Using CSCL Scripts as Supplement to Engineering Education: An Empirical Study on Introductory Course in Computer Science

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1   INTRUDUCTION

Social web sites have been widely used as the media of interactions among people. Due to their abilities for connecting people and fast exchange of information they are soon used in teaching. For example, teachers use social web sites as the platform to share ideas with students, so that the interactions among teachers and students can be extended off the class [13]. In the online learning environment, learning often occurs within the peer interactions among members in group, by sharing knowledge and resources, exchanging of information and experiences [15]. A group means two or more people connected through interactions [1,19]. Collaborative learning (CL) is a way of discussing, helping, sharing among group of learners to achieve common learning goals or construct knowledge [16]. Computer-supported collaborative earning (CSCL) is a kind of collaborative learning facilitating network and information technology to support peer interactions, group activities and knowledge construction and sharing [12].

Facebook is the social web site widely used among students to post, share and forward information, and conducting group activities. It can be used as the tool supporting discussion activities off the classroom. Facebook is integrated in teaching, providing students a self-learning environment. Teacher uploads case study material as the basis for students to discuss with each other [27]. The above studies generally affirm Facebook as an assistant tool to the interactions among teachers and students, facilitating collaborative learning and promoting motivation and outcome of learning. In their research [29], they found that in the networked learning environment the learning outcome can be enhanced by providing clear specification of discussion during the course of collaborations. However, without taking care of the activities of interactions among learners and teachers, Facebook would become the site of information exchange and resource sharing, which would not be effective assistant tool for off-class collaborative learning. Therefore, learning design plays the essential role to unleash the effectiveness of Facebook in collaborative learning [11,29].

Script is a set of rules or guidance for a group of people to consult when working on how to solve problems [18]. Scripts can be classified as macro and micro ones [3,8]. The former are pedagogical methods describing the way how students sharing knowledge and exchange opinions. The latter is a kind of dialogue models, mostly argumentation models; students learn scaffolding the argumentation model through the guide listed in the script. Hernandez [8] put forward that the methods commonly used to guide students to learn are: (1) manual monitoring and (2) script setting. A CSCL script consists of a series of learning activities attempting to form knowledge construction mechanism through peer interactions [2]. CSCL scripts use technique of rules to specify the behaviour of learners when engaging in collaborative learning [26]. Prister [20] proposed using text-based chatting room as the basis to develop CSCL script to enhance the interactions among learners. Notari [27] improves collaborative learning using CSCL scripts to guide the interactions among students by using wiki platform. Demetriadis and Karakostas [4] design a CSCL script, a pyramid script, on case-based learning. It is used to help students to learn in depths the concepts of complicated domain through the case study carried out in collaborative learning. In can be seen from the above descriptions that manual guidance is effective for the collaborative learning in class, and moreover it is essential to bring pedagogical methods and design rules for activities during the course of peer interactions for the off-the-class collaborative learning.

In this paper aim at conducting empirical study on using CSCL scripts to guide the interactions among students to learn and to construct knowledge collaboratively. We consult the five phases of e-Moderating model [23], to choose suitable collaboration strategy for the design of CSCL script according to the topic items listed in course outline. We employ the social web site Facebook as the platform for the implementation of CSCL scripts. After finishing designing a script, it is announced on the Facebook group for the course and students start carrying out the activities in the script. The instructor then monitors the process of the activities, records the result, and assesses the performance.

In the CS Department, we used to teach introductory courses like Introduction to Computer Science using slides in the class, and there are assignments and tests after class. It results in the problem of learning alone and the lack of interactions. We therefore employ CSCL approach by designing scripts and carried out the activities listed in the scripts as the supplement of learning activities of the courses. We first of all conduct an experiment, with steps as below, for a class of Basic Computer Concept having 102 students in class.

2 CSCL AND SCRIPT TECHNIQUES

In this section we first of all give a brief review for computer-supported collaborative learning, and then describe the techniques, i.e., scripts, which are essential in constructing the CSCL experiment.

2.1 Computer-supported collaborative learning

Computer-supported collaborative learning (CSCL) is a method using computer and network technologies to support collaborative learning in group. It focuses on how to promote the interactions and learning in group [13]. The purpose of CSCL is to build up a robust learning environment providing students mutual support and learning, and during the course involving in the process of interaction students can share knowledge, solve problems, and perform tasks. [,7,22].

As the development of Web 2.0, various tools are used to facilitate the process of collaboration such as social web sites. Social web sites are flexible in communication among users, and provide a wealth of information exchange functions. They extend the information flow in the web site from one-way only, content producer to consumer, to working together collaboratively. Thus they become ideal tool for realizing CSCL extending the learning activities off the class [6,13]. Social web site is good platform for collaborative learning; however, it remains to investigate how to improve the interactions among users and construct and share knowledge effectively in the online learning community. During the course of collaborative learning, a well-designed pedagogical method guiding the process of collaboration is effective for the group learning [21]. Collaborative strategies can be used to improve students' collaborative learning. According to the course content, teachers design and carry out collaborative activities for students in groups to achieve the effectiveness of collaborative learning. The common strategies are summarised briefly as below [5].

- **Learning Together** refers to the learning activities carries out by two or more students want to achieve common learning goal [10].

- **Student's Team Achievement Division (STAD)** Teacher forms groups of students with different level of abilities. Members of a group learn together and help each other. Teacher then carries out weekly test for students. If the test score is higher than previous one, the student will earn points. The sum of members' scores becomes the group's score. The group is commended when the score is beyond certain standard [28].

- **Jigsaw** Teacher divides the teaching material into several parts, and then groups students into 3 to 6 members in a group according to the ability levels of students. Each member in a group is assigned to study a part of the teaching material. All the students studying the same part assemble as an expert group to further investigate the part of the material. Each expert group member then returns to the belonging group and teaches other member of the group. Finally teacher carries out test on all the teaching material for all the students in class [24].

- **Group Investigation Method** Divide the students in the class into 2 to 6 member groups and then carry out investigation and discussion activities by group. Teacher and students work out together the topic to be investigated, providing students with diverse and wide learning experience.

- **Co-op Co-op** Learners prepare topics to be discussed by themselves, deciding "what to learn" and "how to learn". Each member in a group shares a part in the topic selected by the group to achieve the common learning

goal.

2.2 Script techniques

A script defines a set of guidelines for group members to collaborate each other when solving the problems. Scripts can be used to facilitate the flow of activity in group interactions and coordinating collaborations [18]. Script can be used in different domains. In education domain, it is mainly used in collaborative learning. The process of collaborative learning among learners is designed as the form of script as the norm to guide the learning activities.

Collaborative scripts guide and support the implementation of activities by groups of learners to obtain personal knowledge required collaborative learning. The concept of script was added to the CSCL learning environment. The collaborative learning among students is designed in the form of script for assisting students to conduct adaptability of learning. Collaborative scripts describe the learning situation in various stages of teaching. The script in each stage describes the following properties about how to carry out the activities [2,17].

- The tasks students must perform.

- Formation of the group

- Task allocation method in the group

- Mode of interactions

- Time period for the execution of task

Papakonstantinou, *et al.*, [21] consider that a script consists of the activities in specific stages participated by learners, the method of group formation, assignment of activities, interaction modes, and the period of each activity. Demetriadis and Karakostas [4] design a pyramid script for case-based learning. It aims at helping student to do case analysis through collaboration, in order that students can have deeper understanding for complicated domains. A pyramid script consists of the following step.

1. Each student is assigned one or two cases, and finishes analysis of the case under the guidance of teacher and hands in the analysis report.

2. After discussing the individual case analysis in step 1, every 2 to 3 students form a grouping in teacher's help.

3. Following Step 2 form groups of students having six or more members, and then teacher provides new case material for students to discuss and analyse using the asynchronous discussion tool. Each group hands in a report describing the discussion result for the specified case.

4. Finally, teacher concludes about the discussion result of each group, stressing the importance of collaborative learning, and explains the ignored part during the course of activity.

3   DESIGN OF EXPERIMENT

We use Facebook as the platform for carrying out the experiment. By consulting the e-Moderating five-step model proposed by Salmon [23], we design collaborative scripts based on learning goals at various stages of course. Students interact with each other according to the guideline stated in the scripts for promoting effective of learning. We design the experiment with steps described below to carry out the empirical study.

1. In the course outline, the instructor elaborates a number of units with learning goals setting up for students to participate in the collaborative interactions.

2. For the elaborated units, instructor selected suitable group activity policy and design the CSCL scripts.

3. The instructor creates a group in Facebook and invites students to join the group. At the beginning of the activity, the instructor explains to students what the activity is going to do and the assessment method.

4. Students then are engaged in the activity according to the guidance stated in the script. During the course of knowledge construction, each student can share knowledge from the answer and reply posts as recorded in the Facebook group site.

5. After finishing the activity, students can investigate whether achieving the learning goal through the course of the activity. On the other hand, both instructor and students can review the learning outcome through the assessment record and modify the script as appropriately.

We first of all conduct an experiment, following the steps described above, for a class of Basic Computer Concept having 102 students in class. Teacher creates a Facebook group for the course, introduces the pedagogical design of the course for students and invites students to join the group at the beginning of the course. In addition to exchanging information and sharing learning experiences using the group, students are designated to participate the group activities as specified in the scripts in accordance with the progress of course. Besides designing scripts, teacher can post relevant material, and can reply and assist students' questions about the course. Teacher observes and records the situation of participation and posting in the group activities as the reference for grading and assessment.

By considering the feature of the course, we set up two phases using different strategies and design activities according to the learning goals of the course units for knowledge construction by carrying out off-class and non-simultaneously on-line discussion. In the first phase, we use the strategy of learning together, taking all the students attending the course as a unit to form the group for the collaborative activity. In the second phase, we use two strategies, jigsaw and co-op. In jigsaw method, we set up 5 topics and students can choose to join one according to their interests to participate in the discussions in groups. In the co-op method, students form groups by themselves, each group with 4 to 6 members. There are 21 groups; each one proposes its research project, including motivation, goal, literature review, analysis and system design and architecture. The group activity is carries out in five steps, with the discussion result of each step recorded in the group's discussion forum.

During the course of experiment, students follow the guidance stated in the CSCL scripts to carry out the collaborative activities. The interactions among students are essential in the collaborative mechanism. The ultimate goal of the mechanism is promoting interactions, feedback, motivation and participation [25]. The CSCL scripts we design is listed Table 1.

Table 1: The CSCL scripts designed for the experiments

Phase 1: learning together method; the students attending the class forming a group for collaborative activity				
Activity number	Topic of Leaning	Learning goal	Discussion topics	Period of activity

01	Introduction to computer	Learn the basic concept and applications of computer	1. Describe the definition and use of computer 2. Explore the advantages and disadvantages of the use of computers 3. On what role does computer play in your daily life?	1 week
02	Internet and World wide Web	Learn the impact of Internet popularization	What do you think the future trend in the application of computer from the popularity of today's smartphone products?	2 weeks
03	Components of System Unit	Learn the components of system unit.	With the advance of computer technology, the type of auxiliary storage is also diversifying. In addition to hard drive, floppy disk drive, CD ROM drive, what other auxiliary memory equipment have you heard? Tyr to include 2 to 3 examples and explain their features.	1 week
04	Storage	Learn the technology of auxiliary storage devices.	1. What is cloud storage service> 2. What are the core features of cloud storage service? Try to give an application example.	2 week
05	Communications and Network, Database Management, Computer Security, Ethics and Privacy	Learn the related technology of network security.	1. Illustrate common hacker attacks. 2. Discuss from technical aspects how to effectively block viruses and hackers.	2 weeks
Phase 2: Jigsaw method; 20 to 22 members as a unit forming a group, each one choose a topic to join discussion and assign a member as leader				
06	Operation Systems and Utility Programs	Learn the related technology of operating system.	What the current common operating systems? Follow your expertise and interest to select one from the following list to participate in the discussion. Microsoft Windows Mac Operating System IBM OS2 UNIX/Linux Smartphone OS	2 weeks
Phase 2: co-op method; 4 to 6 members as a unit to form a group, and assign one as the leader				

07	Development of Information Systems, Programming Languages and Program Development	Learn the related technology of information system development	• Taking network information system as the theme, set up the network information you want to develop, for example, used books online purchase system, cheese cake online ordering system. • Choose the SDLC or OOP as the methodology of system development. • The proposal must consist of motivation, goal, system requirement, system analysis, system design, the programming language selected and the reason, each member's learning experience, and division of task.	2 weeks

We attempt to investigate whether the introduction of Facebook in collaborative learning can promote the learning interest and outcome. We take "the number of comment articles" and "the number of response article" as the base of metrics to measure the assessment of learning outcome. According to the characteristics of the collaborative activity, we define various grading according to the variances of peer communication, feedback and participation. The statistics based on the metrics can provide teacher information about how student learned after the activity, and as reference for further re-arranging the teaching activity. The ways of grading are described as below.

• Learning together method: total 100 points, including 20% for the positive aspect, 50% for the fundamental aspect, 20% for the construction aspect, and 10% for the interaction aspect. All the aspects are described as below.

  ■ Positive aspect: time is the main criterion for participation.

  ■ Fundamental aspect: means the strength of response.

  ■ Construction aspect: means that in addition to the fundamental aspect, the sharing of extra-curricular knowledge; the more accurate knowledge, the higher score.

  ■ Interaction aspect: means for posting interactive exchanges between students.

• Jigsaw method: the scores are divided into three parts, individual activity score, group activity score, and classroom report score.

  ■ Individual activity score: means the score that individual members participate in the activity; total 100 point, including 30% for participation, 40% for the accuracy of posting content, and 30% for experience.

  ■ Group activity score: means the score that the group participate in the activity; total 100 point, including 20% for group participation, 20% for the accuracy of group discussion content, 30% for report content, and 30% for division of work.

- ■ Classroom report score: means the score that the group present in the classroom their report after Facebook discussion.

- ● Co-op method: total 100 points, including 20% for the positive aspect, 50% for the fundamental aspect, 20% for the construction aspect, and 10% for the interaction aspect. All the aspects are described previously.

4   EXPERIMENT RESULT AND FURTHER WORK

The experiment is divided into two phases, first learning together and then collaboration. During the first phase, there are 9 topics to be discussed and there are 516 reply posts, with 0.56 posts in average (number of reply posts/(number of topics*number of students)). In the discussion, a new topic was issued by students and there were 61 reply post, with 0.6 in average.

In the jigsaw activity of the second phase, we set 5 sub-topics for discussion, and each student joins the sub-topic as s/he prefers. The five sub-topics have 1.05, 0.45, 1.39, 0.38 and 0.9 reply post, in average respectively. In the five sub-topic discussion, there derived 63 posts for knowledge sharing. In the following co-op activity, students form groups by themselves, each having 4 to 6 members, and there are 21 groups. Each group proposes its project proposal, dividing into five steps, including motivation, goal, literature review, system analysis and system architecture design, and implementation. According to the statistics, there are 128 topic generated within the 21 groups, with 6 topics in average. There are 2206 reply posts, with each group 17.51 posts in average. In addition to the respective discussion group, there are 15 post for knowledge sharing in the main discussion group. During the five-step discussion, the instructor issued 6 topics for discussion to assist for students to get in the steps in project proposal. For the 6 topics, there are 236 reply posts, with 0.4 in average.

The average reply posts show that in the first phase the way of discussion is based on the mode of "topic-response". In the second phase by group formation students are more proactive to the discussion; in addition to the increase of reply posts, students are willing to provide new topic and share knowledge. Taking a closer look, in the experiment, we found that the number of interactions in the co-op method is higher than the jigsaw one. Furthermore, in group discussion, the topics should be planned carefully to reach consensus. Therefore, the group leader is important to play the role of guiding the discussion returning to the topic when divergence in discussion happens.

At the current stage, we focus our experiment on collecting data of interactions and their posting messages and documents among group members when carrying out the activities in each phase. We made initial analysis about the situations of the collaborative activities. At the next stage we will further analyse the content of the posting messages and documents we collected to see how the progress of knowledge construction and investigate whether it needs teacher's intervention or assistance when the collaborative activities are undertaken. When investigating the progress of knowledge construction, we will adapt the four phases of knowledge construction, initial, exploration, negotiation and con-construction, as proposed by Onrubia and Engel [30, 31] into the first and second phase of our experiment as described previously. We will compare the analysis result with the one carried out by Onrubia and Engel for writing task.

5   SUMMARY AND ACKNOWLEDGMENTS

In this paper, we investigate the acceptance of students in learning activities using the social web site, the interactions among participants, and the effect of knowledge sharing and construction. In brief, the social web site is effective in assistance for student learning. Through the well-designed scripts encourage students to take part in the discussion and focus on the topics to be discussed. The social web site provides an off-class platform for knowledge sharing and construction among students and instructor. In this paper we assess the learning outcome by accessing the number of question and reply posts. In the future we will investigate the elaboration of learning outcome assessment. In this experiment, we design the scripts and evaluate how the activities are going by hand, which need lots of manual work and are the obstacle for using the script-based approach. Thus we start to employ knowledge engineering approach to develop an integrated development environment for relieving the burden of using the script-based CSCL.

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