The Implementation of Collaborative Learning Communities for Object Oriented Programming

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Programming subjects are one of the core and important subjects that should be taken by students majoring in information system or computing. The problems of teaching and learning of programming have been widely reported in literatures. Many attempts have been made to solve this problems and this has led to many new approaches in teaching and learning of programming. This paper will discusses of how we have implemented collaborative learning communities to enhance the learning of object-oriented programming among students enrolled in an open distance learning enviornment using asynchronous online threaded discussions. This paper will also examine group interaction and critical thinking in these collaborative learning communities to detect whether "productive" discussions are actually taking place.

INTRODUCTION

Delivering program of Information Technology through distance learning or E-Learning is indeed a very challenging task. All programs in Information Technology include a few courses in programming which is considered to be the most important skill for IT professionals. Most of the other courses also require students to implement some programs in order to ensure that the students could be able to comprehend concepts that are presented in the course. However, a programming course is known to be a difficult course, both for the instructors and learners, even in the normal mode of learning. Novice programmers suffer from a wide range of difficulties. According to Robins et. al. (2001), it will take about ten years of experience to turn a novice into an expert programmer.

Since 1970's, many innovative approaches have been proposed by educators to overcome problems in teaching and learning of programming. Most of these approaches can be classified under two main categories, namely: pedagogical and tools. Some examples of new pedagogical approaches in teaching of programming are "Tutorial-based teaching of introductory Programming" (Zachary 1994), "Methodology First and Language Second" (Zhu and Meng 2003) and "Process Model" approach (Gantenbein 1989). Some researchers have proposed that the programming curriculum need to be reshuffled to reflect learners need, while other proposed the imposition of mathematics

to the learners who plan to take programming subjects. Another initiative was proposed by Carbone et. al. (2000) that encourages academics to consider the tasks they set for their learners since these tasks will affect the learning and understanding of programming, especially in a first year undergraduate course. In this paper, we will discuss about using collaborative learning communities to enhance the learning of programming among the learners. In particular, we will discuss about how we have implemented collaborative learning communities in asynchronous mode of collaboration by having two students in a group and also the effectiveness of using this approach in learning of Java Programming (an object-oriented programming language) for e-learning learners at Open University Malaysia (OUM).

IMPLEMENTATION OF COLLABORATIVE LEARNING COMMUNITIES

In this section, we will discuss about how we have implemented collaborative learning communities in asynchronous mode of collaboration (by having two students in a group) for learning of programming. In particular, we are looking at the effectiveness of using the approach in learning of Java Programming (object oriented programming) for e-learning learners at Open University Malaysia (OUM). Open University Malaysia was established in the year 2000. At the moment, the university has about 60,000 learners in five areas of studies: information technology, business, science, engineering and education. The university employs three modes of studies: self-managed-learning through specially designed course material, face-to-face learning and web-based learning. For face-to-face learning, learners are required to attend 10 hours of tutorial sessions conducted by tutors at OUM learning centres, which are located throughout the country. For web-based learning, learners collaborate with other learners by using a specially developed system called LMS (Learner Management System).

A subject matter expert (SME) who is normally the lecturer at OUM is appointed to manage the course (for example to determine the course schedule, to set up assignments and preparing examination questions) as well to communicate with all of the tutors.

One of the compulsory courses for all learners majoring in information technology at OUM is object Oriented Programming. In this course, learners are required to write programs by using Java programming language. This is the third course in programming, since prior to this learners are required to take a course in C programming and Java Programming.

This object-oriented programming course covers topics on class, object and inheritance followed by the topics applet, event handling, exceptional handling and file manipulation. The basic syntax of Java including method, loops, conditionals, arrays, string have been covered in Java programming which was taught earlier.

In this research, learners are required to use collaborative learning communities in solving a programming project (later known as task) given to them. To introduce the concept of collaborative learning, an overview about it has been attached on the programming assignment with clear instruction on what the tutor and the learner suppose to do.

The learner submits their programming solution (both hard and soft copy) and print-out of their discussion from the bulletin board on the fourth tutorial. In implementing

collaborative learning, a task consists of carefully designed problems that demand from the learner the acquisition of critical knowledge, problem-solving proficiencies and self-directed learning strategies.

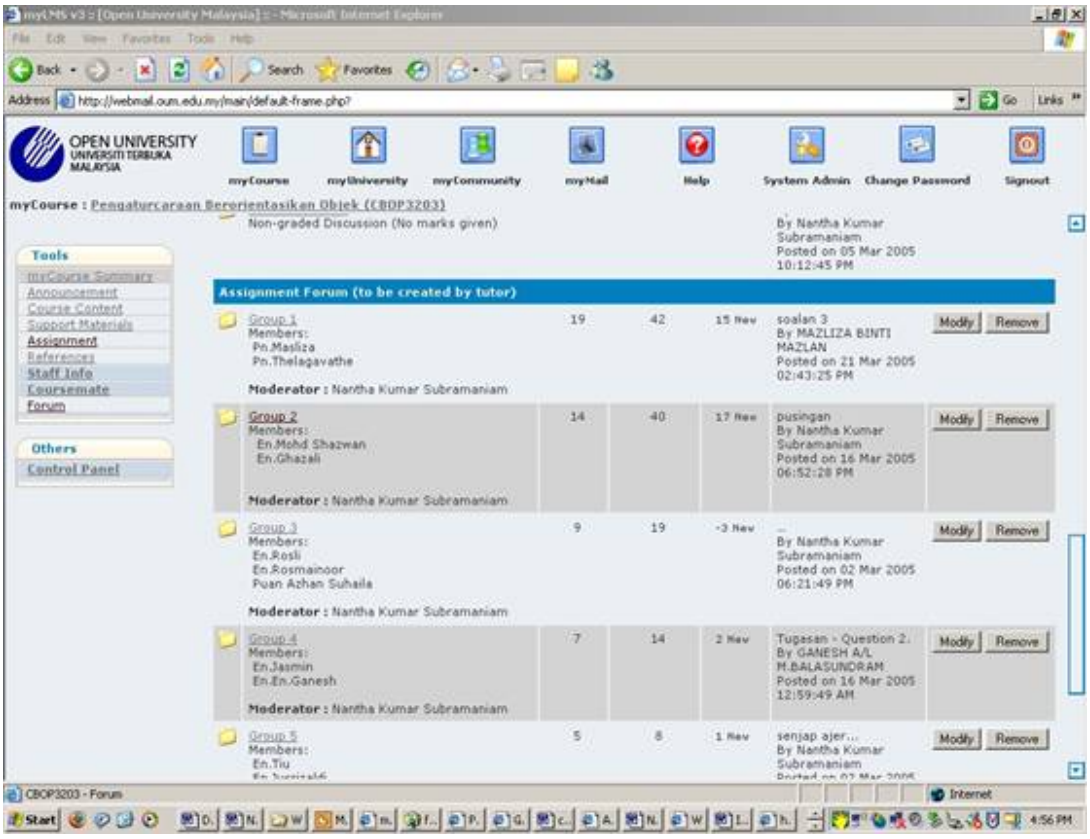

Figure: 1 Snapshot of LMS showing all the special pairs forum used to communicate among the members

The problem thus served as the organizing centre and the stimulus for learning and represented the vehicle that developed learners' creative and high-order thinking skills. There are two questions in this task:

- Question 1 asks the learners to build a user interface using JApplet. This must use their creativity and innovation to make up with a impressive layout for this user interface
- Question 2 tests the learners on the concept of class and objects by asking them to develop a Java-based games application that will stimulate a dice.

This assignment carries 20% of their final grade and their participation on the "pair forum" contributes 5% of their final grade. Each tutor is given a separate forum in LMS which can be used to communicate with their learners.

Tutor been asked to create subfolders in their forums for pair of the learners. A handout on how to create this forum had been prepared and distributed to the tutors. Each pair is given

a different password to enter into their forum, in order to block learners from participate in forums that do not belong to them. The discussion in these forums will be monitored by the tutors, as shown in Figure 1.

RESULTS

At the end of the course, a questionnaire about learners' perceptions on collaborative learning was given to the students. The questionnaire was specially designed to elicit the learners' perceptions toward the effect of the asynchronous collaborations that took place during the learning processes in collaborative learning communities. Readers can refer to Abdullah Mohd Zin, Sufian Idris & Nantha Kumar (2006) of how we have managed to obtain the metrics for the items in the questionnaire. Table 1 shows items in the questionnaire. Questions 1-10 have been tagged with these metrics. Item 11 to Item 13 in the questionnaire are not tagged with any metrics as these questions are use to get some general feedback from the learner.

For questions 1-12, respondents are required to indicate their perception based on the scale of 1-4 (1– Strongly Agree, 2– Agree, 3– Do not Agree and 4– Strongly Do not Agree). For question 13, they are required to indicate either YES or NO.

Table: 1
Items in the questionnaire

No	Metrics	Statements
1	Confidence	Collaboration with my peer gives me more confidence in solving programming problems
2	Confidence	Collaboration with my peer gives me more confidence in writing Java programs
3	Tool	It easy to access forum in LMS
4	Tutor Role	Tutor roles is very much important in guiding the learner to obtain the output
5	Knowledge	I gained more new knowledge by participating in this collaborative forum
6	Learning Process	The discussion in the forum is more focus towards the problem that need to be solved
7	Learning Experience	Collaborating with my peer in solving the given task is a new rewarding experience
8	Peer	My group member gives concrete ideas
9	Persistence	This collaborative learning should be expanded to other subjects
10	Time	Less time is taken to obtain the solution using this approach
11	-	The collaboration in the forum will be more effective if it has more than TWO members
12	-	Pair collaboration with peer could replace the tutorial classes
13	-	The collaborative forum provided in LMS to collaborate with the peer is enough and no other facilities is required

The result of the research is very encouraging. Learners showed special interest in participating in the discussion between their partners. We manage to collect 147 answers from 165 learners registered for the course.

The Cronbach's alpha reliability coefficient was calculated for the Item 1 – Item 11 and a high internal consistency for each of the dimensions was obtained which was 0.92. The analysis of the data involved extracting the means of each of the items with means of 2.50 representing the equilibrium point.

Means smaller than 2.50 reflected the degree of the respondents' agreement with the statement put forward while means with values more than 2.50 reflected the degree of the respondents' disagreement with the statements put forward to them. The effects of the asynchronous collaborative programming process in an E-Learning environment are shown in Figure: 2. In general, the means for all statements (except question 12) are less than 2.

This result indicates that there is a high degree of agreement among the respondents towards statement put forward to them concerning the use of collaborative learning.

It is evident that the learners perceived they had gained the confidence in programming by collaborating virtually with their peer ($\bar{x}$ =1.95) and this has contributed in more confidence on writing Java program ($\bar{x}$ =1.95). The positive result on this confidence could be resulted from new knowledge gained in participating in collaborative learning ($\bar{x}$ =2.06) and rewarding experience they gained in collaborative learning ($\bar{x}$ =2.01).

The positive result on confidence they gained on programming made them support the use of collaborative learning in the future programming subject ($\bar{x}$ =2.01). The result also shows that the role of tutor is very important in guiding the learner in collaborative learning ($\bar{x}$ =1.63).

The concrete ideas given by the peer ($\bar{x}$ =1.94) has made the discussion in the forum more focus on the problem that need to be solved ($\bar{x}$ =1.95).

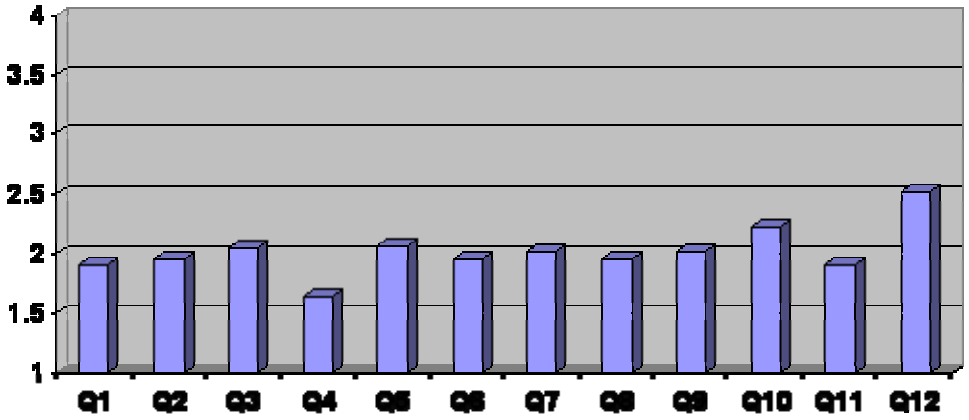

Figure: 2 The effects of asynchronous collaborative learning based on students' feedback

One interesting discovery is the result of item Number 11. For this item, most of the learners agree that having more than two members in a group would be more effective ($\bar{x}$ =1.90), although in general they are happy with their peer ($\bar{x}$ =1.94). In our opinion this is due to the fact that with only two learners in a group, there would be some delay in having the feedback from their partners. By having more than two, this delay could be minimized.

On questions Number 12, there is almost equal number of learners who agree and disagree that collaborative learning could replace the physical face-to-face tutorial ($\bar{x}$ =2.51). This indicates that although generally learner happy with collaborative learning but there are still a large percentage who would like to have face-to-face meetings with their tutors. This confirm to the opinion of Edwards et. al. (1997) who says that learning of programming subjects in e-learning institutions must have some face-to-face interaction. Furthermore, in the Asian culture, it is a norm for learners to have regular face-to-face meetings with the instructors or tutors.

For question Number 13, which is an open-ended, 60% of the respondents do not agree that asynchronous mode of collocation is sufficient.

Those who do not agree mentioned that the some tools need to be added, such as online compiler, online notes and instant messaging tool (such as Yahoo Messenger). This result indicates that learners' wanted some kind of synchronous features in the forum.

CONTENT ANALYSIS

Content analysis is used in discussion forums as systematic way to determine whether critical thinking skills and productive discussions are taking place in the forum. Several studies have been done on analyzing written discussion over computer mediated communication (CMC) (Jeong,2003; Marra, Moore & Klimczak, 2004; Yang, Newby & Bill, 2005; Wickersham & Dooley,2006). Aiming to promote and evaluate critical thinking

(CT) skills, most studies use two major CMC content analysis models, namely, the Newman, Webb, and Cochrane (1995) and Newman, Johnson, Webb, and Cochrane (1997) model of critical thinking for content analysis and the Gunawardena, Lowe, and Anderson (1997) five-phase interaction analysis model (IAM). The Newman, Webb, and Cochrane (1995) and Newman, Johnson, Webb, and Cochrane (1997) model is based on Garrison's (1992) five-stage critical thinking model, problem: (a) identification, (b) definition, (c) exploration, (d) evaluation, and (e) integration model. These researchers (Garrison, 1992; Newman et al., 1996, 1997) instantiated indicators of critical thinking via approximately 40 codes in categories such as relevance, justification, novelty, and ambiguities, each with a plus or a minus appended to indicate whether the coded statement contributes to (+) or detracts from (–) critical thinking development. A complete list of the codes is provided in the figure below.

Category		*Positive Indicator*		*Negative Indicator*	
R±	Relevance	R+	Relevant statements	R–	Irrelevant statements, diversions
I±	Importance	I+	Important points/issues	I–	Unimportant, trivial points/issues
N±	Novelty; new info, ideas, solutions	NP+	New problem-related information	NP–	Repeating what has been said
		NI+	New ideas for discussion	NI–	False or trivial leads
		NS+	New solutions to problems	NS–	Accepting first offered solution
		NQ+	Welcoming new ideas	NQ–	Squashing, putting down new ideas
		NL+	Learner brings new things in	NL–	dragged in by tutor
O±	Bringing outside knowledge or experience to bear on problem	OE+	Drawing on personal experience	OQ–	Squashing attempts to bring in outside knowledge
		OC+	Refer to course material	O–	Sticking to prejudice or assumptions
		OM+	Use relevant outside material		
		OK+	Using previous knowledge		
		OP+	Course related problems brought in (e.g., students identify problems from lectures and texts)		
		OQ+	Welcoming outside knowledge		
A±	Ambiguities clarified or confused	AC+	Clear, unambiguous statements	AC–	Confused statements
		A+	Clear up ambiguities	A–	Continue to ignore ambiguities
L±	Linking ideas, interpretation	L+	Linking facts, ideas and notions	L–	Repeating information without making inferences or offering an interpretation
		L+	Generating new data from information collected	L–	Stating that one shares the ideas or opinions stated, without taking these further or adding any personal comments.
J±	Justification	JP+	Providing proof or examples	JP–	Irrelevant or obscuring questions or examples
		JS+	Justifying solutions or judgments	JS–	Offering judgments or solutions without explanations or justification
		JS+	Discussing advantages and disadvantages of solution	JS–	Offering several solutions without suggesting which is the most appropriate.
C±	Critical assessment	C+	Critical assessment or evaluation of own or others' contributions	C–	Uncritical acceptance or unreasoned rejection
		CT+	Tutor prompts for critical evaluation	CT–	Tutor uncritically accepts
P±	Practical utility (grounding)	P+	Relate possible solutions to familiar situations	P–	Discuss in a vacuum (treat as if on Mars)
		P+	Discuss practical utility of new ideas	P–	Suggest impractical solutions
W±	Width of understanding (complete picture)	W+	Widen discussion (problem within a larger perspective. Intervention strategies within a wider framework.)	W–	Narrow discussion. (Address bits or fragments of situation. Suggest glib, partial, interventions)

Figure 2: Critical thinking indicators in Newman Model of content analysis
(as quoted by Marra, Moore & Klimczak, 2004)

Once a passage is coded, one calculates a critical thinking ratio as CT = (x+ – x–)÷(x+ + x–) where x+ is the count of statements contributing to critical thinking for the coding category and x– is the count of statements detracting from critical thinking for the category. Positive numbers approaching 1 indicate the highest levels of critical thinking (Marra, Moore & Klimczak, 2004).

Three different groups in the collaborative learning under different tutors have been randomly picked in order to analyze the group discussion transcripts. The Newman model highlighted above has been chosen for the content analysis. The following are example of fragments from the group discussions with marked-up transcripts.

MESSAGE 1:

Forum : Group 1 Posted : Mon 29th Jan 2007 Subject : Re : Re : matriks Posted by : XXXX

<AC- I also not very clear with the question, any how have to read the module first..... **-AC>**

MESSAGE 2:

Forum : Group 1 Posted : Fri 02nd Feb 2007 Subject : Re : find reference materials. Posted by : XXXX

<OM+ I just get some information from the net and want to share with you. **+OM>**

The table below shows the average critical thinking ratio for the groups:

Table 1: Calculating critical thinking ratios for Group 1

Scoring criteria	Ratio
R+- Relevance	0.45
I+- Importance	0.67
N+- Novelty. New info, ideas, solutions	0.43
A+- Ambiguity and clarity/confusion	0.36
O+- Bringing outside knowledge/ experience to bear on problem	0.30
L+- Linking ideas, interpretation	0.56
J+- Justification	0.49
C+- Critical assessment	0.20
P+- Practical utility (grounding)	0.55
W+- Width of understanding	0.44

Table 2: Calculating critical thinking ratios for Group 2	
Scoring criteria	Ratio
R+- Relevance	0.36
I+- Importance	0.26
N+- Novelty. New info, ideas, solutions	0.45
A+- Ambiguity and clarity/confusion	0.55
O+- Bringing outside knowledge/ experience to bear on problem	0.31
L+- Linking ideas, interpretation	0.36
J+- Justification	0.44
C+- Critical assessment	0.30
P+- Practical utility (grounding)	0.41
W+- Width of understanding	0.39

Table 3: Calculating critical thinking ratios for Group 3	
Scoring criteria	Ratio
R+- Relevance	0.66
I+- Importance	0.72
N+- Novelty. New info, ideas, solutions	0.70
A+- Ambiguity and clarity/confusion	0.65
O+- Bringing outside knowledge/ experience to bear on problem	0.58
L+- Linking ideas, interpretation	0.69
J+- Justification	0.61
C+- Critical assessment	0.45
P+- Practical utility (grounding)	0.79
W+- Width of understanding	0.41

It is notable from the above table that the critical thinking ratio is not very much encouraging. Only Group 3 that has a good critical thinking ratio for most of the categories. Although learners have a good perception about collaborative learning but they do not use it productively. We are currently investigating the factors that need to be considered in collaborative learning communities in order for the learners to have a “productive” discussions in the forums. Our investigation will focus on both the students needs and the collaborative learning tools. We are also going to investigate students’ examination grade with their groups critical thinking ratio.

CONCLUSION

This research was started with an objective to implement and investigate the effectiveness of using collaborative learning in learning of programming. In particular, this research focus on the use of asynchronous mode of collaboration through the use of the university's learning management system. Content analysis also has been performed to determine the critical thinking ratio.

More than one hundred learners have participated in this research. The result has revealed that the use of asynchronous collaborative learning for learning of programming has produced many positive effects. Learners regarded collaborative learning to be effective, motivating and enjoying. The research has also indicated that collaborative learning has given them the confidence in programming. This may be attributed to the new knowledge gained through the collaborative learning process between the learners as well between learners and tutors. Although the students feel that they gained from collaborative learning but there are few improvements that should be considered in order to make collaborative learning more effective especially after taking into consideration the groups low critical thinking ratio.

In the next study, we are going to investigate the factors that need to be considered in collaborative learning communities in order for the learners to have a “productive” discussions in the forums. Our investigation will focus on both the students needs and the collaborative learning tools. We are also going to investigate the critical thinking ratio in other groups and also the students examination grade with their groups critical thinking ratio.

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