21st Century Teaching For Students Of Medical Laboratory Technology: A Problem-Based Learning Approach

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There was no source of funding for the work described in the study.

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We have the no conflicts of interests to declare.
21st Century Teaching For Students Of Medical Laboratory Technology: A Problem-Based Learning Approach

Abstract

Introduction: The expected knowledge base required for newly qualified laboratory technicians in practice setting is immense. However it is almost impossible to include all the information required at entry into professional practice into the teaching curricula. Problem based learning (PBL) is intended to develop lifelong and self-directed learning. The aim of this study was to analyze students’ opinion about a new model of PBL and to evaluate its effect on the students' conceptual understanding.

Methods: We developed a teaching and learning quality improvement (QI) model for final year medical laboratory technology (MLT) students based on PBL. After finishing an introductory teaching module, students were given a pre-test assessing both reasoning skills and facts at beginning of next class. Students were then randomly divided into four groups in the next session. This was followed by small group PBL discussions on pre-test questions. A similar surprise post-test was then conducted after 2 weeks and each student’s view on PBL was assessed.

Results: A total of three PBL sessions were conducted. The overall mean post-test scores were significantly higher than the mean pre-test scores (p value<0.05). The PBL model was rated as ‘an excellent way in understanding concepts’ by majority of the students and 86.7% of students gave overall positive remarks.

Conclusion: The QI model based on PBL sessions improved the students’ conceptual understanding of the topic. This model may lead to the development of self-directed learning skills and enhance student-centered learning outcomes beyond knowledge acquisition.

Introduction

The expected knowledge base required of newly qualified laboratory technicians for the practice setting is immense. However it is almost impossible to include all the information required at entry into professional practice into the teaching curricula. Also many medical and para-medical graduates were unable to apply the content learned in their classes to clinical practice [1]. Hence we need to develop students into lifelong learners and self-directed laboratory practitioners.

Problem based learning (PBL) is a strategy that uses a problematic stimulus for students to develop and acquire knowledge. Students are presented with a problem to solve rather than a lecture to absorb. Students, working in small groups in a classroom setting, are challenged to apply previously learned information to the problem and identify the knowledge and skills they lack to accurately solve the problem [2]. PBL has been implemented as a main teaching strategy in nursing courses by the Department of Health in UK [3,4]. Similarly many universities have also observed enormous usefulness of PBL strategy for undergraduate medical students. However there is no information available in the literature that addresses the question of usefulness PBL learning methods in laboratory technology courses.

Three types of approaches to PBL have been identified in the literature: (1) completely integrated PBL curricula, (2) transitional curricula, and (3) a single-course approach [5]. We planned to implement PBL in one or more courses of the medical laboratory technology (MLT) curriculum as a trial process in an attempt to gain some of the proposed benefits of PBL. However in high school the learning is passive and focused on factual knowledge. Hence the students’ rapid transition from passive learning to a PBL curriculum where learning is independent and focused on cognitive skills, might be difficult for many students, particularly in the early phases of a PBL program [6]. Hence it has been suggested that a module or short course can be designed to include mixed teaching methods (including PBL) to achieve the learning outcomes. Also small number of lectures may be desirable to introduce topics or provide an overview of subject material in conjunction with the PBL scenarios [7].

As no suitable PBL model was found in the medical
education literature for medical laboratory technology (MLT) students; we developed a simple model where introductory teaching sessions are followed by PBL discussion sessions. The aim of this study was to evaluate the effect of this mode of teaching and learning on the students' conceptual understanding of the topic and the retention of the gain in knowledge after three weeks of introductory class.

**Methods**

**Introduction of PBL for medical laboratory technology in JIPMER, Pondicherry, India**

We developed a teaching and learning quality improvement (QI) model for final year undergraduate MLT students based on PBL models. The new MLT program combined traditional and PBL curriculum features. These features included integration of PBL into regular curriculum, where introductory classroom lectures were followed by PBL discussions with integrated objectives. A problem-solving approach was used with small-group learning in the subsequent session. The goals of these sessions were to foster the development of clinical reasoning and responsibility for learning and to create a forum for students to address laboratory patient care issues.

**Study Unit Design**

The final year undergraduate MLT students (n=18) have weekly biochemistry theory classes in their curriculum. An introductory teaching session from the topic ‘lipid metabolism’ was first conducted. After finishing an introductory teaching module, students were given 10 multiple choice questions (MCQ) of one mark each assessing both reasoning skills and isolated facts at the beginning of next class (pre-test). Students were then randomly divided into four groups, each group consisting of 6–8 students. This was followed by small group PBL discussions on pre-test questions in the presence of a faculty member. Attendance was mandatory for PBL sessions. Students met once a week for 2 to 2.5 hours per session and worked through health care scenarios that were designed to address study unit objectives. Students were challenged to apply previously learned information to the problem and identify the knowledge and skills they lack in accurately solving the problem. A surprise post-test of a total of 10 marks was then conducted after two weeks. At the end of all the sessions, each student’s opinion on PBL was assessed by asking them to tick choices on an anonymous questionnaire. The learning effects of this group discussion were evaluated by comparing the performance of students in pre-test versus post-test using paired student's t-test by SPSS 13 software.

**Interviewing the students**

The second part was concerned with interviewing the students who were exposed to PBL for the first time to explore their opinion on this QI model of PBL. This was analyzed by the content analysis of the questionnaire form filled by the students at the end of all the sessions. The anonymous questionnaire survey (see Appendix-1) sought opinions on (i) rating of PBL model as a tool in understanding concepts' compared with regular teaching model, (ii) the association between the ‘PBL tool’ and ‘development of your skills of critical thinking’ and (iii) overall remarks. The association between the ‘PBL tool’ and ‘development of skills of critical thinking’ was assessed by asking the students to tick on a 0-10 cm visual analogue scale (VAS), where ‘0’ referred to no association and ‘10’ referred to maximum association. The first section of the survey form (questions 1–2) dealt with the demographics of the student. The second section dealt with the students’ opinions on QI model of PBL (questions 3–5).

**Results**

Three regular teaching modules were required to complete the topic lipid metabolism. Hence a total of three PBL sessions and three pretests-posttests were conducted.

(i) **Effect of small group PBL discussion on the students’ conceptual understanding of the topic and the retention of the gain**

The overall mean post-test (post discussion) scores were significantly higher than the mean pre-test (pre discussion) scores, mean±SD: 8.2±1.8 versus 6.2±2.0, mean difference=1.96 (n: 18x3=54 and 95% confidence intervals=2.7, 1.2), p value< 0.001. Hence the gain from the discussion exercise was retained after three weeks of introductory teaching session.

(ii) **Content analysis of the questionnaire form seeking students’ opinion on PBL model**

Of the 15 students who answered the questionnaire, 73.3% were males and 26.7% were females. All the students were between 19-24 years of age. The PBL model was rated as ‘an excellent way in understanding concepts’ compared with regular teaching model by 66.7% of the students (Fig 1A). None of the students rated PBL model as poor compared with regular teaching model. The association between the ‘PBL tool’ and ‘development of skills of critical thinking’ on a
0-10 cm visual analogue scale (VAS) was rated as ‘10 cm’ by 33.3% students, ‘9 cm’ by 13.3% students and ‘8 cm’ by 26.7% of students (Fig 1B). None of the students rated the association as less than 5 cm. About 86.7% of students gave overall positive remarks (Fig 1C). The general verbatim remarks of students are presented in Table 1.

Discussion

Generally in a teacher-directed (teacher-centered) instructional paradigm, students are mainly passive recipients of abundant content knowledge and are not actively involved in the teaching learning process. Consequently the regular classroom based lectures do not nurture enough the students to build a firm foundation for the development of lifelong continuing self-education which is so critical for competent medical practice in the 21st century [8]. Educational systems are accused of being too clumsy, producing bad instruction, and of being out of touch with today’s training needs. There is more emphasis on the process involved in developing instruction and less importance is given to basic learning principles. Insufficient quality in education is likely to result in an inferior product [9].

In the mid-1960s, McMaster University gave birth to a medical school so different it sent ripples of astonishment throughout the educational world. Problem based learning was developed by Harold Barrows at McMaster university medical school in response to student dissatisfaction with the lecture format [10]. It is recognized that there may also be interactions between multiple learners, teachers and others. The PBL model focuses on the interaction between learner and teacher, engaging respectively in learning and teaching activities and simplifies complex interactions into transactions between pairs of individuals [11]. In practice, PBL is usually part of an integrated curriculum using a systems based approach, with nonclinical material delivered in the context of clinical practice [7].

We found that the PBL discussions on pre-test questions after an introductory teaching module improved the students’ conceptual understanding of the topic and the academic gain from the exercise was retained after three weeks of introductory class. Participants found this model of learning and teaching helpful. They also felt that it adequately represented the teaching activities within the wider context of undergraduate medical laboratory technology education. The structure of the PBL sessions allowed students to think critically and they felt that discussing problems are a powerful tool for understanding concepts.

Our study however has few limitations. Although two weeks following the end of the PBL sessions a good predictor of short term retention however this time period is insufficient to assess long term retention of knowledge. Also not all students answered the questionnaire. The small group sessions were also not purely PBL sessions and were rather based on a mixed approach. Nevertheless the overall response of the students was very encouraging and we definitely intend to expand upon these findings in the future and include QI model in the curriculum of the under-graduate MLT students.

Conclusion(s)

We finally conclude that the QI model of PBL may help in developing a professional climate that allows the evolution of students’ from a laboratory technologist being perceived as primarily a technician to being perceived as a professional making decisions regarding diagnosis.

Acknowledgement(s)

We would like to acknowledge the students of BSc MLT, final year 2009 batch for participating in the study with full zeal and enthusiasm.

References

## Illustrations

### Illustration 1

Table 1 General verbatim remarks about PBL model of students

<table>
<thead>
<tr>
<th>Verbatim remarks</th>
<th>Overall category</th>
</tr>
</thead>
<tbody>
<tr>
<td>“This is my first (and best) experience. It will be helpful for us during preparation for higher studies. Please continue this forever”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This model is good”</td>
<td>Positive</td>
</tr>
<tr>
<td>“The concept is fresh and gives chance for the students to relate themselves with classes. After the discussion, a Xerox copy of the correct answers with explanation can be circulated to the students”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This PBL model is working excellent for me”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This model will help while facing problem based questions”</td>
<td>Positive</td>
</tr>
<tr>
<td>“It is a nice model with nice concepts”</td>
<td>Positive</td>
</tr>
<tr>
<td>“PBL model of teaching is better than usual methods”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This model will be very useful for future entrance exams also”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This PBL model is good and with every discussion I acquired useful skills”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This PBL model is good. It develops the individual skills and dealing capacity”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This PBL model is excellent in improving our knowledge and skills”</td>
<td>Positive</td>
</tr>
<tr>
<td>“I feel very glad about this PBL model. I would prefer this type of learning. Thank you”</td>
<td>Positive</td>
</tr>
<tr>
<td>“This model takes more time”</td>
<td>Negative</td>
</tr>
<tr>
<td>“In between the discussion class, give some break, it becomes very tiring”</td>
<td>Negative</td>
</tr>
</tbody>
</table>
Illustration 2

Figure 1 Content analysis of the questionnaire form seeking students' opinion on PBL model

A

![Students' rating of PBL model as a tool in understanding concepts compared with regular lectures](#)

B

![Students' opinion on the association between the PBL tool and development of your skills of critical thinking on a 0-10 cm VAS](#)

C

![Students' general remarks about PBL model](#)
Illustration 3

Appendix-1

Questionnaire survey

We appreciate your honest opinions
The responses will be treated anonymously and confidentially

The first set of questions relate to your demographic information
1. What is your age?
2. Gender? Female Male

The remaining questions relate to your opinions on problem based learning (PBL)
3. How would you rate PBL model as a tool in understanding concepts’ compared with regular teaching model?
   a) Poor
   b) No difference
   c) Good
   d) Excellent

4. Do you think PBL model can be useful in developing your skills of critical thinking?
   Please rate the association between the ‘PBL tool’ and ‘development of your skills of critical thinking’ of each by placing a cross anywhere on the space provided.

5. Please give your remarks about this model of PBL. Also mention your suggestions for improvement of this model.
Reviews

Review 1

Review Title: Review of Article

Posted by Dr. Rakesh Goyal on 08 Apr 2011 02:40:50 PM GMT

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<th>Question</th>
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<tr>
<td>1</td>
<td>Is the subject of the article within the scope of the subject category?</td>
<td>Yes</td>
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<tr>
<td>2</td>
<td>Are the interpretations / conclusions sound and justified by the data?</td>
<td>Partly</td>
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<tr>
<td>3</td>
<td>Is this a new and original contribution?</td>
<td>Yes</td>
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<td>4</td>
<td>Does this paper exemplify an awareness of other research on the topic?</td>
<td>Yes</td>
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<td>5</td>
<td>Are structure and length satisfactory?</td>
<td>Yes</td>
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<td>6</td>
<td>Can you suggest brief additions or amendments or an introductory statement that will increase the value of this paper for an international audience?</td>
<td>No</td>
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<td>7</td>
<td>Can you suggest any reductions in the paper, or deletions of parts?</td>
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<td>Is the quality of the diction satisfactory?</td>
<td>Yes</td>
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<td>9</td>
<td>Are the illustrations and tables necessary and acceptable?</td>
<td>Yes</td>
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<tr>
<td>10</td>
<td>Are the references adequate and are they all necessary?</td>
<td>Yes</td>
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<td>11</td>
<td>Are the keywords and abstract or summary informative?</td>
<td>Yes</td>
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Rating: 7

Comment:
This study is timely and well designed. I will make a greater impact if number of subjects can be increased and taken from different institutions.

Competing interests: None

Invited by the author to make a review on this article? : Yes

Experience and credentials in the specific area of science:
I have taught medical students and residents during my work as resident and registrar for total of 6 years in India.

Publications in the same or a related area of science: No

How to cite: Goyal R.Review of Article [Review of the article '21st Century Teaching For Students Of Medical Laboratory Technology: A Problem-Based Learning Approach ' by ].WebmedCentral 1970;2(4):REVIEW_REF_NUM648
Review 2

Review Title: In overall, the paper is nicely written and easy to read with a good flow. However, certain aspects of the paper can be described in greater detail.

Posted by Ms. Lim SJ on 15 Feb 2011 02:12:58 AM GMT

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<td>No</td>
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Rating: 3

Comment:
In overall, the paper is nicely written and easy to read with a good flow.

However, certain aspects of the paper can be described in greater detail.

Major comments:
1. In the paper, the authors mentioned the use of a teaching and learning quality improvement (QI) model. However, a detailed description and specification of the QI model is lacking:
   - What is the main feature of the QI model? The integration of teaching sessions with PBL discussion sessions? Or the pre and post test?
   - How is this QI model different from other PBL approaches

2. The authors also mentioned the use of a pre and surprise post tests to evaluate the students' understanding of the concepts involved, and compared their scores in both tests. Since the surprise post tests were conducted after three PBL sessions, would the surprise test be predictable and expected by the students eventually and therefore lose its meaning and purpose (since the students can prepare for it)?

   More importantly, there will usually be an increase in scores when comparing the students' understanding before and after any teaching session, regardless of whether a PBL approach is used. Is there any control group to compare the pre and post test scores for MLT students who are not exposed to the PBL approach and those who are exposed to the PBL approach? If a null group is used, ie. students who are not subjected to any additional PBL process, then, we have to be careful to ensure that the improvement is not just due to the extra time students formally spent in going through the material, which can be replicated with other processes including interactive lectures, team-based learning, etc. So a carefully selected control is essential if we want to prove the case with PBL.

3. Discussion: In paragraph 3, the authors described the advantages of PBL in the MLT course, but did not specifically mention the advantages of the QI model which they have developed. Again, how is the QI model
advantageous as compared to other PBL approaches?

Minor comments:

1. Abstract: The introduction paragraph gave an overview of the problem of training laboratory technicians and an overview of PBL. However, the link between training laboratory technicians and PBL is not described clearly - i.e. How does PBL help in solving the problem of training laboratory technicians?

2. Introduction: In paragraph 4, the authors mentioned that no suitable PBL model was found for MLT students. Why is this so? Please describe the reason(s). The authors also mentioned that they developed "a simple model where introductory teaching sessions are followed by PBL discussion sessions". Is this the main feature of the describe QI model? In fact, this model is not novel and has been reported in literature. Please add in the appropriate references.

3a. Methods: In the section "Study Unit Design", the authors mentioned that the small group PBL discussions are on the pre-test questions. However, later in that paragraph, it was stated that "students met once a week for 2 to 2.5 hours per session and worked through health care scenarios that were designed to address study unit objectives". The reviewer would like to know what is the focus of the small group PBL discussions? Is the focus on pre-test questions or health care scenarios or both?

3b. Methods: In the section "Interviewing the students", the word "interview" may not be appropriate since the feedback was evaluated through questionnaires and no actual, direct interview was conducted.

4. Results: In section (i) "Effect of small group PBL discussion...", the authors presented the overall difference between the mean pre-test and post-test scores. Analysing only the overall scores averaged over three PBL sessions may not be adequate since the data may be biased (e.g. the difference in scores in session 1 may be very high but there may be a small insignificant difference in scores in session 2, due to the difference in difficulty levels of the concepts). Therefore, it would be good if the authors can present the difference in scores for each PBL session in the results.

5. It would be good if the authors can provide an example of the pre-test and post-test questions in the Appendix.

Competing interests: No

Invited by the author to make a review on this article? : Yes

Experience and credentials in the specific area of science:
Developing e-learning tools to enhance teaching and learning in undergraduate bioinformatics courses offered in the life science curriculum

Publications in the same or a related area of science: Yes


How to cite: SJ L.In overall, the paper is nicely written and easy to read with a good flow. However, certain aspects of the paper can be described in greater detail.[Review of the article ‘21st Century Teaching For Students Of Medical Laboratory Technology: A Problem-Based Learning Approach’ by ].WebmedCentral 1970;2(2):REVIEW_REF_NUM471
Review 3

Review Title: Pleasantly written

Posted by Chaitra Sreenivasaiah on 27 Oct 2010 01:23:58 AM GMT

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Rating: 0

Comment: “21st Century Teaching For Students Of Medical Laboratory Technology: A Problem-based Learning Approach” authored by Sajita Setia et al, puts forth the view that compared to traditional didactic lectures, a problem based approach to teaching and learning is more rewarding in terms of knowledge retention and application. The author presented an orderly explanation of the idea behind the study, and the methods. The authors hold that “Educational systems are accused of being too clumsy, producing bad instruction, and of being out of touch with today?s training needs.” I strongly agree with the author’s stated position, that clinical-problem based learning produces much better results than mere theory lectures. I have received undergraduate and post-graduate medical education, and have always been deeply interested in the different methods employed during my courses. When theoretical knowledge is extrapolated simultaneously to clinical scenarios, its impact on patient management becomes evident, and the concepts are grasped much better. The article is written in a smooth style and well referenced. While there were some grammatical errors, they did not detract significantly from the reading experience. I would like to suggest to the authors to expand the discussion section. Apart from the reiteration of the results, it would be interesting to know the views of the authors on how certain factors influenced the study; namely the topic chosen for PBL, the institute in which the study was conducted, and so on. Which concepts in their opinion would be best taught by PBL, and how effective could this model be with students in other disciplines. Overall, I would rate this article as a good and worthwhile read. I believe it would be very useful for professionals in the field of medical education, as it highlights some of the reforms needed to give our education system a much needed revamp.

Competing interests: None

Invited by the author to make a review on this article? : Yes

Experience and credentials in the specific area of science: Am a Masters degree holder. As a student, I received courses in various forms such as theory classes, practical sessions, group discussions, modules on clinical case scenarios and bedside rounds. I have also taken a few classes for small groups of undergraduates, mostly clinical case discussions. Ingenuity in the field of medical education always fascinates me.

Publications in the same or a related area of science: No

How to cite: Sreenivasiah C.Pleasantly written [Review of the article ‘21st Century Teaching For Students Of Medical Laboratory Technology: A Problem-Based Learning Approach ‘ by ].WebmedCentral 1970;1(10):REVIEW_REF_NUM87
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