Computer Mediated Problem based Learning and Higher Order Thinking Skill - A Preliminary Study

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***Abstract*—**Problem-Based Learning (PBL) can foster learners' lifelong learning attributes such as critical thinking, decision making and collaboration in managing real life problem. The added value of educational technologies such as computer mediated PBL can facilitate the building of learning community and co-construction of knowledge. The objectives of this study was to investigate if the computer mediated PBL learning can facilitate the development of lifelong learning attributes such as higher order thinking skills among learners. The major findings of the study demonstrated that cognitive knowledge was co-constructed and higher order thinking skills was fostered in the computer mediated PBL environment. The contribution of the study are two folded: 1) the Interaction Analysis Model by Gunawardena et al., (1997) provides a useful tool for investigating collaborative PBL processes enabled by web-enhanced activities, 2) The analysis of the online discussion illuminated the understanding on how the computer mediated PBL process had promoted the mastery of higher order thinking, although some classifications were found to be a bit problematic, in particular, in differentiating the phases of knowledge construction between I and III. In conclusion, the findings can be further examined how interactivity has contributed to effective cognitive learning in the computer mediated PBL community.

***Keywords*—**Co-Construction of Knowledge; Computer-Mediated Problem-based Learning; Content Analysis; Higher Order Thinking Skills; Interaction Analysis Model.

***Abbreviations*—**Problem-Based Learning (PBL).

I. INTRODUCTION

TO equip students for the challenges of the 21st century, it is now widely agreed that education must keep abreast of global trends, including setting a path for lifelong learning as a key initiative [Ma, 2009A]. As one strategy to achieve this goal, Problem-Based Learning (PBL) has received increasing attention in different educational scenarios as it potentially revolutionizes pedagogies of learning. Yet, while there is much speculation about the potential benefits of PBL, there are few studies analyzing the explicit benefits of employing PBL, in particular, the added value of educational technologies such as computers and networks. One of the problems of researching learning in computer mediated PBL environments is perhaps the realisation of the complexity of learning interactions being probed [De Laat, 2002; Lally & De Laat, 2002]. The problem can be easily understood as it relates to the analytical tools used with the complicated procedures for content analysis. Content analysis is cumbersome and time consuming and the choice of coding categories is a complex issue in itself [Lally & De Laat, 2002]. The motivations of this project are to investigate: a) the initiative to create computer mediated PBL experiences and opportunities for learners in health studies, b) the anticipated benefit of this pedagogical approach in enhancing student learning experiences and fostering their lifelong learning capacity. The objective of the study are to investigate: a) the quality of computer medicated PBL learning processes, b) learners' ability to master a range of attributes typically aligned with lifelong learning attributes, in particular, the higher order thinking skills. The contribution of this study hence fill up a gap in knowledge around the use of computer mediated problem-based learning techniques.

II. LITERATURE REVIEW

Problem-based learning was firstly adopted in medical education because the traditional classroom teaching failed to meet the need for medical students to solve clinical medical problem after their graduation [Albanese, 2010]. Since then, it was widely adopted as a teaching strategy in various areas such as psychology, business and nursing studies. Problem-

based learning is a teaching strategy to stimulate learners to acquire knowledge, analyse information critically, search information, synthesize and apply collected information [Wood, 2003]. The benefits such as positive effect on social and cognitive aspects of students and difficulties of problem-based learning have been reported [Koh et al., 2008]. The advanced development of information technology in recent decades can break the time and geographical limitations of face to face PBL and the use of computer mediated problem-based learning in teaching is thus receiving great attention.

Computer mediated problem-based learning can facilitate communication between individual learner, and learners and facilitators. There is no time and district limitation among learners and facilitators, so that the learning process becomes instant. Learners' learning skills can be visualized through online learning platform. Positive learning outcomes of online problem-based learning have been documented [Helokunnas & Herala, 2001; Şendağ & Odabaşı, 2009]. The added value of such educational technologies will also make collegial collaboration and the creation of problem-based learning community possible, leading to co-construction of knowledge. Pain is a common health problem that requires either medical or non-medical attention [Wong & Fielding, 2011]. Managing pain in a non-medical context requires effective clinical judgment and decision making ability. Problem-based learning is able to develop critical thinking and decision making skills of students in the real life problem. Learners' mastery of the above mentioned attributes typically aligned with lifelong learning attributes, viz: research abilities, information technology, collaboration, reflection and critical thinking which are most valued in the society. Therefore, computer mediated problem-based learning was adopted in this project.

The aims of this study were thus

- To explore the computer mediated PBL processes through which understanding is shared and cognitive knowledge is co-constructed;
- To investigate if the computer mediated PBL learning can facilitate the development of lifelong learning attributes such as higher order thinking skills among learners.

III. METHOD

3.1. Implementation Plan

Participants were the first year students enrolled in the Bachelor of Health Education programme. The study was restricted to the course of Pain Education in the academic year of 2012/2013. Each group of student had to select one case scenario randomly and study it following the 7-step of problem-based learning in Moodle. Students had to conduct intra-group discussions online with submission of weekly reflective journals for making group dynamic transparent and a final PowerPoint presentation for intergroup peer assessment and written feedback. The instructors took the role of facilitators during the process and provided the ongoing feedback on learners' participation.

3.2. Evaluation Methods

The data were collected from two means to evaluate the outcomes of the project. Written information collected from intra and inter-group discussions was content-analyzed to explore the computer mediated PBL processes through which understanding was shared and cognitive knowledge was co-constructed. The conceptual model suggested by Gunawardena et al., (1997) was adopted to identify the cognitive practices. This model evaluates the social construction of knowledge in an online discussion forum and distinguishes between five phases of knowledge construction (Phase I – V), indicating progress from a lower to a higher mental function and revealing how learners contribute toward the construction of knowledge.

Additionally, team members were required to complete a reflective journal every week using web-based forms. On the form they had to report whether they had communicated with their team, and, if so, via which medium. They had to answer a few brief questions assessing aspects of team progress, communication for that week, whether they had faced any problems and suggestions for an improved course of action. Journal entries were then transcribed and coded for content analysis. The merits and shortcomings of the collaborative PBL activities reflected in the weekly journals provided concrete evidence of the collaborative efforts and areas that had been improved as a result of the group interaction.

IV. DATA ANALYSIS

4.1. Content Analysis Scheme

Content analysis was based on the Interaction Analysis Model developed by Gunawardena et al., (1997). This model examines social construction of knowledge, reflecting one of the key characteristics of computer mediated PBL. The replication of Gunawardena et al., (1997) model on eliciting evidence for the social construction of knowledge is justified by it merits offered; a) it focuses on interaction as the vehicle for the co-construction of knowledge; b) it focuses on the overall pattern of knowledge construction emerging from a conference; c) it is most appropriate in a collaborative computer mediated learning context; d) it is a relatively straightforward schema, and e) it is adaptable to a range of teaching and learning contexts. There are five phases in the model, they are 1) sharing or comparing of information; 2) discovery and exploration of dissonance or inconsistency among ideas, concepts of statements; 3) negotiation of meaning or co-construction of knowledge; 4) testing and modification of proposed synthesis or co-construction and 5) agreement statement(s) or applications of newly constructed meaning. The five phases indicate progress from the lower to higher mental functions and revealing how learners contribute toward the construction of knowledge. In which, phase 1 and 2 represent lower mental function while phase 3

to 5 indicate higher mental function [Gunawardena et al., 1997]. Since the assessment design of the collaborative PBL task was in terms of a group project, there were some coded messages involved in the presentation of the content. These units did not fall into any Phases of the model and were classified as others.

4.2. Content Analysis Procedures

Content analysis comprised four steps; a) a compilation or selection of the transcripts for analysis; b) development of a coding scheme and the training of coders to implement the protocol; c) comparison of coding decisions for inter-coder reliability, and d) an analysis and reporting of the coded data either in describing the variables or identifying the relationships between variables [Gunawardena et al., 2001]. Each online posting was first studied and divided into the appropriate unit of analysis and content analysis was conducted based on Gunawardena et al's model which each appropriate unit was categorized to Phase 1, phase 2, Phase 3, Phase 4, or Phase 5 of the Interaction Analysis Model [Gunawardena et al., 1997].

4.3. Inter-Coder Reliability

Inter-coder reliability can be defined as "the extent to which different coders, each coding the same content, come to the same coding decisions" [Rourke et al., 2000]. Two authors coded all the discussion content independently. The comparison of the results showed that the percentage of agreement between the two coders was 91.1%. The major discrepancies fell in the categories of sharing/comparing of information (phase I) and negotiation of meaning (Phase III).

V. RESULTS

A total 215 discussion messages were analyzed for the computer mediated problem-based learning activity.

5.1. Social Co-Construction of Knowledge and Higher Order Thinking Skills

With reference to figure 1, Group One demonstrated clear patterns over phase I to IV but failed to show phase V, indicating that they were able to test and construct new knowledge but failed to go beyond this phase to synthesize these new ideas. Group Four demonstrated clear patterns over phase I to III and V but not phase IV, which illustrated that they were able to co-construct new ideas and knowledge and apply them in new situation. Group Two and Three almost remained in the phases of sharing or comparing information (Phase 1). This phenomenon is expected because phase I is a learning phase which provides foundation of further discussion and exploration of the subject matter. There was no statement belonging to phase II, IV & V in Group Two and Three. Clearly, Group Two and Three failed to establish a learning community that could, foster higher order thinking skills leading to co-construction of new knowledge. Amongst all groups, Group One and Four demonstrated that they were cognitively engaged with high quality interactions that occurred in the discussion forum. They were actively participating in negotiation of meanings and synthesizing new information.

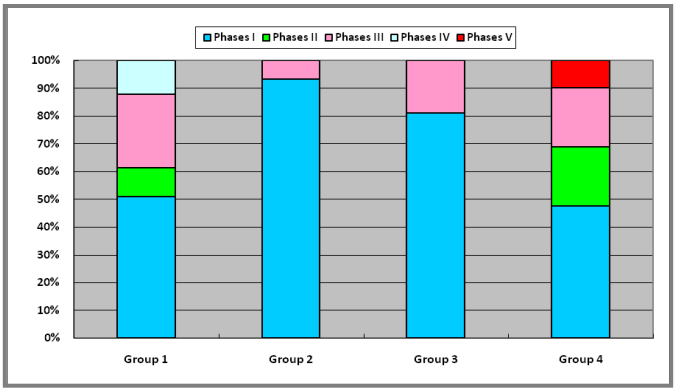

Figure 1: Total Message Units (Percentage) at each Phase of Knowledge Construction

5.1.1. Excerpt from Group Four illustrating different Phases of Knowledge Construction Activity in the Computer Mediated PBL Environment

The following sample excerpt from Group Four showed students' collaborative knowledge construction activity in the computer mediated PBL environment. The example illustrates how students participating in collaborative computer mediated PBL learning, confront their previous knowledge and possible misconceptions, examine new evidence and apply new knowledge.

A. Phase I: Sharing/Comparing of Information

Problems: (I think) she (Mrs Wong) is lack of knowledge to manage severe surgical wound pain (G4-AHC-8)

B. Phase II: Discovery of Dissonance

I don't think Mrs. Wong is lack of knowledge to manage severe surgical wound pain, since she does not treat the pain as usual and suffer the pain herself without any treatment. She seeks help from nurses for relief her pain, which is a correct concept to manage her surgical wound pain (G4-CCKE-10)

C. Phase III: Negotiation/Co-construction

I try to analysis problem 1: Why the ward nurses did not trust Mrs. Wong's pain? Ward nurses do not trust patient's pain is one of the common barrier to effective pain management. The reason may be due to : 1. The nurses do not have sufficient pain management knowledge. 2. The nurses do not acknowledge the definition of pain that they do not accept the variability of pain sensation of the patients receiving the same operation (G4-HCHE-59)

D. Phase IV: Testing Tentative Constructions

No message

E. Phase V: Agreement Statement/Applications of Newly Constructed Meaning

I suggested and concluded the reasons for the Problem: Mrs. Wong's unhealthy diet maybe one of the causes of the Acute

1. Cholecystitis. 2. The nurses do not have sufficient pain management knowledge. The nurses do not acknowledge the definition of pain that they do not accept the variability of pain sensation of the patients receiving the same operation. 3. According to the Patients' Charter of the Hospital Authority, the use of placebo infusion in ward seems not appropriate practice, that 's why the nurses didn't use it on Mrs. Wong. 4. The type of pain unrelieved pain is an acute pain, so Mrs. Wong had increased blood pressure, pulse and respiratory rate, since these are the physiological response to acute pain. 5. So we can move to Step 4: Arrange explanations into a tentative solution, right? (G4-CCKE-66)

Although testing of new ideas was not demonstrated in the above excerpt, intensive social interaction, peer critique and application of newly constructed ideas were illustrated. The higher order thinking was promoted among learners in the computer-mediated PBL community.

VI. DISCUSSION

To reveal how individuals change their understanding, or co-construct new knowledge as a result of social interaction within the group, possible evaluation questions on cognitive presence will be addressed as follows: When conducting their computer mediated PBL activities, the following questions arise:

- Is knowledge constructed within the group by means of the exchanges among participants?
- Do participants change their understanding or create newly constructed knowledge as a result of interactions within the group?
- What quality of cognitive skills do the learners exhibit?

Interaction Analysis Model developed by Gunawardena et al., (1997) was used to examine if cognitive knowledge was co-constructed and higher order thinking skills was fostered in the computer mediated PBL environment..The quality interaction generated and maintained within the learning community of Group One and Four was demonstrated by relatively high percentage of coded message related to negotiation of meaning and promoting cognitive change (Figure 1). 26.3% and 21.3% of coded messages belonged to phase III in Group One and Four respectively. In Group One, there was 12.3% of coded message in phase 4 and 9.8% of coded message in phase 5 of Group Four. The discussion and identification of strategies to solve problems bring team members' interest to construct a shared view to the goals and tasks required to be executed. Group interaction was built successfully by working towards a common task or goal and active participation of discussion of each member in the forum promote the atmosphere of such interaction. New ideas and cognitive change appear when active participation in discussion is taking place thus moving from lower to higher level thinking. The missing messages of Phase IV and V in Group Four and Group One respectively showed that appropriate guidance may be required during the whole learning process. The facilitator should guide students towards high order mental process whenever necessary. Further content analysis on coded messages of online interaction and focus group meeting will be conducted to explore if interactivity in terms of level and intensity of participation; and nature of interaction including teaching presence, social presence, and technical factors will have potential impact on this cognitive presence [Ma & Wong, 2014] which will be presented in coming paper.

On the other hand, lower mental function activity was found to adversely affect knowledge construction in Group Two. There were 93.3% of coded messages in phase I, focusing solely on information sharing. Among all coded messages, only 6.7 % of coded messages contributed to negotiation of meaning which was far less than the other groups. No statements of Phase VI and V was identified for Group Two whereas 12.3% of phase IV statement was identified for Group One and 9.8% of phase V statement was identified for Group Four. The result showed that Group Two only acquired surface knowledge and no mastery of higher order thinking skills was demonstrated. Failure to co-construct knowledge in the computer-mediated PBL environment may be due to technical difficulties, language barriers, insufficient facilitator guidance and/or failure to establish a harmonious learning environment which will be further investigated in the coning paper.

In light of methodological issue, there were nearly 10% disagreement between the two coders and most of them fell between Phase I and III, in particular, Phase IB "a statement of agreement from one or more other participants" and IIIC "identification of areas of agreement or overlap among conflicting concepts". Mutual agreement was made after further elaboration of these two statements. The Interaction Analysis Model provides clear distinction between lower (Phase 1 & 2) and higher mental function (Phase 3 -5) and there are clear elaboration on each phase. This analytical tool was found to a useful one for investigating computer mediated activities. By applying this model to forum exchanges, it was possible to examine these learning processes from within the spaces. It was also possible, from coding the range and complexity of the postings to identify where some further developments to the model could be made [Ma, 2009B]. Since some arbitrary was found between two phases, coder training is strongly recommended before using this model as a analysis tool.

VII. CONCLUSION

In conclusion, findings of the study demonstrated that cognitive knowledge was co-constructed and higher order thinking skills was fostered in the computer mediated PBL environment. The movement from lower to higher level thinking was clearly demonstrated in Group One and Four, illustrating that these groups were able to negotiate meanings, construct and apply knowledge, and master higher order thinking skills. However, surface learning was found to take place in Group Two and Three as their learning was limited

to lower level thinking phases. In the coming paper the Activity System framework [Engeström, 1987] will be adopted to further explore how a wide range of factors that may impact on these learning activities. The following pair of attributes, interactivity versus cognitive presence, will be further discussed based on the findings to examine how interactivity, social presence and teaching presence have contributed to effective cognitive learning in the computer mediated PBL community. Besides, this study suggests that the Interaction Analysis Model provides a useful tool for investigating collaborative PBL processes enabled by web-enhanced activities.

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