The Comparative Study of Collaborative Learning and SDLC Model to develop IT Group Projects

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Abstract – The main objectives of this research were to compare the attitudes of learners between applying SDLC model with collaborative learning and typical SDLC model and to develop electronic courseware as group projects. The research was a quasi-experimental research. The populations of the research were students who took Computer Organization and Architecture course in the academic year 2015. There were 38 students who participated to the research. The participants were divided voluntary into two groups including an experimental group with 28 students using SDLC model with collaborative learning and a control group with 10 students using typical SDLC model. The research instruments were attitude questionnaire, semi-structured interview and self-assessment questionnaire. The collected data was analysed by arithmetic mean, standard deviation, and independent sample t-test. The results of the questionnaire revealed that the attitudes of the learners using collaborative learning and SDLC model were statistically significant difference between the mean score for experimental group and control group at a significance level of 0.05. The independent statistical analyses were significantly different between the two groups at a significance level of 0.05. The results of the interviewing revealed that most of the learners had the corresponding opinions that collaborative learning was very useful with highest level of their attitudes comparing with the previous methodology. Learners had left some feedbacks that collaborative learning should be applied to other courses.

Keywords – SDLC model, Waterfall model, Collaborative Learning, IT group projects.

1. Introduction

The current curriculums of the school of Information Technology and Innovation in 2015 [13] consist of three curriculums including computer science, information technology and software engineering. Instructors have cultivated the software development life cycle model in order to develop the software or solving any problems systematically. Learners can learn and apply the SDLC model in many courses of the school. However in the third year of education, all students have to take the senior project courses which can be divided into two semesters by considering the processes of SDLC model. Senior project I course consists of two phases including requirement gathering phase and analysis phase. Senior project II course consists of three phases including implementation and unit testing phase, integration of individual program phase and operation and maintenance phase. However there are quite small numbers of senior projects which can be completed on the scheduled plan. Therefore, most of the learners must have to retake the senior courses again until they can finish their projects completely which are wasting not only registration tuitions but also wasting times. For example, if there were fifty students that must have to retake the senior project II which cost about 10,000 baht for each learner as a result there were approximately 500,000 baht which learners must have to pay for the tuitions for the next semester. Furthermore, those students must spend at least one semester or more until they can finish their

senior projects. However, from the several years in the past, when the advisors have assigned the IT group projects, we have found that there were some problems of the group projects such as individual responsibility, communication skills, group collaboration, group interaction and collaborative skills of the team members. Therefore those problems had caused misunderstanding during communication, irresponsibility of the team members, and contradiction of the team members. These problems may cause the failures of the senior projects. As a result, there were rarely completed senior projects which can be finished on scheduled plan.

Software development life cycle [7], [8], [10], [11] deals with various parts and phases starting from planning to testing and deploying software. All these activities are carried out in different methods. Each method is known as a software development lifecycle model. Software process model is an abstract representation of a software process. A software development life cycle model is either a descriptive or prescriptive characterizations of how software should be developed. A descriptive model describes the history of how a particular software system was developed. A descriptive model may be used as the basis for understanding and improving software development processes or for building empirically prescriptive models. The students of this research have used waterfall model as software development life cycle due to the size and the complexity of the determined problems. The problems were suitable enough to use the waterfall model. Waterfall model [6], [9], [12] is the sequential development model which is a sequence of stages in which the output of each stage becomes the input for the next stage. An adaptability approach has been adopted to collaborate and teach a mobile software design [22] and development to achieve a better adaptability software model in software engineering course. The students of this course almost were the sophomore and third year students; they are familiar with waterfall model more than other developing models.

The researcher aimed to study the collaborative learning which is a novel learning methodology for School of Information Technology and Innovation, Bangkok University. The collaborative learning is a circumstance that involves more than two learners who try to share their learning experiences between each other. In this environment, the learners can learn from each other by using their skills, resources and sharing experiences that can make advantages to the group. From the collaborative learning theory [14], it was found out that learners by using collaborative

learning gain the knowledge from the group and also can work through collaborative working to achieve the team's common goals. In addition, they tend to achieve in their careers when they work with their co-worker. On the other hand, learners who work on their own, tend to express their behavior in competition. This research used group investigation technique to solve the problem which was the development of e-learning courseware; this technique will allow learners understand research methodology and deeper knowledge.

Collaborative learning not only has several advantages for learners in academic domain but also learner's social personnel, because this approach emphasizes on teamwork and team spirit. Therefore the researcher would like to study the comparison of learners' attitudes that used collaborative learning and software development life cycle to develop e-learning courseware of Computer Organization and Architecture course to the students as group projects. Even though researcher could not apply collaborative learning with SDLC in the senior courses because there are several advisors who might have different methodologies. Therefore, the researcher applied collaborative learning and SDLC model to the Computer Organization and Architectures course. The researcher wishes the results of the study can help to solve the previous problems of the school. This courseware can also be used as an alternative material which learners can use for self-learning, repetitively revising or assessing their knowledge of this course. Finally, the researcher hoped that collaborative learning would help improve the processes and outcomes of the senior project courses of the School.

1.1 Research Objectives

1. To compare the attitudes of the learners between applying SDLC model with collaborative learning and typical SDLC model to develop IT group projects.

2. To develop e-learning courseware of Computer Organization and Architecture course as IT group projects.

1.2 Research Framework

The independent variables of the research were based on five basic principles of cooperative and collaborative theory proposed by May and Doob (1937) which was referenced by Pappas [14]. Figure 1 showed research framework.
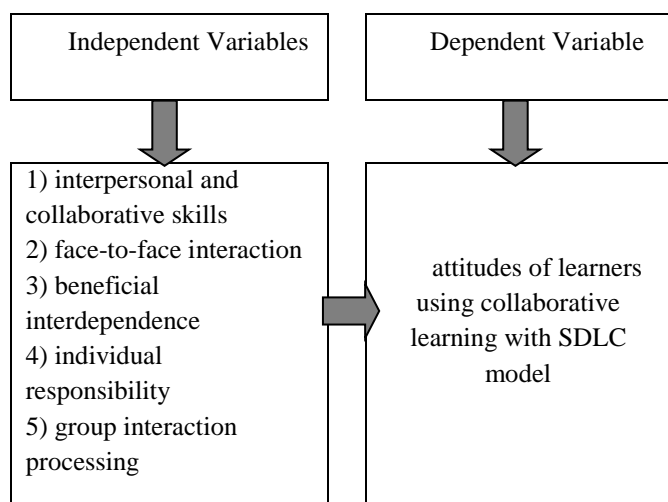
Independent Variables	Dependent Variable
1) interpersonal and collaborative skills 2) face-to-face interaction 3) beneficial interdependence 4) individual responsibility 5) group interaction processing	attitudes of learners using collaborative learning with SDLC model

Figure 1. Research Framework

1.3 Research Assumptions

The research assumption was that applying collaborative learning with SDLC model to develop IT group projects could improve the attitudes of the learners more than typical SDLC model.

2. Literature Reviews

Pozo, M. M., Gómez-Pablos, V. B. & Muñoz-Repiso, A. G. [5] proposed their research in which the main objective was to investigate whether first year university pre-service primary teachers hold a generally positive or negative attitude towards collaborative learning with video games. This research was using quantitative approach. Research instrument was a questionnaire with 5-point Likert attitude scale. The participants of the research were 193 students who were studying for pre-service primary school teachers. The data analyses were descriptive statistics, Chi-square, Mann Whitney U test. The findings of the research were 1) the more years and time the students have played video games, the better attitudes they present towards collaborative learning with video games and 2) the male students have more positive attitude towards collaborative learning with video games than the female students. Finally, the results showed that pre-service primary school teachers had positive attitudes towards collaborative learning with video games which could affect the use of video games in education practices.

Bozanta, A., & Mardikyan, S. [4] proposed their research in which the main objective was to determine the effects of social media on collaborative learning. This research was using quantitative approach. They proposed theoretical model based on Technology Acceptance Model (TAM) which included seven factors. Research instrument was an online questionnaire. The populations of the research were students of one of the largest universities in

Turkey. The sampling method was convenience sampling. There were 231 respondents but only 166 completed the surveys. 65% of the respondents were female and 35% were male. The statistical analyses were used such as goodness of fit indices, absolute fit measures, incremental fit indices, and parsimony fit indices. The findings showed that 1) perceived ease of use is a predictor of perceived usefulness and both of these have impact on social media use of the students for educational purposes, 2) social media usage improves peer interaction and course engagement of students and also students' interaction with faculty members, and 3) peer interaction and course engagement have positive significant effect on collaborative learning.

Márquez, L. M. T., Llinás, J. G., & Macías, F. S. [3] proposed their research in which the main objective was to compare two methodological tools with two groups of pre-university secondary education students. This research was quasi-experimental research. The participants of the research were 28 students of a school in Extremadura, Spain. The students were divided into two groups equally. The research instruments were a satisfaction questionnaire, pre-test and post-test examinations. The data were analyzed using Mann-Whitney U-test, non-parametric test, at the 5% level of significance, however, the Mann-Whitney U-test showed that the two post-test distributions were with no significant differences. Furthermore, the attitudes showed that the students were always very positive with experimental teaching approach.

Laal, M. & Ghodsi, S. M. [1] proposed their research which was a documentary research. The main objective of the research was to synthesize the benefits of collaborative learning from previous documentary researches. They concluded their findings that collaborative learning has several benefits and typically results in higher achievement and greater productivity, more caring, supportive, and committed relationships, and greater psychological health, social competence, and self-esteem.

Chu, S. K.W., Capio, C. M., Van Aalst, J. C.W., & Cheng, E. W.L. [2] proposed their research which major objective was to investigate the direct relationship of collaborative activities to the quality of a group writing output on wikis. The research was a mixed-method approach including qualitative and quantitative research. The participants were 219 Hong Kong secondary school students in academic year 2013-2014. The research instruments were a questionnaire and group interviews. All of the 219 students participated in the questionnaire which was used to examine student's perception of PBworks with five categories, however, only 118 students participated in the group interviews. The data

analyses of the questionnaire were descriptive statistics, correlation and one-sample Kolmogorov-Smirnov. One-sample Wilcoxon singed rank test was used to data analyze the group interviews. Finally, Generalized Linear Mixed Model (GLMM) was used to analyze group writing quality. The findings of the research were 1) students who made more collaborative revisions on the wikis produced higher-quality writing output 2) students reported a moderately positive attitude towards the pedagogical value of the wikis and wikis promote collaborative writing.

From the reviewing, there were one documentary research [1], two quantitative researches [4], [5] and two mixed-method researches [2], [3]. This research was a mixed-method research including qualitative and quantitative research which was suitable for the present research. Because the mixed-method can help to gather data from several aspects of the participants not only the answers from the questionnaires but also the opinions or feedbacks which were very useful and to deeply analyze the data.

There were two research papers that mentioned and analyzed about gender which was one of the independent variable of their studies [4], [5] , however, there were three research papers that did not mentioned and analyzed about gender which was not in the scope of their studies [1], [2], [3]. For example, Pozo, M. M., Gómez-Pablos, V. B. & Muñoz-Repiso, A. G. found that the male students have more positive attitude towards collaborative learning with video games than the female students. This research had mentioned the gender of the participants but did not deeply analyze gender in the study.

There were two researches which the participants were studying at university level [4], [5]. There were two researches which the participants were studying below the university level [2], [3]. The participants of this research were studying at university level. The ages of the participants of these researches were different, therefore, therefore, the attitudes of each level of the ages were also different. However, most of the participants of these researches were teenagers. There was a research which had more than 200 participants [2]. There were two researches which had more than 100 participants [4], [5]. There was one research which had less than 100 participants [3]. This research had 38 participants which gave the data for both questionnaire and interviewing. Even though 38 participants might not suitable for questionnaire but they might suitable for interviewing.

There were two researches which used social media as learning tool along with collaborative learning [2], [4]. There was one research which used video games as learning tool along with collaborative learning [5]. There was one research which used Jigsaw technique as learning tool along with collaborative learning [3]. This research used IT group projects as learning tool along with collaborative learning. Even though there were different techniques of each research, however, every research had the same goals which provided that the new techniques can help improve learning processes of the learners.

The findings of each research might be different and the findings depended on the research's objectives. This research had also found out that applying collaborative learning and SDLC model was very useful. The results from the questionnaire showed that the learners' attitudes of the experimental group had statistically significant higher mean score than the attitudes of the learners of the control group. The results from the interview showed that most of the participants had left some feedbacks that collaborative learning methodology was very useful and should also be applied to other courses of the School.

3. Theoretical

3.1 Software Development Life Cycle

Waterfall model is composed of five process activities to develop software as shown in figure 2. Requirement analysis is the process of analyzing and determining of the system's services, constraints and goals by consultation with system users. They are then defined in more specific details and serve as a system specification. System and software design is the process of designing the system, user interface and other components by transforming the system specification into some famous diagrams such as UML diagram. System design represents overall system architecture. Software design involves identifying and describing the fundamentals of software system abstraction and their relationships. Implementation and unit testing is the process of developing a set of each program units and unit testing involves verifying that each unit meets its specification. Integration and system testing is the process of integration of individual program units or programs and testing as a complete system. This process can also be used to verify the software requirements that have been met. After testing, software system is delivered to the users. Operation and maintenance is the process of installation of the system and its putting into practical use. Maintenance involves correcting errors not recovered in earlier stages of the life cycle, improving the implementation of system units and enhancing the system's services as new requirements are discovered.
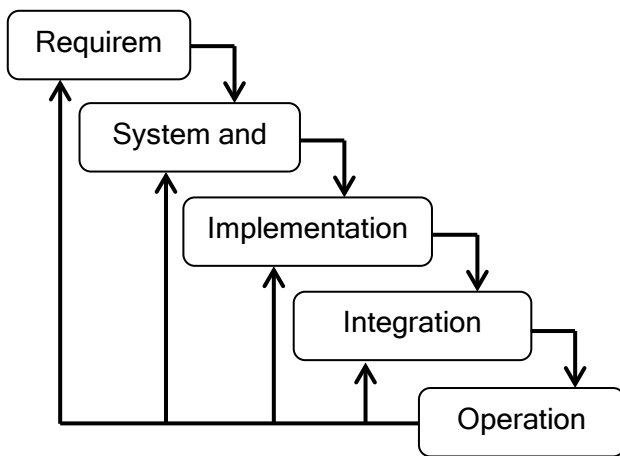
Figure 2. Modified Waterfall Model

Balaji, S., & Murugaiyan, M.S. [26] mentioned that the waterfall model has been used as software development life cycle, an oldest model of software development life cycle (SDLC) models. A SDLC models have several models consisting of waterfall, spiral, V-Model, rapid prototyping, incremental, synchronize and stabilize. The waterfall model represents the fundamental process activities of specification, development, validation and evolution and represents them as separate process phases such as requirements specification, software design, implementation, testing and so on. Figure 2 represents waterfall model as software development life cycle.

Ragunath, PK., Velmourougan, S., Davachelvan, P., Kayalvizhi, S., & Ravimohan, R. [25] mentioned that a software cycle deals with various parts and phases from planning to testing and deploying software. All these activities are carried out in different ways, as per the needs. Each way is known as a Software Development Lifecycle Model (SDLC). A software life cycle model is either a descriptive or prescriptive characterization of how software is or should be developed. A descriptive model describes the history of how a particular software system was developed Descriptive models may be used as the basis for understanding and improving software development processes or for building empirically grounded prescriptive models.

Software process model is an abstract representation of a software process. In this research, students were assigned to develop information technology project by using collaborative learning and SDLC model comparing with typical SDLC approach. SDLC is a systematic approach analysis and a phase approach. A software cycle deals with various parts and phases from planning to testing and deploying software. All these activities are carried out in different ways, as per the needs. Each way is known as a Software Development Lifecycle Model (SDLC).

Ali, A. [24] mentioned that programmers and systems developers often plan their programs and systems using a specified sequence of steps referred to as a Program Development, Systems Development Cycle or Systems Development Life Cycle. It is a phased approached aimed at solving computer problems, for examining an information systems and/or improving. In academia, the SDLC is widely used in systems analysis courses as well as entry level programming courses in specific or any other programming courses in general. In system analysis course, the emphasis for covering SDLC is on the larger picture of developing systems and the repetitive nature of the same tasks. In programming courses, the use of the SDLC is intended to give a glimpse of the steps that are followed to develop the program as well as give a conceptual understanding of the flow of the program prior to coding it. Using the SDLC model to understand the program is more often beneficial to beginner programming students. The common notion that is often followed by beginner programming students is to jump into coding without having a conceptual understanding of the program or the problem they are trying to resolve. Following a planning model (such as the SDLC model) may help to shed some light on the concepts covered and the methodology followed to solve the problem in order to give some understanding of the program prior to coding it.

3.2 Collaborative Learning

In each phase of the designed courseware, the researcher and the learners will not only exchange opinions but also share the experiences, and collaborate with each other in order to design courseware based on cooperative and collaborative theory proposed by May and Doob (1937) which was referenced by Pappas [14]. Pappas proposed conclusions of the cooperative and collaborative theory which composed of five basic principles including 1) interpersonal and collaborative skills 2) face-to-face interaction 3) beneficial interdependence 4) individual responsibility and 5) group interaction processing. This theory also corresponds to the conclusions of cooperative learning by Johnson and Johnson [23].The researcher had mentioned that cooperative and collaborative theory was not only giving several advantages for education aspect which focused on friendship, long term relationship, improving communication skills and recognition skills, and critical thinking but also the working aspect which focused on teamwork and team spirit.

The five basic principles of cooperative and collaborative theory proposed by May and Doob (1937) composed of 1) interpersonal and collaborative skills means the team members should

have social skill which can help them to work with other members happily consist of leadership, decision making, trusted making, communication and solving ability of contradiction in collaborative working. These will help to work as team and can lead to success. 2) face-to-face interaction can help to open the opportunity for students to help each other, to have discussions, knowledge or ideas sharing. Direct interaction among group members can help to create learning. Listening to the reasons of group members will help to develop thinking processes of the learners which can help to open the opportunity for learners to learn about social interaction. 3) beneficial interdependence means the interdependence in work processes or result-based interdependence for team work to achieve goals. This requires that each learner in the group be aware that they are important to the success of the group. 4) individual responsibility means that each member has responsibility to do the assigned job as fully as possible. There should be a tool to evaluate individual responsibility of each member which will become group's outcomes. These include the work of the group, providing both group and individual feedback to all members. 5) group interaction processing means that learners must learn from the group as much as possible, collaborate on ideas or works, and have responsibility together to achieve goals. The group must have good leaders, good members, and good work processes, furthermore each member must understand the goals of working together. This will allow group operations to be effective and achieve the goal.

4. Group Project Procedures

The processes to develop IT group projects were based on waterfall model which consists of five phases as shown in Figure 2. This course consists of eleven chapters including Introduction, Data, ALU, Instruction Sets, Processor Design, Pipeline-Scalar & Vector Processor, Memory, Cache & Virtual Memory, Storage Devices, Bus & Interface, and Input & Output. Each chapter would be assigned to each group of both experimental group and control group. Each group of both experimental group and control group had to hand in the documentations and they had to present their progresses in front of the class for every phase of the waterfall model systematically.

Each chapter consisted of title, objectives, contents, conclusions, practice questions, and quiz questions. By applying student center concept, users can browse the entire chapter satisfyingly [16], [21]. Learners can use any kinds of development tools such as MS PowerPoint, Adobe Captivate or some open source software. However, the researcher had

also requested them to apply SCORM 2.0 for their projects. There are several advantages to use SCORM 2.0 [20]. For example, Interoperability allows the users to use the courseware with a different set of tools or platforms. As a result, their group projects were very much satisfied because the projects were developed systematically. Figure 3 was an example of user interface of chapter 2 of the courseware which was displayed on web browser.
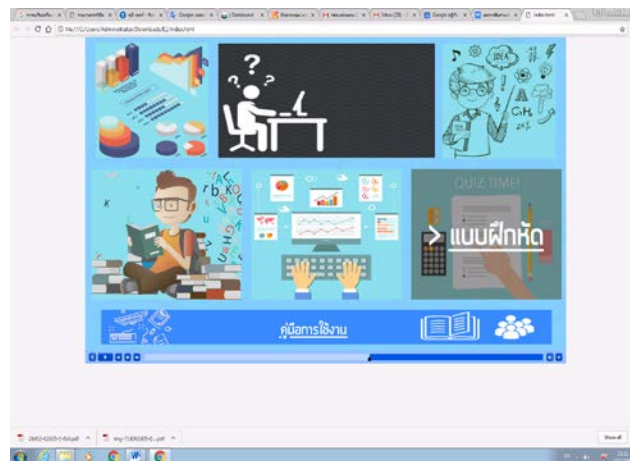

Figure 3. Example of User Interface of an IT group project.

5. Research Methodology

The processes to develop IT group projects were based on waterfall model which consists of five phases as shown in Figure 2. This course consists of eleven chapters

5.1 Populations and Sampling

Populations of this research were the students of School of Information Technology and Innovation, Bangkok University who enrolled Computer Organization and Architecture course in second semester of the academic year 2015. There were 38 students who participated in this research. There were 3 female students and 35 male students. The researcher planned to collect data from all students without sampling because the numbers of students were quite small. The students were divided into two groups voluntarily. First group was an experimental group with 28 students which used SDLC model and collaborative learning methodology to develop the group projects. The other group was a control group with 10 students which used typical SDLC model to develop the group projects.

5.2 Variables

Independent variables of the research were the activity arrangement of development software using collaborative learning including interpersonal and

collaborative skills, face-to-face interaction, beneficial interdependence, individual responsibility and group interaction processing. Dependent variable of the research was the attitude of the learners of both using collaborative learning with SDLC model and typical SDLC model as shown in Figure 1.

5.3 Research Instruments

The instruments of the research consisted of three major components including attitude questionnaire, semi-structure interview and self-assessment questionnaire. Each of the instruments is described as follow:

1. The attitude questionnaire consisted of questions to gather the attitudes of learners who used collaborative learning with SDLC model and typical SDLC model. The questionnaire composed of 14 questions and 1 open end question.

2. semi-structure interview consisted of 14 questions and 2 open end questions.

3. self-assessment questionnaire consisted of the questions to gather the self-assessment data of the learners. The questionnaire composed of three sections including self-assessment of each learner within group using rubric scoring, assessment of group members and assessment of the outcomes of a group.

5.4 Research Instruments Creation Process

The creation processes of research instruments were as follows:

1. the researcher created the questions from reviewing related documents such as journals, books or theses.

2. the researcher brought the questions and then submitted them to specialist to check the accuracy.

3. the researcher modified the questions as the recommendation of the specialist

4. the researcher let these instruments to be tried out by some other students.

5. the researcher made the final version of the instruments.

5.5 Collecting Data Process

The collecting data process of research instruments was as follows:

1. the researcher informed the students with behavioral objectives and practical activities.

2. the researcher divided populations voluntarily into two groups: experimental group with 28 students and control group with 10 students.

3. the researcher had assigned IT group projects for each group, experimental group and control group. The sub-group in each group had been assigned to develop e-learning for one chapter in the Computer Organization and Architecture course.

4. the learners responded by completing the questionnaire via online Google form. For semi-structured interview, the researcher had interviewed the group representative.

5.6 Data Analysis

The collected data were analyzed by using arithmetic mean, standard deviation and independent t-test of these two groups to compare the attitude scores of learners who used collaborative learning with SDLC model and typical SDLC model. Researchers used five level of likert scale to evaluate learner's attitudes by using questionnaires which consisted of 14 questions and one open ended question. The scale of each questions were: 5 point is the strongest attitude, 4 point is strong attitude, 3 point is moderate attitude, 2 point is less attitude and 1 point is the least attitude. The results were based on cooperative and collaborative theory proposed by May and Doob (1937) which was referenced by Pappas [14].

6. Results

6.1 Results of attitude questionnaire

Table 1 showed the results of data analysis of comparing the attitude scores of learners who used collaborative learning with SDLC model and typical SDLC model to develop IT group projects. The result of the experimental group of overall collaborative learning principles showed that it was in excellent level with the average score of 4.314 and S.D. of 0.381 comparing with the result of control group were in good level with the average score of 3.536 and S.D. of 0.548. The results of the questionnaire revealed that the attitudes of the learners using collaborative learning methodology and SDLC model was statistically significant difference between the mean score of experimental group and control group at a significance level of 0.05.

Table 1. Results of the experimental

Collaborative Learning	Experimental Group*		Control Group**	
	Mean	S.D.	Mean	S.D.
Interpersonal Skills	4.430	0.504	3.200	0.919
Collaborative Skills	4.140	0.651	3.500	1.080
Face-to-Face Interaction	4.360	0.621	3.500	0.707
Beneficial Interdependence	4.390	0.567	3.500	0.707
Individual Responsibility	4.430	0.504	3.700	0.483
Group interaction processing	4.210	0.630	3.500	0.972
Mean	4.314	0.381	3.536	0.548
*N1=28, **N2=10, α=0.05				

Furthermore, the results were analyzed by using independent samples test statistic with SPSS. An independent samples t-test is used to compare the means of a normally distributed interval dependent variable for two independent groups. Because the P-values of

Levene's Test for Equality of Variances were less than a significance level of 0.05, therefore the variances of these two groups were equal. Then the independent statistical analyses (t-test) were significantly different between the two groups at a significance level of 0.05. Therefore, the attitudes of the learners of the experimental group had a statistically significant difference than the attitudes of the learners of the control group as shown in table 2.

Table 2: Independent Statistical Analyses (t-test)

Independent Samples Test	Levene's Test for Equality of Variances		t-test for Equality of Means	
	F	Sig.	t	Sig.
Interpersonal Skills	1.642	0.208	5.263	0.000
Collaborative Skills	2.897	0.097	2.236	0.032
Face-to-Face Interaction	0.225	0.638	3.613	0.001
Beneficial Interdependence	0.842	0.365	4.006	0.000
Individual Responsibility	2.715	0.108	3.965	0.000
Group interaction processing	1.405	0.244	2.654	0.012
*N1=28, **N2=10, α=0.05				

6.2 Results of Interviewing

There were 11 participants from the experimental group in the interview, and there were 9 participants from the control group in the interview. There were 90% from the experimental group which had the same opinions that collaborative learning was very useful with the highest level of their attitudes compared to the previous methodology. There were 10% from the experimental group which had the same opinions that collaborative learning was very useful with high level of their attitudes compared to the previous methodology. They also had left some feedbacks that collaborative learning can help to determine duty and responsibility for each group member clearly, to reduce the development time consuming, to communication of the group members, and to collaboration of the group members. Finally, they had the same opinion that collaborative learning should be used in other courses of the school.

On the other hand, most of the control group had the same opinions that they still had found the same problems as the previous methodology such as the differences of computer literacy, the differences of time scheduling, the differences of individual responsibility, the differences of communication skills, the differences of making group decisions, and so on.

Most of the participants had left some feedbacks that collaborative learning methodology was very useful. Applying SDLC model with collaborative learning methodology should also be applied with other courses in school curriculum.

7. Result Discussions

The results of the research showed that the learners had excellent level of attitudes to the collaborative learning with SDLC model compared to the typical SDLC model whose learners had moderate attitudes. The collaborative learning is a circumstance that involves more than two learners who try to share their learning experiences to each other. In this environment learners can learn from each other by using their skills, resources and sharing experiences that can make advantages to the group. From the collaborative learning theory, it was found out that learners by using collaborative learning will gain knowledge from the group and also can work with collaborative working to achieve the team common goals, in addition, they tend to achieve in their careers when they work with their co-worker. On the other hand, learners who work on their own, tend to express their behavior in competition. This research used group investigation technique to solve the problem which was the development of e-learning courseware; this technique will allow learners to understand research methodology and deeper knowledge.

After applying the collaborative learning with SDLC model of Computer Organization and Architecture course of the students of School of Information Technology and Innovation who enrolled this course, learners can have opportunity to help each other, to advice and counsel each other. As a result, the learners have a sense of unity and help them to be responsible for themselves and the team member.

8. Future Work and Conclusion

Applying the collaborative learning with SDLC model can be used for other courses of School of Information Technology and Innovation which can help to solve the problems of the learners in order to develop IT group projects. However, there were some limitations of this research as the following:

1. The number of populations of this research was small number. However this is the nature of the school. Furthermore, research should keep continuously information of these groups of students on success in other courses after the research.

2. The contents of this course are quite difficult and have many topics to be taught, for example, CPU pipelining and virtual memory. Therefore, the students who have moderate or low academic performance, may lack diligence and boredom in teacher-centered approach [16], [21]. Organizing learning activities using collaborative learning is one of the learning approaches to be applied [15], [17], [18], [19].

3. The teachers should monitor far away from the students because they will mutually support each other among the group. The moderate or low academic performance students will be helped from team members within their group.

4. The research should continuously collect data from the learners who use the same methodology of the next academic year. Then the researcher can analyze the collected data by using time-series statistical which may take three to five years. Time-series can be used to extract meaningful statistics and other characteristics of the collected data.

References

[1]. Laal, M., & Ghodsi, S. M. (2012). Benefits of collaborative learning. *Procedia-Social and Behavioral Sciences*, *31*, 486-490.

[2]. Chu, S. K., Capio, C. M., van Aalst, J. C., & Cheng, E. W. (2017). Evaluating the use of a social media tool for collaborative group writing of secondary school students in Hong Kong. *Computers & Education*, *110*, 170-180.

[3]. Márquez, L. M. T., Llinás, J. G., & Macías, F. S. (2017). Collaborative Learning: Use of The Jigsaw Technique in Mapping Concepts of Physics. *Problems of Education In The 21st Century, 75*(1), 92-102.

[4]. Bozanta, A., & Mardikyan, S. (2017). The Effects Of Social Media Use On Collaborative Learning: A Case Of Turkey. *Turkish Online Journal of Distance Education (TOJDE), 18*(1), 96-110.

[5]. Pozo, M. M. M., Gómez-Pablos, V. B. & Muñoz-Repiso, A. G. (2017). A quantitative approach to pre-service primary school teachers' attitudes towards collaborative learning with video games: previous experience with video games can make the difference. *International Journal of Educational Technology in Higher Education, 14*(11), 1-18.

[6]. Sommerville, I. (2011). Software Engineering, 9th Edition. Pearson Addison Wesiley.

[7]. Fan, R. H. (2006). Development Life Cycle (DLC) for a software development firm. California State University, Dominguez Hills, ProQuest Dissertations Publishing.

[8]. Kendall, K. E. & Kendall, J. E. (2011). System Analysis and Design 8th Edition. Pearson Addison-Wesley.

[9]. Avison, D. & Fitzgerald, G. (2006). Information System Development: Methodologies, Techniques and Tools. Mc Graw Hill.

[10]. Dennis, A., Wixom, B. H. & Roth, R. M. (2015). System Analysis and Design. 6th Edition. John Wiley & Sons Inc.

[11]. Ragunath, PK., Velmourougan, S., Davachelvan, P., Kayalvizhi, S. & Ravimohan, R. (2010). Evolving A New Model (SDLC Model-2010) For Software Development Life Cycle (SDLC). *IJCSNS International Journal of Computer Science and Network Security, 10*(1), 112-119.

[12]. Balaji, S. & Murugaiyan, M.S. (2012). Waterfall vs V-Model Vs Agile: A Comparative Study on SDLC. *International Journal of Information Technology and Business Management. 2*(1), 26-30.

[13]. School of Information Technology and Innovation, Bangkok University. (2015). Retrieved from: http://science.bu.ac.th , (accessed 07 July 2017).

[14]. Pappas, C. (2014). Instructional Design Models and Theories: Cooperative and Collaborative Theory. Retrieved from: http://pappas199.rssing.com/browser.php?indx=2528 1988&item=42 (accessed 22. July 2017).

[15]. Barron, A. E. & Calanda, B. D. (2003). The Use of Audio in Multimedia Learning: Theory and Practice. *Journal of Interactive Instruction Development. 16*(1), 25-34.

[16]. Gibbs, G. (1995). Assessing Student Centred Courses. Oxford: Oxford Centre for Staff Learning and Development.

[17]. Microsoft Australia Education. (2012). Measuring Innovative Teaching in your School.
Retrieved from:
https://blogs.msdn.microsoft.com/innovative-education/2012/03/05/measuring-innovative-teaching-in-your-school/   (accessed 22 June 2017).

[18]. Suwannachot, P. & Monsakul, J. (2007). The blended learning management using Blackboard learning management system of undergraduate students of Technology Education for program, Proceeding of Faculty of Education, Chulalungkorn University.

[19]. Supasetsiri, P. (2013) E-Learning Media Development: Contemporary Aesthetics. *Institute of Culture and Arts Journal, 15*(1), 66-76.

[20]. Murphy, L. (2008). SCORM 2.0: Grab the Low Hanging Fruit. Learning Education Training Systems Interoperability.

[21]. O'Neill, G. & McMahon, T. (2005). Student-centred learning: What does it mean for students and lecturers? Emerging issues in the practice of University Learning and Teaching. Dublin:AISHE.

[22]. Pukdesree, S. & Netinant, P. (2016). Conceptual Framework: The Adaptive Biometrics Authentication for Accessing Cloud Computing Services using iPhone. Recent Advances in Information and Communication Technology 2016. *Advances in Intelligent Systems and Computing, Springer, 463*, 209-216.

[23]. Johnson, D. W., Johnson, R.T., & Holubec, E. J. (1994). The Nuts and Bolts of Cooperative Learning. Minnesota, Interaction Book Company.

[24]. Ali, A. (2009) A Conceptual Model for Learning to Program in Introductory Programming Courses *Issues in Informing Science & Information Technology, 6*(1), 517-529.

[25]. Ragunath, PK., Velmourougan, S., Davachelvan, P., Kayalvizhi, S., & Ravimohan, R. (2010). Evolving A New Model (SDLC Model-2010) For Software Development Life Cycle (SDLC). *IJCSNS International Journal of Computer Science and Network Security, 10*(1), 112-119.

[26]. Balaji, S., & Murugaiyan, M.S. (2012). WATEERFALLVs V-MODEL Vs AGILE: A COMPARATIVE STUDY ON SDLC. *International Journal of Information Technology and Business Management, 2*(1), 26-30.