Original Research

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Student's perception of mind mapping in Problem-based learning

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ABSTRACT

Background: Problem based learning enables active learning but an inherent disadvantage is that the knowledge is perceived to be unorganized. The use of concept maps and flow charts has been suggested to enhance reflection in PBL. The objective of the study was to determine if the PBL experience can be enhanced using a mind map for summary writing. **Methods:** Semester 2 medical students were briefed on the process of mind mapping for summarizing the PBL group discussion. Students who consented to participate in the study completed a pre-intervention questionnaire on the perception of PBL process. Each student constructed a mind map at the end of every PBL session for three consecutive triggers. The students completed a post-intervention questionnaire on the perception of PBL process at the end of the module. Data analysis of the pre and post-intervention questionnaires was carried out using Independent t-test. **Results:** Students perception of the PBL learning process continued to be positive after the intervention of summary writing with mind map and there was a difference in the ranking of the PBL learning processes with summarizing and structuring concepts at the top after mind mapping. Students comments indicated that the mind mapping exercise was useful although it was time consuming. **Conclusions:** Mind mapping can help in summarizing the PBL discussion however, not all students may find that it enhances the PBL learning process. The findings of this study support the use of mind maps only as an optional tool for summarizing PBL discussion and may be used to complement the learning process in PBL based on students' learning needs.

KEY WORDS: Mind Maps; Summary Writing; Problem Based Learning; Student's Perception.

INTRODUCTION

Problem-based learning (PBL) has been extensively applied in medical education over the last few decades with the objectives of facilitating constructive, contextual and collaborative learning and enabling students to become self-dependent life-long learners [1].

A meta-analysis on the effects of PBL [2] demonstrates that while PBL had a negative effect on knowledge acquisition, there was a positive and statistically significant effect on knowledge application. The positive effect on skills or knowledge application was not apparently affected by the degree of implementation of PBL pertaining to a single course or an entire curriculum. The recent rapid rise of PBL has closely paralleled the timing of the information explosion era and the growing dominance of PBL could thus worsen the problems of information management [3]. Hemker [4] perceived the inherent disadvantage of PBL is that the knowledge acquired through PBL tends to remain unorganized.

The curriculum at the International Medical University is outcome-based, where the student learning outcomes are mapped to competencies in knowledge, skills and attitude and delivered through a hybrid PBL approach [5]. PBL is employed as a teaching component for 20% of the teaching time in the scheduled curriculum. The PBL is delivered in rooms designed exclusively to support and foster small-group learning, with access to computers and white boards

to enable discussion. The PBL process involves working in a group in the initial session to either hypothesize or clarify the problem trigger and identify relevant learning issues. After the first session, students research and gather information on the learning issues and reconvene in the second session to present and discuss the knowledge acquired. At the end of the second session, students and their facilitator usually have a feedback session on the PBL process, group participation or the problem trigger. In some instances, before the feedback session, the student group leader would summarize the group discussion in relation to the problem trigger. Studies suggest that it may be useful for students to document their thought processes when learning and discussing in PBL. One study [6] suggested that use of a lab notebook as a written record of the student's train of thought would be an effective documentation process. Guerrero [7] described a technique of stepwise diagramming to organize information and fully realize the benefits of PBL and also stressed the importance of providing a lasting "thought record" that enables retrospective evaluation of clinical reasoning and subsequently improving the students' efficiency at self-directed learning. Barrows [8] alluded to the usefulness of concept maps or flow charts to encourage reflection in PBL.

Mind mapping developed by Tony Buzan [9] is a multisensory tool that uses visuo-spatial orientation to integrate information and consequently helps students to organize and retain information [10]. Mind maps can be used as

a teaching tool to promote critical thinking in medical education by encouraging students (adult learners) to integrate information between disciplines and understand the relationship between basic and clinical sciences. The added dimensions of pictures and colours that are unique to mind maps facilitate memory and this strategy benefits more students with diverse learning styles [11].

Studies that have investigated the potential role of mind mapping in medical [11-14] and health science education [13] have indicated that mind maps are a useful learning tool. Farrand et al [12] reported that mind mapping significantly improved long term memory of factual information and also suggested that the mind map technique could be suited to medical curricula based on PBL as both approaches support and encourage students to adopt a deeper level of learning.

We modified our PBL process for year 1 medical students by introducing them to the concept of mind maps. We hypothesized that developing the skills of summary writing through a mind map at the end of the PBL discussion will enhance the learning experience during PBL. The objective of this study was to determine if the PBL learning experience can be enhanced by using a mind map for summary writing. Our research paper discusses students' perception of mind mapping in PBL and explores the potential use of mind maps in PBL.

METHODS

Study participants

Semester 2 undergraduate medical students were invited to participate in this study at the start of their semester. The cohort comprised of 246 medical students. These students had prior experience with PBL as they had been introduced to PBL since semester 1. However, the PBL processes the students were exposed to in semester 1 did not include the use of a mind map. Each PBL group in this cohort consisted of 10 members. The participating students belonged to various groups in the cohort. As participation was voluntary, only the participating students in each PBL group made the mind maps in their PBL sessions.

Research and ethical approval was obtained from the IMU Research Committee (CtME25/2012). Participation in the study was voluntary. Students who were interested were asked to sign the consent forms and to complete a questionnaire on students' perception of PBL.

Study design [Fig. 1]

Two investigators briefed the students on the process of mind mapping at the start of their module. In this briefing, an example of a mind map for the PBL trigger that the students had completed in a previous module was also presented to make it relevant to the students. Following the briefing, the students were invited to participate in the study. Only the students who volunteered to participate in the mind mapping exercise were included in the study.

The PBL facilitators were also briefed about the study to help them guide the participating students in their group. The mind mapping exercise was done by each participating student by staying back at the end of the PBL session for 20-30 minutes while the non-participating students were free to leave the group at the end of the PBL session. As participation in the study was voluntary, each PBL group consisted of students who may or may not participate in the study. The study was conducted for three consecutive PBL triggers over a period of six weeks. All the PBL groups were scheduled for PBL sessions under the same Haematology module during the study period.
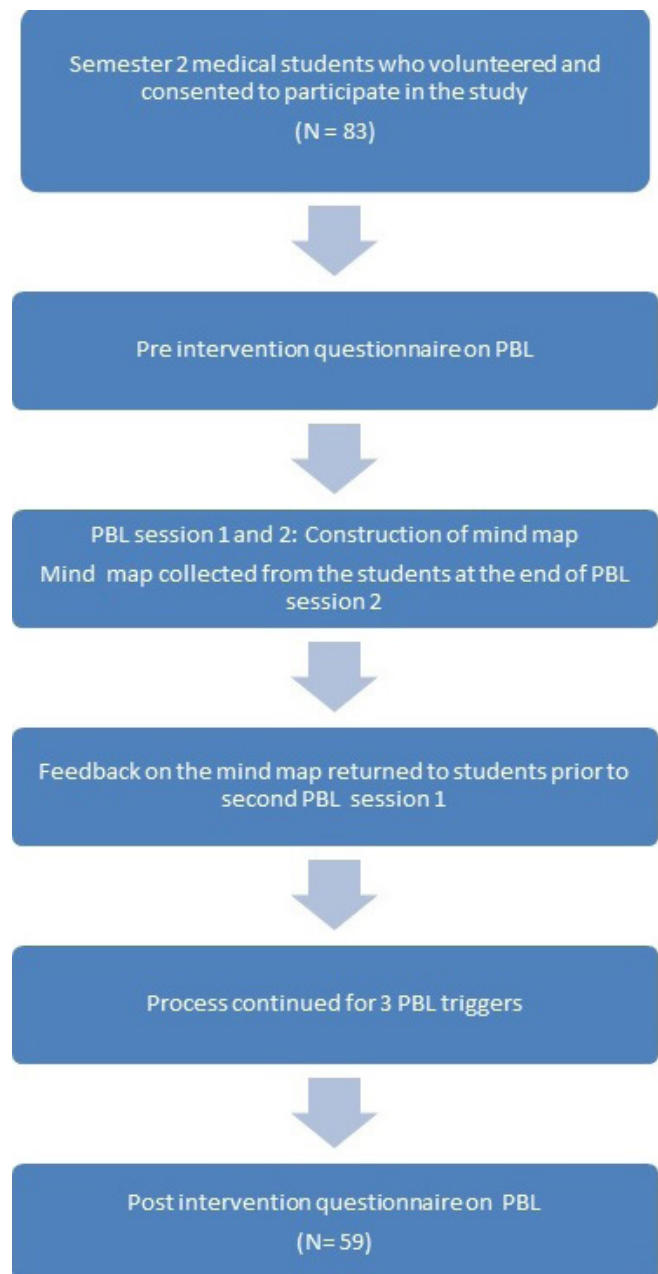

Semester 2 medical students who volunteered and consented to participate in the study

(N = 83)

↓

Pre intervention questionnaire on PBL

↓

PBL session 1 and 2: Construction of mind map
Mind map collected from the students at the end of PBL session 2

↓

Feedback on the mind map returned to students prior to second PBL session 1

↓

Process continued for 3 PBL triggers

↓

Post intervention questionnaire on PBL

(N= 59)

Figure 1. Flowchart of the study processes

Study instrument [Appendix 1]

A questionnaire was developed based on the essential characteristics and learning principles of the PBL [1, 8, 15, 16]. The questionnaire comprised of 10 items on PBL learning processes with a 6 point Likert rating scale, and was piloted in a smaller cohort of 10 students prior to the study. The students were asked to rate whether PBL enables the learner to experience the learning processes stated in the questionnaire and face validity was accepted. The same questionnaire was used for pre and post-intervention.

A total of 83 students consented to participate in the study and completed the pre-intervention questionnaire. The mind maps were collected at the end of the second PBL session. Examples of student mind maps are shown in Figures 2a, b and c.

Two investigators provided written feedback for each mind map collected at the end of the PBL session to help the students improve the mind mapping technique and summary writing. The mind maps with the written feedback was returned to the participating students before the next PBL trigger.
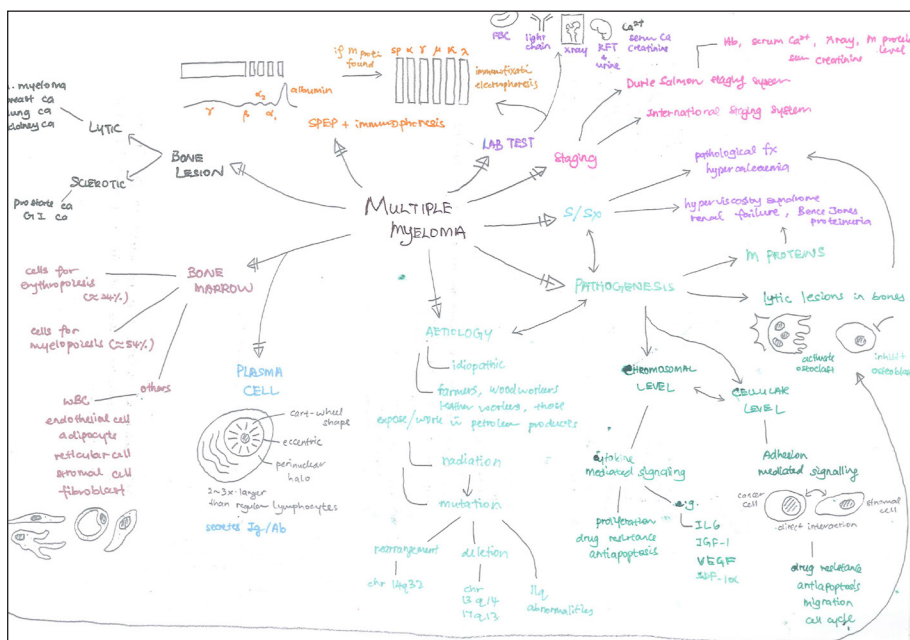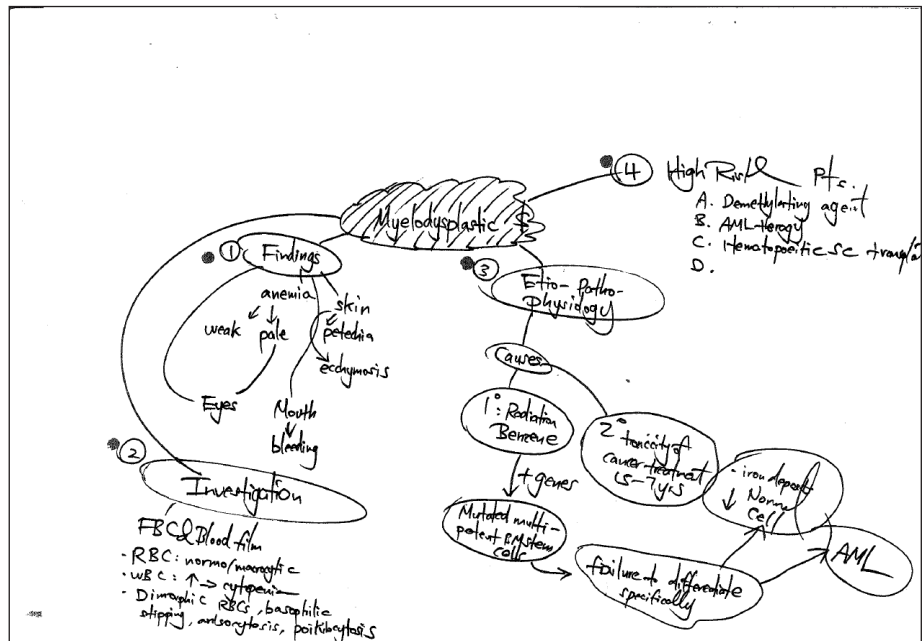

Figure 2(a). Example of student mind map

Figure 2(b). Example of student mind map

Figure 2(c). Example of student mind map

At the end of the module, the post-intervention questionnaire was provided to all the participants to capture their rating on the effectiveness of summary writing with a mind map for their PBL learning process. A total of 59 students returned the post-intervention questionnaire (response rate 71%).The items on the pre and post-intervention questionnaires were identical however; there was an additional section for students' comments in the post-intervention questionnaire. Independent t-test was applied to compare the difference in the pre and post-intervention questionnaire rating as data distribution was normal. Statistical analysis was performed using SPSS version 18.

RESULTS

Descriptive analysis of the mind maps

There was variation in the structuring and presentation of ideas in the mind maps among participating students in the same PBL group. Some mind maps showed more ideas presented and interconnected with branching and sub-branching as well as diagrams [Fig. 2a and b]. Evidence of reasoning was present as students related ideas from the trigger into a pathway to confirm their hypothesis. Some students constructed the mind map with the problem trigger as the central theme [Fig. 2a]. These mind maps represented the student's reasoning from the given problem trigger to the hypothesis. Many students used the derived hypothesis (disease/condition) as the central theme [Fig. 2b] where they summarized the discussion in relation to the disease/condition discussed in that PBL session. The branches usually consisted of various related topics such as etiology, types, pathogenesis and treatment. The extent of branching and sub branching and the breadth of topics covered were also variable between students [Fig. 2a, b and c]. Some students demonstrated clear hierarchical organization and interrelation of the topics by the use of links between branches [Fig. 2a and b].

Pre and post-intervention scores on PBL learning processes (Table 1)

The mean pre-intervention scores show that the students' rating for all the PBL learning processes averaged above 4. The mean post-intervention score was also above 4 indicating that students' perception towards PBL continues to be generally positive even after the intervention of summary writing using a mind map. There was however a small but significant (P<0.05) decline in student perception in the post-intervention rating for most statements related to the PBL learning process. On the statement related to improvement in critical thinking skills, there was a lower and highly significant difference (P<0.001) in the mean of the post-intervention rating compared to the pre-intervention rating.

Interestingly though, we observed the mean pre and post-intervention scores for the PBL learning process statements were ranked differently. In the pre-intervention rating, the highest mean scores were for the PBL learning processes of critical thinking skills, skills as a self-dependent learner and skills in relating concepts learnt whereas, in the post-intervention rating, the highest mean scores were for summarizing the concepts learnt and for structuring the concepts and ideas discussed.

Of the 59 students who returned the post-intervention questionnaire, 20 students had provided written comments on the mind mapping in PBL. The students' comments were grouped into 5 themes (Table 2). The first theme was on the PBL learning processes used in the questionnaire. The other prominent themes that emerged were 'time consuming activity', 'helps in revision', mind mapping

Table 1. Pre and Post-intervention perception on PBL learning process

PBL enables learner to	Pre-intervention rating (N=83)		Post-intervention rating (N=59)		Mean difference	P value
	Mean	SD	Mean	SD		
summarize the concepts learnt	4.48	0.980	4.69	1.038	.213	0.215
structure the concepts and ideas discussed	4.52	0.875	4.32	1.238	.196	0.270
apply most of the concepts learnt in relevant contexts	4.55	0.887	4.14	1.121	.419	0.014*
assess and improve skills as self-dependent learner	4.69	1.011	4.15	1.324	.534	0.007*
assess and improve contribution to team work	4.54	1.063	4.12	1.274	.424	0.033*
evaluate the contribution to team work	4.48	1.162	4.02	1.280	.465	0.026*
improve skills in relating concepts learnt	4.69	1.104	4.27	1.284	.416	0.041*
assess extent of relevant research for the learning resource	4.47	1.108	4.17	1.220	.300	0.129
improve critical thinking skills	4.90	0.892	4.05	1.121	.853	.000**
benefit by reflective learning	4.27	1.240	4.19	1.196	.079	0.706

* Mean difference significant at 0.05, ** Mean difference significant at 0.001level
Note: Likert scale rating: 1 = strongly disagree, 2= disagree, 3=somewhat disagree, 4=somewhat agree, 5= agree, 6= strongly agree

Table 2. Students comments on mind mapping in PBL

Theme	Students comments in the Post-intervention feedback form following the use of mind map in PBL
PBL learning processes	'It's very helpful to **summarize** the topic as a whole.' '...good move to have a **whole idea** of the discussed topic.' 'A very good idea to make sure we **understand the concept**.' 'Useful in **summarizing** the thought.' 'Able to learn through **summarizing** the key point… glad to join this activity, at least I could **get my concept right**.' '… really good. Helps me understand the learning trigger in a **concise** manner ' 'Improves the **critical thinking ability** and also the ability to **summarize** the main points to make into a mind map. **Teamwork and communication** is also improved greatly.' 'It is a great way to **summarize** what we learnt …'
Time consuming activity	'… the process tends to consume a lot of precious time as I need to overthink the links between each point and trying to minimize the number of words for the summary.' 'Needs a lot of time but is overall beneficial' 'Time consuming as it was meant to be completed right after PBL.' '…but quite troublesome to summarize. Time consuming.'
Mind mapping skills	'It would be good if we are given class on how to produce a better mind map.' 'Learnt something useful like to do mind map with a lot of info.'
Helps in revision	'…for those who are interested in it; it will help a lot especially in quick revision.' 'It's a good method of revision that proves very effective when it comes to exams.' '…is easier to recall'
Attitude towards mind mapping in PBL	'The mind mapping was helpful once you've completed it.' 'It was beneficial. I enjoyed myself.' '…depends on the student because some prefer to do mapping but some not.' 'Good experience, have not tried mind-mapping before.' 'Mind maps are not really my cup of tea.' 'Very good. Keep it up.' '…was good and should be continued… .'

skills and attitude towards mind mapping.

Most students commented that mind mapping in PBL helped them to summarize the key points discussed in the PBL session. Some felt that the process of mind mapping itself was time consuming although it was a beneficial exercise. A few students also indicated a need for training in mind mapping skills. Students also mentioned the usefulness of the mind map as a revision tool that helped in recall. Only one student commented, "Mind maps are not really my cup of tea."

DISCUSSION

The mind map study elucidated interesting observations and learning points for us as educators. The considerable variation in the structure of the mind maps between the groups reflected the extent of discussion that took place during the PBL sessions and the depth of knowledge and understanding achieved in each group. Within each group also, there was variation in the mind maps suggesting that although all students in the group were having the same group discussion, they may not share the same thought process. As suggested by Schmidt et al [17], this variation can also be due to the differences in the epistemological beliefs among students and they tend to avoid elaboration (in this case, in the mind map) based on the incorrect assumption that everybody in the group already knows what the individual knows.

The study hypothesis was that PBL learning experience can be enhanced by using a mind map for summary writing. We observed that the students' perception of PBL in the pre-intervention scores indicate that students strongly agree that PBL helps in critical thinking process, relating concepts and independent learning. This observation is supported in literature [2, 15, 16] as PBL is based on the constructivist approach to learning, with greater knowledge application than knowledge acquisition and promotes self-directed learning.

The scores for each item of the learning processes in both the pre and post-intervention questionnaire remained consistently above 4. But, there is a significant decline in the scores for the learning process related to critical thinking skills and skills as a self-dependent learner. This indicates that although the students agreed that PBL enables the learner in achieving the key learning processes used in the questionnaire, the mind map has not enhanced the PBL learning processes in the context of this study. The results from the post-intervention scores suggest that the most positive outcome of mind mapping perceived by the students is that it helps in summarizing the concepts learnt and structuring the concepts and ideas discussed by establishing the interrelations between the various ideas. These results however, are limited by the short duration of the intervention of mind mapping.

The students' comments although weakly representative generally indicates that the students considered the mind mapping exercise useful even though it was time consuming. The students have a packed schedule and there was little time during their PBL sessions to complete the mind maps. The key benefits perceived by the students were that it helped in summarizing the PBL discussion and provided a revision tool for reflection and recall. The study by Farrand et al [12] indicated that there was low motivation for the use of mind maps and they recommended a mind map training course in the first few terms of the medical curriculum along with other sessions in study skills. In the present study, the students also felt the need for a training session for mind mapping.

The study is limited by the attrition in the student numbers over the weeks due to the timing of the PBL sessions. In our outcome-based curriculum, PBL is delivered along with other teaching and learning methods such as plenaries and clinical skills sessions. Hence, students may use various resources other than PBL to revise the concepts learnt. However, in schools with PBL-centered learning philosophy, the use of mind maps may have greater benefit for students as a summarizing and revision tool and future studies could explore this avenue. In our study, students were asked to construct individual mind maps after the PBL discussion. For future studies it would be useful to generate a group mind map at the end of the discussion in the second PBL session in order to structure and summarize the group discussion and obtain a clear understanding of the problem. Such initiatives could enable the development of cognitive techniques for facilitating the comprehension of knowledge base acquired in PBL discussion.

A useful outcome of this study is the understanding that students and tutors need to spend more time summarizing and structuring the discussion and the mind map is an accessory learning tool that may enable this specific learning process. Mind mapping could be offered to students as a learning tool during the PBL and students may opt to use it in the PBL sessions based on their unique learning needs. Our study demonstrated that not all students benefit by the mind-mapping exercise and such interventions should not be imposed as a required process.

CONCLUSION

Mind mapping has the potential to help in summarizing the PBL discussion and allows for reflection and recall; however, not all students may find that it enhances the PBL learning process. Instead, the findings of this study suggest that it may be worthwhile to teach the mind mapping skills so that the students may use it as an optional tool for summarizing the PBL discussion.

Appendix 1. Questionnaire

Date:

Semester: 2   Group:

Course: Medical Sciences   Attendance Seq. No:

Please tick (✓) where most appropriate.

Scoring guide

1= strongly disagree …… 6=strongly agree

PBL enables learner to	1	2	3	4	5	6
1. summarize the concepts learnt						
2. structure the concepts and ideas discussed						
3. apply most of the concepts learnt in relevant contexts						
4. assess and improve skills as a self-dependent learner						
5. assess and improve contribution to team work						
6. evaluate the contribution by other team members						
7. improve skills in inter relating concepts						
8. assess extent of information search for the learning resource						
9. improve critical thinking skills						
10. benefit by reflective learning						

Comments on summary writing in PBL (if any) **for post intervention only**

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