THE PROPOSED MODEL OF COLLABORATIVE VIRTUAL LEARNING ENVIRONMENT FOR INTRODUCTORY PROGRAMMING COURSE

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ABSTRACT

This paper discusses the proposed model of the collaborative virtual learning system for the introductory computer programming course which uses one of the collaborative learning techniques known as the "Think-Pair-Share". The main objective of this study is to design a model for an online learning system that facilitates the collaborative learning activities in a virtual environment such as online communications and pair or small group discussions. In order to model the virtual learning environment, the RUP methodology has been used where it involves the data collection phase and the analysis and design phase. Fifty respondents have been randomly selected to participate in the data collection phase to investigate the students' interest and learning styles as well as their learning preferences. The results have shown the needs for the development of online small group discussions that can be used as an alternative learning style for programming courses. The proposed design of the virtual learning system named as the Online Collaborative Learning System or OCLS is being depicted using the object-oriented models which are the use-case model and class diagram in order to show the concise processes of virtual "Think-Pair-Share" collaborative activities. The "Think-Pair-Share" collaborative learning technique that is being used in this model has been chosen because of its simplicity and relatively low-risk. This paper also presents the proposed model of the system's architecture that will become the guidelines for the physical development of OCLS using the web-based applications.

Keywords: Collaborative learning, "Think-Pair-Share", introductory computer programming, virtual learning environment

INTRODUCTION

The trend of using the Web these days are evolving not just as the platform for searching and surfing but also as a portal for many educational activities such as the knowledge publication, reference literature as well as a medium for communication and collaboration among the lecturers and students (Tsai, Wu, Elston & Chen, 2011). The emerging trend of the Web-based platform have shown tremendous amount of educational materials that are viable over the Internet such as videos, audios, presentation slides, learning objects, papers and textbooks (Tsai, Wu, Elston & Chen, 2011).

These trends have showed that the e-learning styles are progressively moving towards the c-learning styles which encompass various elements such as the community, collaborative and the communicative learning (Owen, Grant, Sayers, & Facer, 2006).

Recent studies have shown various ways to use the Web as the mediator to teach and learn computer programming course. SCALE stands for Supporting Collaboration and Adaptation in a Learning Environment was a web-based system developed to engage students with an active learning environment by providing them with multiple informative and tutoring feedback components (Verginis, Gogoulou, Gouli, Boubouka, & Grigoriadou, 2011). Law, Lee, and Yu (2010) have proposed the used of an e-learning system called the Programming Assignment aSsessment System (PASS) to support the teaching and learning of computer programming. Through the study, they claimed that a well facilitated e-learning environment would be beneficial in enhancing learning motivation and students' self-efficacy.

AutoLEP, which is developed to aid novice programmers to attain their programming skills, has been proven effective in helping the students to adequately test and evaluate the programs (Wang, Su, Ma, Wang & Wang, 2011). It is also claimed that AutoLEP can help to improve students' learning experience in programming and reduce the workload of the tutors.

Previous studies have also included the development of web-based visualizations for learning programming concepts named Codewitz (Lahtinen, Ala-Mutka & Jarvinen, 2005). The system was aimed to develop solutions through visualizations that would benefit teaching and learning of computer programming. Another research done by Cheung (2006) has also revealed that by using the web-based learning system to deliver lecture notes of object-oriented programming course, it has helped to improve the teacher-student interaction, improve students' participation, and also has helped the students with their compilation activities in real-time manner. Van Hiele Web-Based Learning System was developed by Chen and Chih (2006) has also included the concept of knowledge management. The Van Hiele Web-Based Learning System includes various Web 2.0 tools such as email, discussion board, Internet assignment unit, tutorial unit, quick-run unit, expert template, and knowledge management.

Although there are a lot of web-based systems that have been developed to support the learning of programming courses, however, most of the systems do not emphasize on the collaborative learning techniques that can be used to facilitate and support virtual learning. Varieties of collaborative learning techniques such as the "Round Robin", "Numbered-Heads-Together", "Jigsaw", "Think-Pair-Share" and many others have been widely implemented in a classroom-based environment and they have also been proven to effectively enhancing the students' performances. According to Roschelle and Teasley (1995), collaboration can be described as coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem. Therefore, collaborative learning can be viewed as a group of people working together to achieve a common goal (Barfurth, 1995). With collaborative learning, it will focus on helping students to plan and design their problem solving strategy and guide them to evaluate the problem during the learning process (Mahfudzah, Muhaini, Nurzaid, Atiqqah, Mohd Norafizal, 2010).

The lack of collaborative learning techniques used in virtual learning systems will constraint the idea of learning collaboratively and also limit the system's capabilities to become more interactive and effective especially in supporting pair and small group discussions.

Therefore, the main objective of this study is to design a model of a collaborative virtual learning system that uses the "Think-Pair-Share" technique to facilitate the online communications and collaborations. The proposed model also aimed to introduce a virtual learning environment that support the online learning in pair or small group discussions of the introductory computer programming course.

THE CONCEPT OF THE COLLABORATIVE VIRTUAL LEARNING ENVIRONMENT

A virtual-based collaboration differs from the classroom-based collaboration in terms of the interactions among the community members. The main purpose of group collaboration is to bring the team together in order to accomplish a common goal which can be easily achieved within classroom-based collaborative activities. The main challenge for a virtual-based collaboration is; it should be able to facilitate and support the learning activities among the action-oriented teams over the geographic distances and from dispersed locations. The virtual learning system must be able to provide tools that will facilitate communication, collaboration and the process of problem solving. These tools are important in order to provide the team with common means for communicating ideas and brainstorming. In addition, the virtual learning system should also be able to facilitate the project management functions, for instance, the uploading and downloading assignments and time-managements.

Therefore, for this study, the Online Collaborative Learning System or OCLS is designed with two levels of collaboration tools which have been identified as the communication and the collaborative management tools. Both tools will be used for conferencing purposes and online coordination. The communication tools will involve the Web 2.0 technologies such as online chatting, instant messaging and discussion board.

Furthermore, the "Think-Pair-Share" collaborative learning technique is being selected to accommodate the collaborative activities in the virtual environment. In a classroom-based environment, the "Think-Pair-Share" technique will involve three steps of cooperative structure. During the first step which is the "Think" phase, each of the students will think silently about a question posed by the instructor within the given amount of time. After the time for the "Think" phase has ended, the students will then pair up and discuss their possible answers together. Later, during the final phase, which is the "Share" phase, the pairs will share their answers with the other pairs, other teams, or the entire group (Mahfudzah, et.al, 2010). It has been found that the "Think-Pair-Share" technique is a relatively low-risk and short collaborative learning technique and therefore, it is ideally suited to be infused in a virtual learning environment.

MATERIALS & METHODS

In this study, the Rational Unified Process (RUP) methodology has been used as the guideline for the overall development of the OCLS. Generally, there are four phases of the RUP as depicted in Figure 1 below, which are; the inception phase to define the scope of the project, elaboration phase where we plan, specify features and baseline architecture of the project, construction phase to build the product and finally, the transition phase to transit the product into the end user community (IBM Corporation Rational University, 2004).

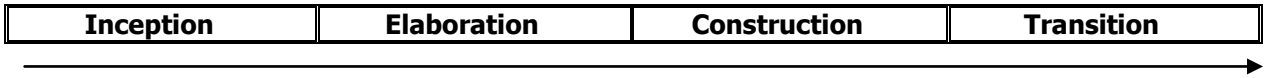

Figure: 1
Lifecycle Phases in RUP

However, in this paper, only two of the phases will be discussed which are the inception and the elaboration phase, where the later phases will be conducted for future research.

Inception Phase

During the inception phase, the system scope will be defined where the system' requirements and the functional requirements are identified. For this study, the inception phase is divided into two other phases which are; i) the data collection phase where the fact-finding technique using questionnaires will be conducted and ii) the design of the use-case model to depict the logical structure of OCLS based from the fact-finding analysis.

For the data collection phase, the respondents have been randomly selected and they are consists of fifty students from the Department of Computer Science in Universiti Teknologi MARA Perlis and Universiti Tun Hussein Onn, Malaysia. The purpose of conducting the fact-finding technique is to enable the researcher to investigate the current situation in order to further understand the current problems and deriving the possible solutions. The investigation involves two sets of questionnaires where the first set is to investigate the factors that influence the students' performances in programming subject. Various factors have been questioned such as factors of interests, understanding the concepts in programming and methods that have been used by the lecturers in classes to teach the programming subjects. All of the selected students have been introduced to learn programming in varieties of programming languages such as C++ and Java. The second set of the questionnaires is to investigate the students' learning preferences in learning programming and the preferred materials used to accompany their learning in programming subject. The questionnaires contain questions on the effectiveness of learning and teaching programming in a traditional way or using the e-learning portals. All of the data gained from the fact-finding process will then be analyzed using SPSS 16.0.

Based from the findings gained from the data collection phase, the logical structures of OCLS will be designed and illustrated using the use-case modeling. As mentioned before, for this study, in order to model the collaborative virtual environment, a well-known collaborative learning technique named "Think-Pair-Share" has been chosen.

The use-case model is used to describe what the system will do, encompassing the use cases and the actors involved in the "Think", "Pair" and "Share" collaborative activities. Each use case in the OCLS model is described in detail in the following section, showing the step-by-step on how the system interacts with the actors and what the system does in the use case in order to realize the "Think-Pair-Share" collaborative activities.

Elaboration Phase

The second phase which is the elaboration phase is where the analysis and design of OCLS will be implemented.

The main purpose of the analysis and design is to transform the requirements into the system design and most importantly, is to ensure the design matches the implementation environment.

The input artifact for the analysis and design for OCLS is the use case model that has been previously designed. In this phase, the class diagram will be designed to illustrate the logical structure and flows of events in OCLS.

RESULTS & DISCUSSIONS

Inception phase

Data collection phase

As discussed in the previous section, the investigation done in this phase consists of two sets of questionnaires where the first part investigates the factors that influenced students' performances in programming. Table 1 below shows the results of students' understanding towards programming subject.

Table: 1
Students' understanding towards programming subject

Factors	Percentage
Hard to understand the fundamental concepts of programming	40.0%
Hard to understand the syntax of the programming languages	36.0%
Hard to understand the operation aspects of programming	48.0%
Less knowledge on how to use the programming software	43.8%
Knowledge in programming are only used to pass the exams	60.0%
Programming courses are tough	76.0%
Hard to understand the subject when programming is only being taught in classrooms	32.0%
Students are not interested to think rigorously in solving programming problems	40.0%
Students have less effort to think to solve problems	58.0%

From the results in Table 1, it shows that 76% of the respondents (38 students) strongly agreed that programming courses are tough and about 32% of them (16 students) found it hard to understand the subject when programming is only being taught in classrooms. Furthermore, Table 2 below shows the results of students' interests in learning programming subjects. From the analysis, it shows that about 76% of the respondents (38 students) prefer to work in groups while learning programming.

Table: 2
Students' interests in learning programming subjects

Factors	Percentage
Students are very interested in learning programming languages	48.0%
Students always update their knowledge about programming	25.0%
Students are expert in programming languages	7.0%
Students prefer to work in groups while learning programming	76.0%
Students are very interested to solve problems that require logical thinking skills	46.0%

Meanwhile, Table 3 below depicts the results of students' opinions towards the lecturers' teaching methods.

From the analysis, it shows that about 86% of the respondents (43 students) strongly agreed that the used of e-learning portals by the lecturers are effective for information sharing and knowledge distributions.

Table: 3
Students' opinions towards lecturers teaching methods

Factors	Percentage
Lecturers' teaching methods are effective	72.0%
Students can understand the way the lecturers teach programming courses	62.0%
Students prefer to ask questions to lecturers about programming problems	48.0%
Students prefer to meet the lecturers to discuss the programming problems	28.0%
Lecturers have given enough programming exercises	82.0%
Lecturers have given the appropriate programming test questions	90.0%
Lecturers are experts in programming	92.0%
The used of i-learn/e-learn portals by the lecturers is effective for information sharing & knowledge distribution	86.0%

The second part of the data collection phase investigates the students' learning preferences and their preferred learning materials. Table: 4 below shows the results for the students' learning preferences. From the result, it shows that about 54% of the respondents (27 students) strongly agreed that they prefer to study programming during exercise sessions in small groups while about 42% of them (21 students) prefer to explore the e-learning portals to enhance their knowledge and skills in programming.

Table: 4
Students' learning preferences

Factors	Percentage
During lectures in classes	56.0%
During exercise sessions in small groups	54.0%
During practical sessions in labs	58.0%
While studying alone	46.0%
While working alone on programming coursework	28.0%
When exploring e-learning portals	42.0%

Meanwhile, Table: 5 below depicts the results for students' preferred materials. From the analysis, it shows that about 60% of the respondents (30 students) strongly preferred to use example programs given by the lecturers to accompany their learning in programming and about 34% of them (17 students) preferred to use the web tutorials, e-learning materials or other Internet resources for their supporting learning materials in programming subjects.

Table: 5
Students' preferred learning materials

Factors	Percentage
Programming course book	36.0%
Lecture notes/copies of transparencies	56.0%
Exercise questions and answers	58.0%
Example programs given by lecturers	60.0%
Still pictures of programming structures	36.0%
Web tutorials/e-learning portal/other Internet resources	34.0%

All of the analysis derived from the data collection phase has showed that most of the students agreed that the programming courses are tough and therefore, they need more

supporting learning materials other than given by the lecturers and they also prefer to work in small groups as an alternative learning strategy to improve their performances. The uses of e-learning portals, web tutorials or other Internet resources have also been the preferred learning materials for the students. Therefore, the findings from this phase have contributed to the analysis and design of the Online Collaborative Learning System (OCLS).

Use-Case Modeling

The use-case diagram is modeled based from the findings derived from the data collection phase. In order to model the virtual collaborative environment, the "Think-Pair-Share" technique has been chosen because of the simplicity and low-risks of this technique. Figure 2 illustrates the use-case diagram of OCLS where it shows that OCLS is composed by three main actors which are the administrator, lecturer and student. Administrator in OCLS is responsible for the coordination and management activities such as handling of the users' registrations, creating the classes and most importantly managing the system's administration in whole.

The next actor depicted in Figure: 2 is the lecturers. In OCLS, lecturers will be given the privilege to manage their respective classes.

The lecturers will be granted a full access to approve the classes and students that have been pre-registered by the system's admin.

Other than that, the lecturers also will be granted the privilege to manage their own collaborative classes such as creating new collaborative classes, assigning the collaborative partners, and also engage in the collaborative activities which are the "Think", "Pair", and "Share" activities.

Besides that, there are other activities that can be performed by the lecturers in OCLS such as managing their announcements, and post assignments as well as notes to the collaborative classes.

Besides the chat room which is available in the "Share" phase, the lecturers may also use the messaging system to communicate with the students.
The final actor for OCLS is the students.

The students who have been pre-registered by the system's admin will be granted the access to their collaborative groups.

Their partners as mentioned before will be pre-assigned by the lecturers of the respective collaborative classes.

After been assigned a partner and a task has been posted by the lecturer, the students will be able to engage in the collaborative activities.

The collaborative activities in OCLS will undergo three main phases which are the "Think", "Pair" and "Share" phases.

During the first phase, which is the "Think" phase, after accessing the tasks posted by the lecturers, each of the students be given a certain amount of time to think individually about any possible answers.

After the "Think" session has elapsed, they will be directed automatically to the "Pair" phase where the students are required to discuss their answers with their

partners using the chat rooms. Again, the timer has been pre-set by the lecturer, therefore the pair needs to discuss and submit the possible answers to the lecturer before the timer ends.

Finally, in the "Share" phase, the submitted answers from the pairs will be graded by the lecturers and then posted in the online discussion board that can be viewed and downloaded by the entire collaborative class.

This is to ensure that the information sharing and knowledge distribution are well-organized and implemented in the virtual collaborative environment.

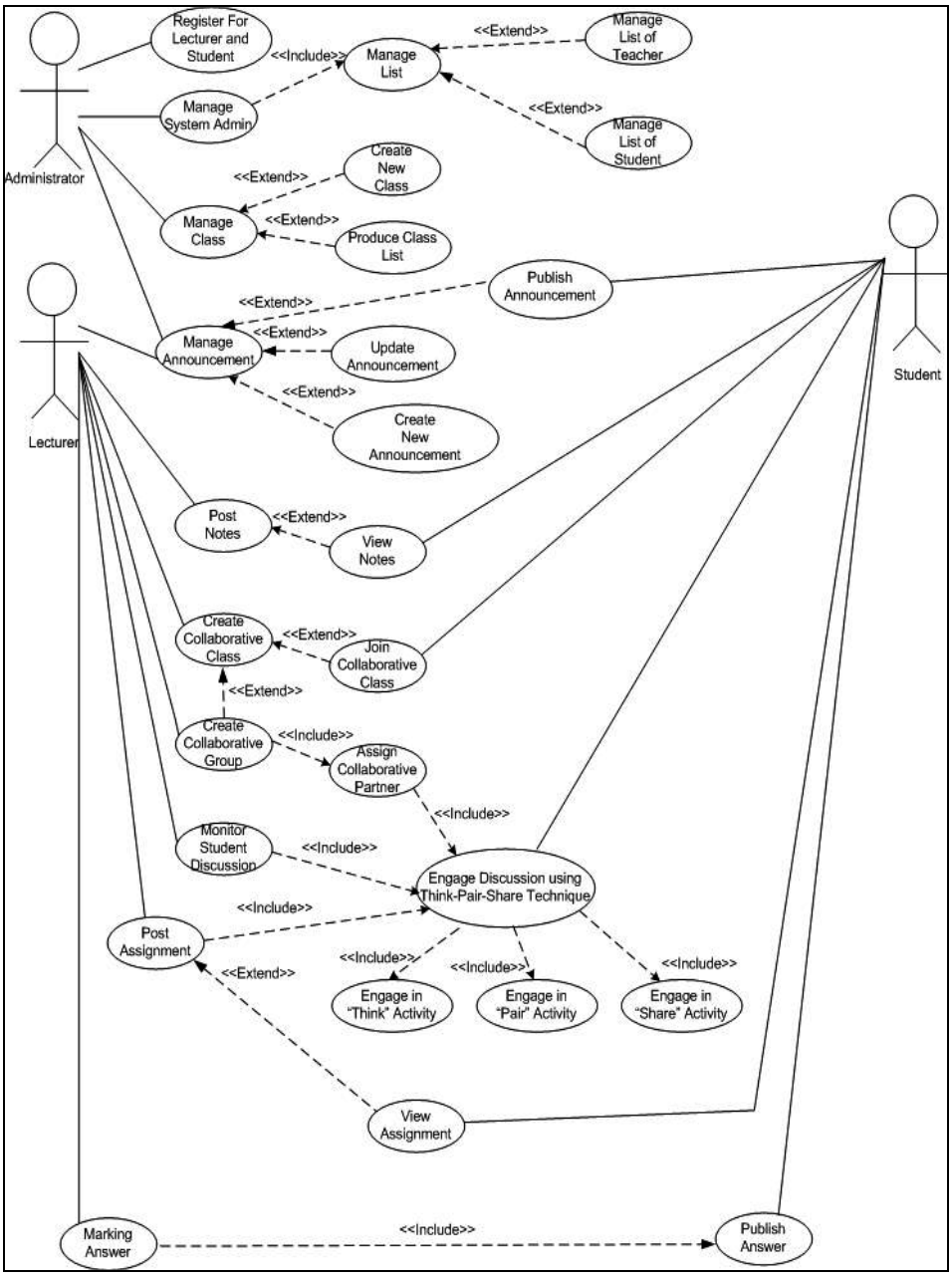

Figure: 2
Use-Case diagram for OCLS

Elaboration phase

Class Diagram

Figure: 3 depicts a class diagram that illustrates the logical relationship among the entities in the OCLS. As shown in Figure 3, the class diagram consisting of seven entity classes that represent the main table in the system. For instance, the administrator of OCLS will manage the lecturers and students' registration. Meanwhile, the lecturer in other hand creates collaborative classes where each class can consists of many collaborative groups. The lecturer will also be managing the notes and most importantly, post the assignments that will be discussed in the collaborative activities.

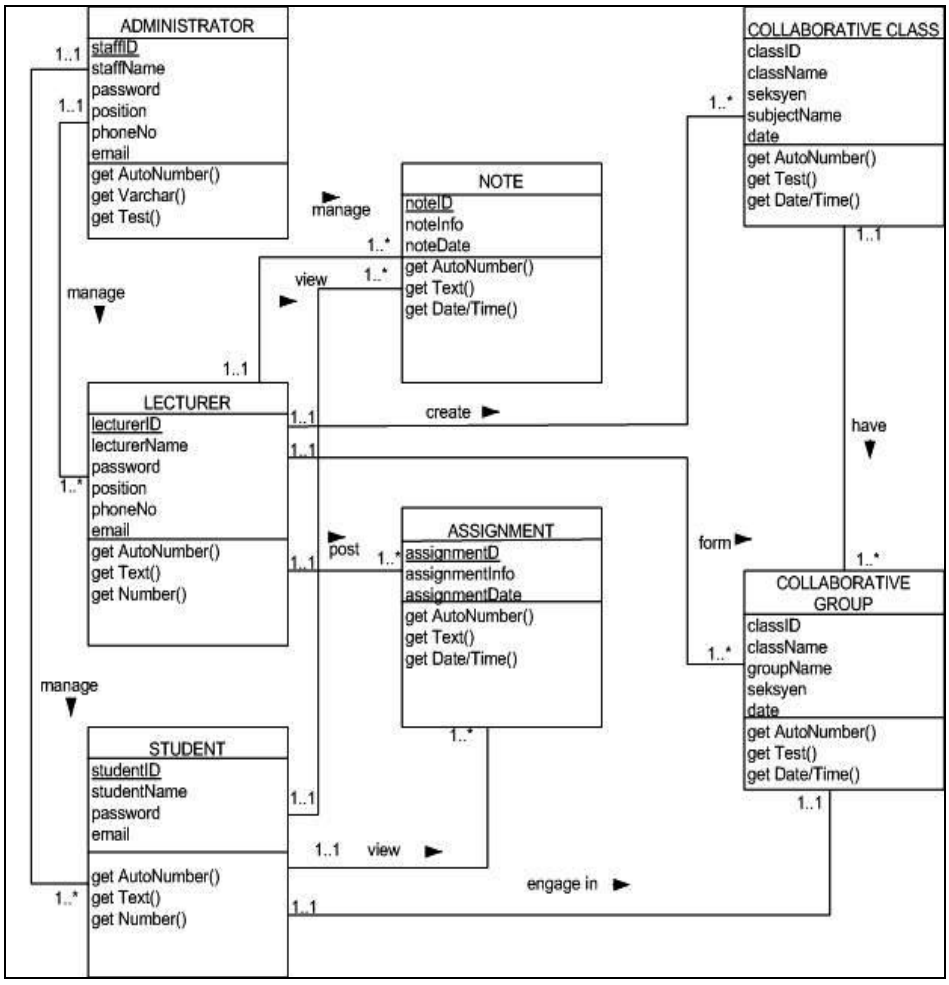

Figure: 3
Class Diagram for OCLS

The proposed model of OCLS architecture

Figure: 4 below illustrate the proposed model of system architecture for OCLS that is derived from the analysis and design phase discussed previously.

As shown in Figure: 4, the system will be developed using the web-based application framework in order to allow the system to be readily and easily accessed by multiple users from dispersed locations.

OCLS will provide the platform for knowledge and information repositories where they can be shared among the community members in real-time processing.

The collaborative activities that have been designed using the use case modeling and class diagram will become part of the OCLS's engine for the online collaboration.

The engine will be integrated with various communication and collaboration tools such as the Web 2.0 technologies to facilitate the communication and interaction over the Web browsers.

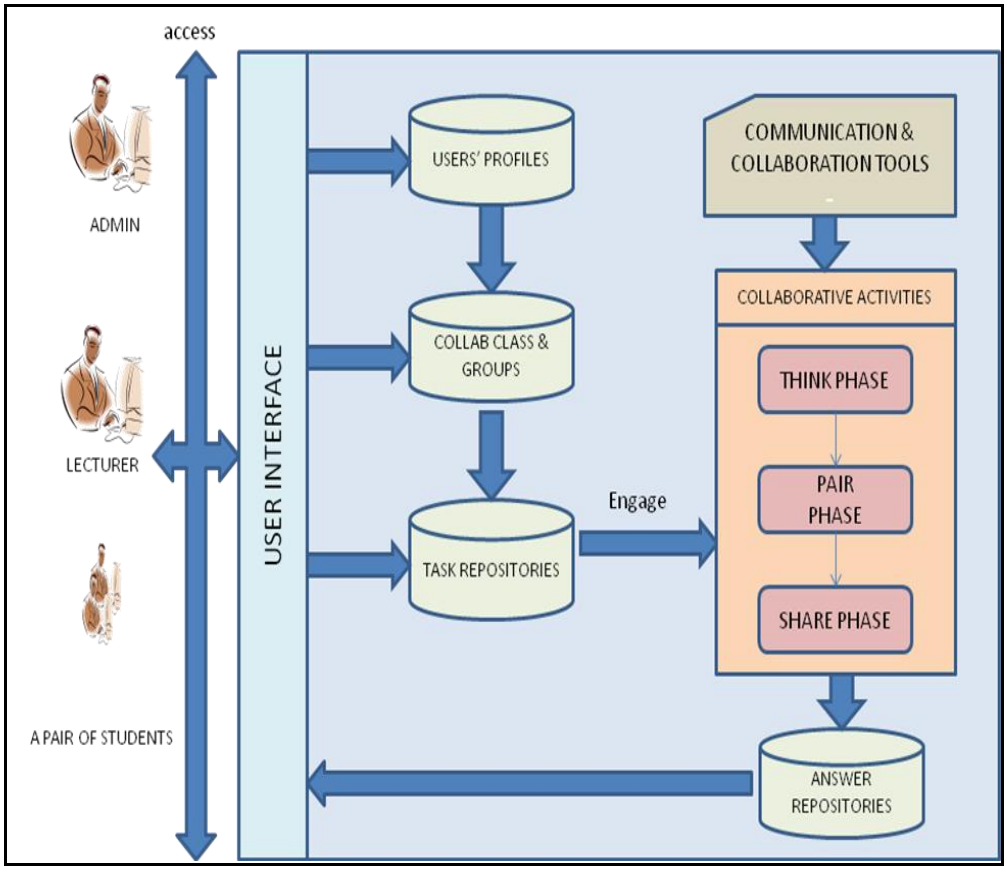

Figure: 4
Proposed model of system's architecture for OCLS

CONCLUSION

The classroom-based collaborative learning has been proven effective in enhancing students' performances and individual self-esteems. Such benefits can be easily achieved as the interactions among and between the community members are visible and can be directly monitored and evaluated by the instructors.

Meanwhile, designing the virtual collaborative learning system, in the other hands, involves complex issues and challenging tasks in order to create the virtual environment that suits every community members ideally. The developer needs to consider the selections of the right collaborative learning technique, tools and technologies that can be ideally used in a virtual environment.

In this study, series of fact-finding processes have been implemented to further understand the current situations and most importantly to gain users' needs and requirements.

The results have shown that students prefer to work in small groups in order to enhance their understandings in programming and they also prefer to search learning materials from various Internet resources such as from the e-learning portals. Realizing the needs for online materials and online group discussions for distance learning, Online Collaborative Learning System (OCLS) has been designed using object-oriented modeling in order to fulfill the users' requirements as well as the system's functional requirements. A well-known collaborative learning technique known as the "Think-Pair-Share" has been selected to be modeled in OCLS because of its simplicity and suitability to be implemented in a virtual learning environment.

OCLS is specifically designed to support the teaching and learning of the introductory computer programming course with the objective to provide supporting virtual learning aids to the students in order to promote active learning in a virtual learning environment. The proposed model of the system's architecture will become the input for the future work that will involve with the physical development of the system using the web-based application framework which is the ASP.Net and the C# programming language.

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REFERENCES

Barfurth, M. A. (1995). *Understanding the Collaborative Learning Process in a Technology Rich Environment: The Case of children's Disagreements.* Department of Science and Education, University of Quebeca Hull.

Chen, J.W. & Chih, C. L. (2006). A van Hiele Web-based Learning System with Knowledge Management for Teaching Programming. *Proc. 6th IEEE Int. Conf. Advanced Learning Technologies*, Washington D.C., USA, pp. 114-116.

Cheung, R., (2006). A web-based learning environment for object-oriented programming. *Int. J. of Information & Operations Management Education, vol.1, no. 2,* pp. 140 – 157.

IBM Corporation Rational University. (2004). *Mastering Object-Oriented Analysis and Design with UML 2.0 Student Guide (Vol 1).*, International Business Machine Corporation, Cupertino, CA.

Lahtinen, E., Ala-Mutka, K., Jarvinen, H., (2005). A study of the difficulties of novice programmers. *ACM SIGCSE Bulletin, vol. 37, no. 3*, pp. 13-14.

Law, K.M.Y., Lee, V.C.S., & Yu, Y.T. (2010). Learning motivation in e-learning facilitated computer programming courses. *Computers & Education, vol. 55*, pp. 218–228.

Mahfudzah O., Muhaini O., Nurzaid M.Z, Atiqqah K.Z. & Mohd Norafizal A. A. (2010). Enhancing logical thinking level among computer science students through cooperative learning, *Proc. 2010 Science, Technology and Social Sciences Regional Seminar*, Pahang, Malaysia, pp. 617-624.

Owen, M., Grant, L., Sayers, S., & Facer, K. (2006). Social software and learning, in *Opening Educ. Rep*, Bristol, UK.

Roschelle, J. & Teasley, S. D. (1995). *The Construction of Shared Knowledge in Collaborative Problem Solving in Computer Communication and Cognition Vygotskian Perspectives,* pp. 67-197. Cambridge: Cambridge University Press.

Tsai, W.T., Wu, L., Elston, J. & Chen, Y.N. (2011). Collaborative Learning Using Wiki Web Sites for Computer Science Undergraduate Education: A Case Study. *IEEE Trans. Edu., vol 54, no. 1,* pp. 114-124,

Verginis, I., Gogoulou, A., Gouli, E., Boubouka, M., & Grigoriadou, M. (2011). Enhancing Learning in Introductory Computer Sciences Courses Through SCALE: An Empirical Study. *IEEE Trans. Edu., vol. 54, No. 1,* pp. 1-13.

Wang, T.T., Su, X.H., Ma, P.J., Wang, Y. Y. & Wang, K.Q. (2011). Ability-training-oriented automated assessment in introductory programming course. *Computers & Education, vol. 56,* pp. 220–226.