators during the small group discussions. The post-test was conducted after PBL using a questionnaire that was identical to that used for the pre-test. The scores from students in the two sub-groups were combined for analysing results of the pre- and post-tests. The outcome studied was the difference in cognitive domain scores after LBL (by pre-test) and PBL (by post-test).

The pre-test and post-test scores were tabulated in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and were statistically analysed using EpiInfo Version 7.0 (public domain software package from the Centers for Disease Control and Prevention, Atlanta, GA, USA). Mean, Standard Deviation (SD) and standard error of difference between two means were calculated for continuous data. 95% Confidence interval (CI) was stated as: [Mean-(1.96)\*Standard Error] - [Mean+(1.96)\*Standard Error]. The differences in results were considered to be statistically significant if the 'p' value was less than 0.05.

## RESULTS

### Overall scores

A total of 61 students (males=26; 42.62% and females=35; 57.38%) participated in this study. The overall mean pre-test scores increased from 26.44±3.58

(95% CI: 25.55 - 27.34) to  $32.74 \pm 4.46$  (95% CI: 31.62 - 33.86). The difference between the overall pre- and post-test scores was highly significant ( $Z=8.604$ ;  $p<0.00001$ ).

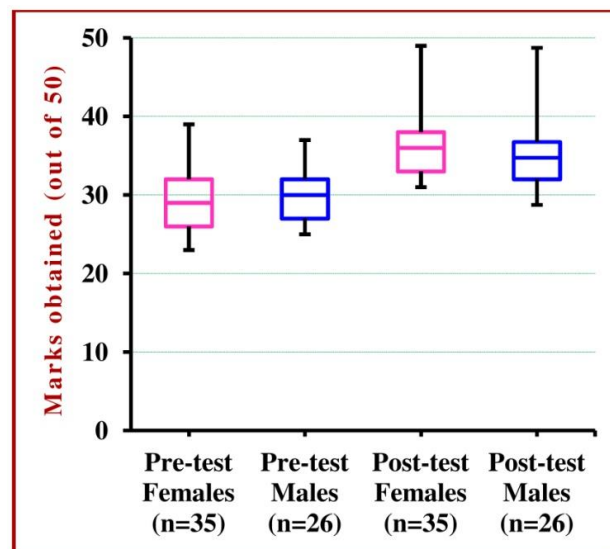
### Gender-wise scores

In the pre-test, the third quartile, median and first quartile of scores (out of 50) was nearly identical for males and females. In contrast, the maximum pre-test score (36) and minimum pre-test score (20) were obtained by female students (Figure 1). In the post-test, the maximum, third quartile, median, first quartile and minimum scores were marginally lower for male students (Figure 1).

In the pre-test, the mean score in each topic (out of 10) was marginally higher among males for four topics except radiation. The standard deviation of scores was also higher for female students. The gender differences in pre-test scores were not statistically significant (Table 1).

The scoring pattern reversed in the post-test, with lower standard deviation in the scores obtained by female students. The mean score in each topic (out of 10) was slightly higher among male students for three topics except radiation and ventilation, wherein female students

outscored their male counterparts. The differences in post-test scores were not statistically significant (Table 2).



**Figure 1: Boxplot of gender-wise pre- and post-test scores.**

**Table 1: Gender-wise mean scores in the pre-test (out of 10).**

| Topic              | Females (n=35)  |           | Males (n=26)    |           | Z value | P value |
|--------------------|-----------------|-----------|-----------------|-----------|---------|---------|
|                    | Mean $\pm$ SD   | 95% CI    | Mean $\pm$ SD   | 95% CI    |         |         |
| <b>Water</b>       | 4.97 $\pm$ 1.07 | 4.79-5.15 | 5.15 $\pm$ 0.67 | 5.02-5.28 | 0.805   | 0.418   |
| <b>Sanitation</b>  | 5.00 $\pm$ 1.26 | 4.79-5.21 | 5.19 $\pm$ 1.06 | 4.98-5.40 | 0.638   | 0.522   |
| <b>Entomology</b>  | 5.31 $\pm$ 1.05 | 5.13-5.49 | 5.35 $\pm$ 0.94 | 5.17-5.53 | 0.156   | 0.873   |
| <b>Radiation</b>   | 6.14 $\pm$ 0.88 | 5.99-6.29 | 5.96 $\pm$ 0.87 | 5.79-6.13 | 0.795   | 0.424   |
| <b>Ventilation</b> | 4.83 $\pm$ 1.12 | 4.64-5.02 | 5.04 $\pm$ 0.72 | 4.90-5.18 | 0.889   | 0.373   |

SD=Standard deviation; Z=Standard error of difference between two means; CI=Confidence interval.

**Table 2: Gender-wise mean scores in the post-test (out of 10).**

| Topic              | Females (n=35)  |           | Males (n=26)    |           | Z value | P value |
|--------------------|-----------------|-----------|-----------------|-----------|---------|---------|
|                    | Mean $\pm$ SD   | 95% CI    | Mean $\pm$ SD   | 95% CI    |         |         |
| <b>Water</b>       | 6.31 $\pm$ 1.11 | 6.12-6.50 | 6.46 $\pm$ 1.42 | 6.18-6.74 | 0.447   | 0.652   |
| <b>Sanitation</b>  | 6.43 $\pm$ 1.04 | 6.25-6.61 | 6.50 $\pm$ 1.27 | 6.25-6.75 | 0.230   | 0.818   |
| <b>Entomology</b>  | 6.40 $\pm$ 0.95 | 6.24-6.56 | 6.62 $\pm$ 1.02 | 6.42-6.82 | 0.858   | 0.389   |
| <b>Radiation</b>   | 7.11 $\pm$ 0.68 | 7.00-7.22 | 6.96 $\pm$ 1.22 | 6.72-7.20 | 0.565   | 0.568   |
| <b>Ventilation</b> | 6.37 $\pm$ 0.84 | 6.23-6.51 | 6.35 $\pm$ 1.13 | 6.13-6.57 | 0.076   | 0.936   |

SD=Standard deviation; Z=Standard error of difference between two means; CI=Confidence interval.

## DISCUSSION

In the present study, the difference in cognitive domain scores after LBL (determined by pre-test) and PBL (determined by post-test) was highly significant. A study from North India also found that the students who underwent PBL obtained higher mean scores as compared to their counterparts who were exposed to LBL.<sup>16</sup> A study from Peshawar, Pakistan, on 146 third-year MBBS students concluded that PBL was more

effective than LBL in the academic performance of medical students since the mean scores in the former group were higher.<sup>17</sup> Similar results have been reported by comparative studies from England and The Netherlands.<sup>13,18</sup> A study from Taiwan on nursing students reported that the group who received PBL as the training method showed more satisfaction, critical thinking and self-motivated learning and that PBL training was more effective than conventional teaching.<sup>19</sup>

In contrast, other studies from England and The Netherlands have reported no statistical difference in impact of PBL and LBL on cognitive scores.<sup>20,21</sup> Likewise, a randomized-controlled trial in Hong Kong, which compared PBL with LBL, found that PBL was less effective at imparting knowledge, as compared to LBL.<sup>22</sup> A Korean study concluded that learning outcomes of PBL were not significantly different from that of LBL, although students in PBL group showed improved abilities in problem solving, self-directed learning and critical thinking.<sup>23</sup>

In LBL, students, who are passive recipients of information from a teacher, tend to memorise the content instead of comprehending the concepts.<sup>24</sup> LBL presents the topic systematically with logical organization of sub-topics, is easier for students to memorize, understand the information presented and emphasizes development of fundamental clinical skills that are indispensable in clinical practice.<sup>25</sup> Other researchers have found that LBL is insufficient for the absorption of the culture of clinical thinking and teamwork spirit.<sup>26-28</sup>

On the other hand, in PBL, the students in the group work together in a non-competitive environment to develop their own questions about the problem and to seek their own answers. This new information is then integrated with existing knowledge (at individual and group levels) in attempting to formulate a solution. It is believed that problem-based curriculum will produce doctors who are well versed in group problem-solving and capable of working independently.<sup>9</sup> However, since PBL requires interactive participation, the more verbose and articulate students may dominate the discussion and students with poor communication skills are likely to lag behind.<sup>29</sup>

In 1992, Norman and Schmidt reported that the general problem-solving skills were not enhanced by PBL but the knowledge learned by PBL was better retained. They concluded that integration of basic science into clinical concepts and application of basic science in solving clinical problems were considerably improved by PBL courses.<sup>30</sup>

## CONCLUSION

In the present study, the difference in cognitive domain scores after PBL was significantly higher than that after LBL. Before joining the MBBS course, the students in the present study had studied in different educational institutions and therefore inter-student systematic differences may pre-exist due to their heterogeneity. Since PBL offers a standardized method of teaching wherein the knowledge can be applied, it can be used as an adjunct in educational settings that focus mainly on LBL. A limitation of this study was that long-term retention of knowledge and its application was not studied. More studies would be required to unravel the mechanisms underlying the perceived effectiveness of PBL.

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