Problem-based learning in a large classroom setting: methodology, student perception and problem-solving skills

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1. Introduction

Problem-based learning (PBL) can be described as a learning environment where the problem drives the learning. Students are given a problem that is posed such that they realize the need to gain up-to-date, evidence-based knowledge before they can solve the problem. Studies with small group PBL have identified the following immediate benefits to students: increased retention of information, an integrated (rather than discipline bound) knowledge base, development of lifelong learning skills, exposure to real-life experience at an earlier stage in the curriculum, increased student-faculty liaison, and an increase in overall motivation[1]. However, very little research has been done on the educational benefits of PBL in a large classroom setting. Furthermore, several studies have suggested that PBL may not be superior to conventional educational approaches in all aspects of learning. Therefore, it cannot be assumed that introducing the PBL technique to a large undergraduate class setting will lead to enhanced student learning or satisfaction. The superiority, or at least the non-inferiority, of PBL over the standard course delivery techniques must be proven for each individual PBL delivery method. We are therefore exploring various approaches that could be used to compare student learning during didactic lectures with PBL exercises that are being conducted within a large classroom, and are assessing the student perception of this process.

2. Tutor-less PBL Process in a Large Class(40-80 students)

PBL Method (The Seven Steps)[2]

1. Understand the situation/clarify terminology
2. Identify the problem
3. Suggest possible causes (hypothesize)
4. Connect problems and causes
5. Decide what type of information is needed
6. Obtain information
7. Apply the information

New data and information provided

PBL Process

- PBL cases take up 25% of instructional time and are either 'stand alone' or are integrated with lecture material that is delivered in parallel
- During PBL, laptops can be used for word processing only; no textbooks or encyclopedias are allowed; students are not required to prepare for the first tutorial
- Class (40-80 students) is divided into groups of 7-9 that are created either randomly or by stratified randomization
- Each PBL case spans three 1.5 hour lecture periods, at least one week apart
- Problem is presented on several slides
- Time is allowed for individual analysis
- Group discussion follows (no tutors)
- Whole class discussion follows (moderated by instructor)
- Learning issues are identified by students
- All slides, class notes/lists and learning issues are made available through an online course management system (WebCT Vista used at UBC Okanagan) immediately after the PBL sessions
- Required reading papers are assigned after each PBL session
- Everyone is expected to study all the learning issues established during the three PBL sessions
- The second and third sessions begin with the discussion of previously identified learning issues, followed by presentation of new information about the case
- The third session concludes the case; however, new learning issues may also be generated or left over from the previous PBL sessions

Marking of PBL work

- Each PBL case is worth 5-8% of the final mark
- UBC iPeer website is used by individuals to assess peer performance within groups anonymously
- Criteria for marking PBL performance:
  - Preparation
  - Participation
  - Professionalism
- PBL class attendance is marked (1% per class)
- Ability to submit peer evaluation marks on time is also assessed (2% of the mark)
- In addition, PBL case materials are examined during the midterm and final exams

3. Possible PBL Outcomes

- Increased **student satisfaction**
- Superior **problem-solving skills**
- Improved **understanding and retention of course content**

3.1. PBL Outcomes: Student Satisfaction

Informal surveys

At the end of their course work, students were asked the following question**: Would you like to continue with PBL, studying another case this term? Why?**

'YES' answer given by 41 out of 44 students[a]; summary of **positive** comments given by more than one student:

- Process fun/enjoyable/interesting (28)
- Process makes you think (17)
- Retain/learn the information better (15)
- Enjoy group interactions (13)
- Learn practical information(11)
- Enjoy researching (10)
- Prefer this method of learning over others (8)

'NO' answer given by 10 out of 44 students[a]; summary of **negative** comments given by more than one student:

- Discomfort with the unknown (student hypotheses & research rather than the professor providing the answers) (6)
- Exam discomfort (4)
- The extent of the information that needs to be researched is overwhelming (2)

[a] note that some students answered both yes and no.

Formal Survey

		Participating in problem-based learning has:					Attending classes with traditional lecture formats has:					P value, sign test
		1[a]	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	
1[b]	Increased my motivation to participate in class	0[c]	3	10	14	7	2	13	13	5	1	**0.001**
2	Not increased my motivation to attend class	12	8	6	4	4	0	8	16	9	1	**0.017**
3	Enhanced my communication skills	0	2	12	19	1	5	21	5	3	0	**<0.001**
4	Increased my motivation to do well in the course	0	3	12	15	4	1	3	17	11	2	0.48
5	Enhanced my retention of course content	1	2	5	15	11	1	8	11	13	1	**0.002**
6	Not increased my understanding of course content	6	18	7	3	0	2	18	10	3	1	**0.049**
7	Assisted my learning in other courses	0	6	12	14	2	1	5	11	16	1	0.63
8[d]	Increased my comfort level in working in groups	0	0	7	16	11						
9	I like the idea of evaluating myself and my group members	2	5	7	17	3						
10	If given a choice, I would choose courses that used problem-based learning over traditional lecture format	0	4	5	19	6						

[a] Five-point Likert scale: 1 - strongly disagree; 2 - disagree ; 3 - neither agree or disagree; 4 – agree; 5 - strongly agree.
[b] Questions 1 – 7 were asked about PBL and traditional lecture experiences.
[c] Number of students giving this score in response to the survey question.
[d] Questions 8 - 10 were related to PBL exercises only.

Student Attendance

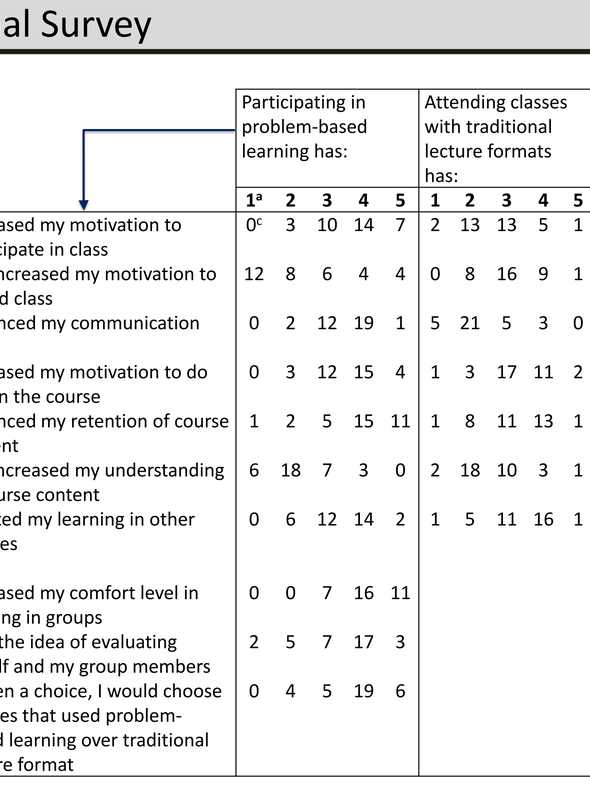

Figure 1. Student attendance of PBL sessions is significantly higher compared to standard lectures, independent of whether the attendance of these sessions is marked or not. ** P<0.01, Bonferroni post hoc test.

3.2. PBL Outcomes: Problem-Solving Skills

The students completed a problem-solving exercise in September and were informed that they would be asked to do another similar exercise in December, towards the end of the first term. Two PBL cases were conducted during the term, after which students were asked to solve the exact same problem they were given at the beginning of the term. This problem was not related to course material studied during the term. In both instances they were asked to answer the two questions identified below.

Problem-solving exercise

Problem: Nolan is a healthy 25 year old male, who works as a Park Ranger in Florida. One day, he wakes up with a fever, stomach cramps, and nausea. Nolan goes to see his family doctor, and after a brief examination, the doctor prescribes a 5 day course of Tamiflu, along with Aspirin for his fever. Although Nolan's fever subsides, the nausea and stomach cramps persist. 4 days later, Nolan is still not feeling better, and notices a rash on his torso. Nolan goes to the hospital complaining that his symptoms have progressed. He is experiencing thirst, and occasional vomiting. Nolan's vital signs were taken, with the following results:

Blood pressure: 120/80 mmHg
Temperature: 39 C
Respiration Rate: 20 breaths per minute
Heart rate: 72 beats per minute
Blood glucose level is within normal range

Questions:
1. List all the probable causes of these symptoms. Number your answers.
2. List clinical and laboratory tests that could be performed to help the diagnosis. Number your answers.

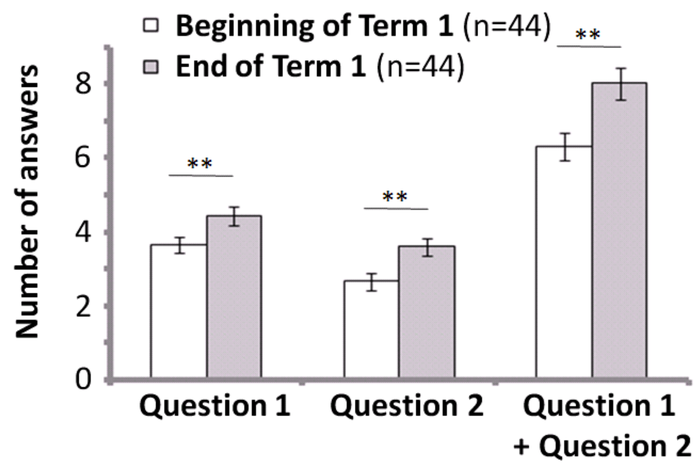

Figure 2. Students were able to generate significantly higher numbers of answers at the end of the term compared to the beginning of their course work. Acceptable answers given by students in response to the two questions listed above were counted. ** P < 0.01, Student's t-test for paired observations.

4. Conclusions

We describe a PBL approach (using tutor-less groups) that was introduced as a supplement to standard didactic lectures. PBL was chosen as an effective method to assist students in learning biochemical and physiological processes. By monitoring student attendance and using informal and formal surveys, we demonstrate that PBL has a significant positive impact on student motivation to attend and participate in the course. Student responses indicate that PBL is superior to traditional lecture format with regard to understanding of course content and retention of information. We also demonstrate that student problem-solving skills are significantly improved after exposure to course work involving PBL exercises. These data indicate several positive outcomes of using PBL in a large classroom setting, although further studies aimed at assessing student learning, understanding and retention of course content are needed to further justify implementation of this technique in courses that are delivered to large undergraduate classes.

5. Acknowledgements

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6. References

1. Robbs, J., Meredith, S. (1994) The Problem-Based Learning curriculum at Southern Illinois University School of Medicine [online]. Retrieved from: URL http://www.suimed.edu/pblc/pblcur.html (link no longer active)
2. Wood, D.F. (2003) ABC of learning and teaching in medicine: problem-based learning. Brit. Med. J. 326: 328-330.