

# Development and Evaluation of CSCL System for Large Classrooms Using Question-Posing Script

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**Abstract**—In the area of Computer Supported Collaborative Learning (CSCL) research, scripting collaborative learning is a relatively new but promising approach to promote learning. The term scripting is used to describe ways of prescribing relevant elements for collaborative interaction, such as group formation, roles, learning activities, sequence of learning activities. Many studies have shown that free collaboration without explicit scaffolding rarely produces effective interaction and that the script can be one of the most effective scaffoldings. Basing on SWISH model proposed by Dillenbourg, we have adopted the reciprocal teaching approach and designed a script which allows students to create questions and answer them mutually. To implement this question-posing script for large classrooms, we have developed a CSCL system which has two important functions: automated group formation function that can form groups on the fly, based on students' personal traits, and chat function by which students can discuss each other within their group. For the evaluation, we have conducted an experiment with some 300 students in a large classroom to evaluate our system and analyze interactions in detail during each sequence of learning activities. The evaluation result indicates that the learners felt encouraged to understand better about learning task. At the same time, it becomes clear that the quality of discussion on chat affects reciprocal question posing. As well, it is indicated that group size and knowledge level of leader or other members affect the process of reciprocal actions and activities at some degree.

**Keywords**—Collaborative learning; CSCL; large classroom; collaborative script; question-posing

## I. INTRODUCTION

This article is an extended version of a conference paper presented at eLmL 2014, the Sixth International Conference on Mobile, Hybrid and On-line Learning [1]. It introduces more information on the theoretical background of this study, a more specific and technical presentation of the system and some new data from the experiment.

### A. CSCL and its issues

According to the social constructionism presented by Vygotsky [2] and the theory of legitimate peripheral

participation presented by Lave and Wenger [3], the learning, which was understood as a cognitive process in an interior of an individual learner, will be recognized as a social process, or social cognition that progresses while cooperating with others [4]. Far from denying the learning as an individual cognitive activity, the social cognition can promote knowledge construction at an individual level and metacognition for learning strategies, through problem-solving by discussing with others [5].

The environment for such collaborative learning is built on the computer network, and such computer technologies are used as a supporting tool to promote collaborative learning, which is called, Computer Supported Collaborative Learning (CSCL). Advantages of CSCL over the face-to-face learning are: learners who are geographically or timely distant from each other can learn, a large number of learners can learn and be managed, logs of the learning process in details can be saved for learners, managers and scholars to re-use them, learning software and contents can be used and many more.

On the other hand, many case studies on the collaborative learning point out that it is highly unlikely for learners to carry out collaborative activities voluntarily while learning without an external scaffolding [6] [7]. For this reason, in order to resolve such issues in learning, various methods have been developed to appropriately regulate and structure the learning process within a group for effective and productive work and discussions among learners.

In this study, one of such methods, “collaborative script” was implemented in the CSCL system and used in a large classroom in the university. First, the next section will provide the overview of the collaborative script.

### B. Collaborative script and its issues

The concept of script was originally suggested by Schank and Abelson in the field of cognitive science, and it has a meaning of internalized knowledge about socially sharing steps and rules people should follow in a certain situation (e.g., eating at a restaurant) [8].

Once the concept was introduced in the field of collaborative study, the script became a series of external scaffolding methods that are provided to promote collaborative learning. The first study on collaborative script was proposed by O'Donnell and Dansereau [9] [10], which defines the script as a scenario for a small learning group,

which prescribes in details, who is carrying out what kind of learning activities and when. Due to the complexity of the script before the learning activities themselves, learners needed to be trained to follow the script.

After the script was adopted in CSCL, instead of training learners to execute the script prior to learning, the system interface was used to indirectly lead them to the scripted learning process [11].

Many researches indicate that the script can be designed at 2 levels in the CSCL environment. First, there is a design approach at a macro level; it defines who will learn, what assignment subjects for a group and how to distribute tasks among learners. On the other hand, there is a micro level approach which consists in prescribing the details of each learning activity in order to revitalize social interactions among learners [12] [13].

There have been many studies that indicate the effectiveness of various CSCL systems with the script, but there are some issues at the same time. First, there is an issue on controlling a compelling power of the script. In other words, it means how to deal with the risk of over-scripting which takes too much self-motivation out from learners [14]. Next, despite a lot of empirical case studies, yet there are very few suggestion on a script design model that can be commonly used, with some exceptions [15] [16] [17]. About the first issue, we suggested previously a method to flexibly adjust compelling power of the script according to learners' traits and learning situation [18]. So, this study focuses on the second issue, adopting a design method as the approach in order to design the script based on the design principle and implement and assess it.

### C. SWISH MODEL as Design Principle

The purpose of the collaborative script is to support the problem solving and knowledge construction by social interactions among learners. To do so, a mechanism to trigger effective interactions is an important element. A Swiss scholar, Dillenbourg, suggests SWISH model as such mechanism. This model is the design principle for collaborative script that gives tasks that would generate conflicts among learners; it is supposed to promote intense interactions (statements, explanations, discussion, etc.) to overcome these conflicts [13].

Exactly, SWISH is an abbreviation of "Split Where Interaction Should Happen". And this model can be formulated in three points:

1. Learning results from the interactions while students are constructing a shared understanding of the task despite the fact that the task is distributed.
2. Task distribution determines the nature of interactions. Interactions are mechanisms for overcoming task splits.
3. Task splits can be designed for triggering the interactions that designer wants to elicit.

From this model, three script schemata are drawn as design guidelines: 1. jigsaw schema, 2. conflict schema, 3. reciprocal schema. In the jigsaw schema, the information necessary to solve the problem being distributed, no group member is able to solve the problem alone. This split elicits social interactions to seek mutually the solutions in bringing

complementary knowledge each other. The conflict model forms groups with students having conflicting opinions; this conflicting relation elicits argumentation.

In this study, we adopt the third schema, reciprocal one. This schema defines the roles for each student and switches these roles. The horizontal split is realized between cognitive and metacognitive layers of the task and is counterbalanced by reciprocal regulation. The most well-known example of this schema is Palinsca and Brown's reciprocal teaching method [19]. In their approach for enhancing reading skill, four roles (questioner, summarizer, clarifier, predictor) are assumed in rotation by students. Through the reciprocal teaching process, the activation of mutual monitoring activity is particularly expected; learning accuracy is monitored during asking questions or clarifying and summarizing the content, whereas learning consistency of predictions is assessed.

According to Dillenbourg, by using collaborative script, the entire learning process is composed of multiple phases that are linear occurrence in succession [14]. Each phase has attributes, being regulated by: 1. Type of task, 2. Group structure, 3. Tasks assigned to group members, 4. Communication method and 5. Required time. As it will be shown in Section II, in conformity with the above, our script proposed in this study can be outlined as follows: 1. Tasks for the major phase is to prepare questions and discuss/refine the questions reciprocally, 2. The groups have 3 to 5 members (depending on the system specifications, a number of group members can be flexible) 3. Tasks are assigned to question preparer, answerer and grader based on reciprocal tutoring method, 4. The major communication method is to chat, using the network and 5. Time required is a deadline for the final project to be submitted, which is the end of the class.

Also, many existing systems have a control function in place such as an order in making comments and attributes of comments (suggestion, question, approval, disapproval, etc.) [20] [21]. This study, on the other hand, does not have such control in place at this time. We felt that such function to control attributes and occurrence of comments is unnecessary when the conditions are narrow and limited such as to prepare questions and allocating tasks to each learner.

### D. Structure of this paper

This paper is structured as follows. Section II presents the general outline and the purpose of this study, and Section III describes our CSCL system for large classrooms. The collaborative script design is discussed in Section IV. In the Section V, the details of page structure is described with their function. Then, we present our experiment and results from our evaluation in Sections VI and VII. Section VIII concludes the paper.

## II. PURPOSE OF THE STUDY

In this study, the script based on the reciprocal schema, is designed and implemented in the system to assess its effects. The system is for an environment where several hundred students in higher educational institutions cannot interact

with one another face-to-face. The collaborative learning is carried out by those students using the system online.

As for the assessment, assignments and chat log data are used to assess the quality of interactions during the collaborative process and its learning effects. By analyzing the correlativity between the two, we aim to have some guidelines for improving the script and design principle.

### III. SYSTEM

As Fig. 1 shows, our system was developed for an environment, such as a large classroom with several hundred people at higher educational institutions where face-to-face group learning is difficult. A teacher and students gain access to the CSCL server through PCs that are connected to the network. Learners can form a group regardless of where their locations are, and a teacher can remotely keep track of learning state of each group.

Our system is a server-client web application. As Fig. 2 shows, Linux server was constructed by using Java. We used Apache for Web server and Tomcat for Web container. The application was realized by JSP and servlet. Mysql was used for the data base in which information about the script and users properties is contained.

On client-side, there is, practically, no limitation about the choice of OS and browsers, but the use of Windows is recommended

#### A. System Overview

As Fig. 3 shows, the system consists of different functions, such as “automated group formation” and “questionnaire preparation” by which a teacher designs a collaborative learning, “assignment submission”, “reciprocal reviews” and “chat within a group” that provide a collaborative environment to learners. “Learners’ properties” in Fig. 3 are drawn from questionnaires and pre-tests that were administrated before. Based on the properties, the system automatically forms groups.

#### B. Flow of Collaborative Learning

The collaborative learning in this system is composed of 5 blocks, as Fig. 4 shows. The following is the learning flow.

1. “Prior Setting” allows a teacher to conduct questionnaires, prepare pre-tests and register to the system.
2. In “Pre-learning”, each learner submits the questionnaire and pre-test, which was registered in “Prior Setting” on the system.
3. In “Group Formation”, the system automatically forms groups based on the parameters the teacher has set and results of statements/answers by the learners. Small adjustments to the group formation can be made manually by the teacher.
4. In “Collaborative Learning”, reciprocal reviews within a group and among groups as well as chat system within a group can be done in the system. The learners carry out

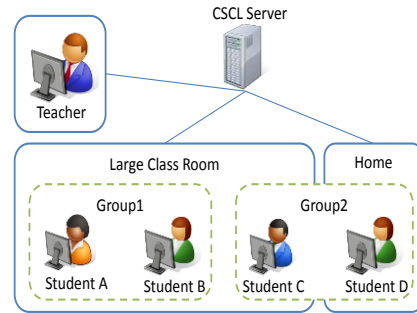


Figure 1. System overview

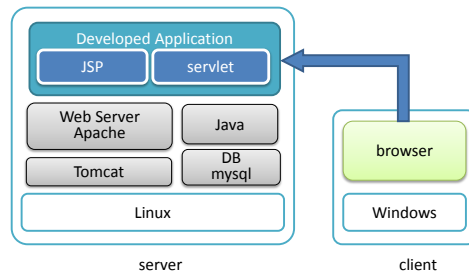


Figure 2. Technical Details

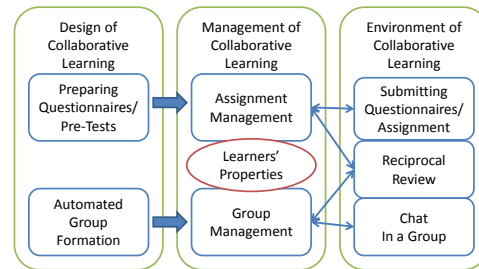


Figure 3. System structure

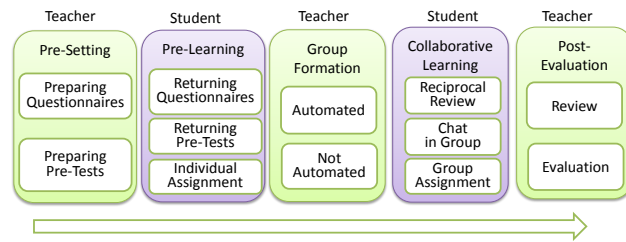


Figure 4. Flow of collaborative learning suggested by the system

these collaborative works according to the collaborative script.

5. In “Post Assessment”, the teacher reviews and grades submitted assignments.

#### C. Automated Group Formation Function

In this study, group formations are made possible in various ways that a teacher intends to do, by combining multiple elements of user characteristics that are obtained beforehand.

For example, a teacher can freely decide how many people to be in a group. He can also form flexibly groups with members of which properties are similar, or different.

Our system has two possibilities for group formation; the first possibility is to form groups with homogeneous students who have similar properties, the second is to form groups with heterogeneous students who have different properties. These properties are extracted from the test score or from the result of questionnaire, and then they are represented as numeric values .

Fig. 5 shows the case of group formation with 3 students. At first, the numeric values are sorted. For forming homogeneous groupus, three students are picked up in number order, from the first to the last (Fig. 5). In contrast, for forming heterogenous groups, each student is distributed to each group from the first student to the last student (Fig. 6).

**D. Collaborative Script Function**

In collaborative script, tasks are assigned according to roles, such as “Preparer”, “Answerer” and “Grader”. In the system, the group management function assigns tasks to each learner while the assignment management distributes allocated tasks. Also, roles that each learner is supposed to play and tasks are given automatically so that learners can work on their tasks at an appropriate speed without having to think about the collaborative script.

**IV. COLLABORATIVE SCRIPT DESIGN**

Supposing the experimental environment shown in Table I, the details of the collaborative script to be executed in the proposed system were designed.

**A. Question-Posing Script**

A script was made for the learning process in the task model called “reciprocal question-posing”. The following is a flow of “reciprocal question-posing collaborative script”, which was designed in this experiment.

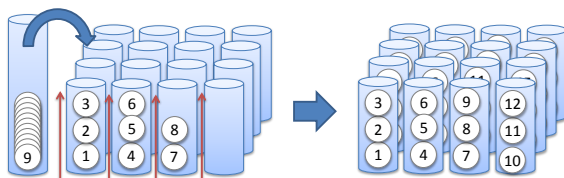


Figure 5. Formation of homogenous group

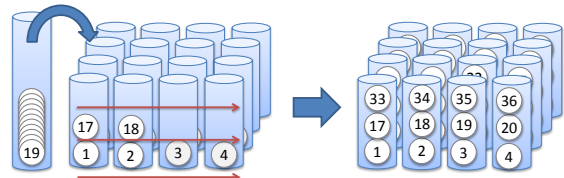


Figure 6. Formation of heterogeneous group

**Phase-1: Preparing individual questions**

A theme of question posing is given to learners. All the students prepare a question based on the given theme and submit it, including the answer and explanation about the question.

**Phase-2: Reviews within group**

Regarding the question prepared at Phase-1, 3 members within a group are assigned as a question preparer, answerer and grader and review reciprocally within the group through the following activities (Fig. 7).

- a. An answerer prepares answers to the questions prepared by a question preparer and submits the answer and evaluation of the question.
- b. A grader grades the answer submitted by the answerer in a. and submits the graded result and evaluation of the question.
- c. Based on the evaluation submitted in a. and b. a question preparer evaluates himself/herself,
- d. The above process from a to c is repeated until all the learners rotate to take a different role within the group and become a question preparer

**Phase-3: Question preparation within a group**

Through a discussion in a group chat, a question must be prepared for submission. The answer and explanation are prepared along with the question.

**Phase-4: Submission and publish of final questions**

Students submit a question/answer/explanation to their teacher. The teacher then publishes the questions as a assignment among groups.

**Phase-5: Solving questions reciprocally among groups**

Students solve group questions that are published.

**V. PAGE STRUCTRE**

In this section, the page structure of our system will be shown below with Webpage transition diagrams.

TABLE I. PRECONDITION OF COLLABORATIVE SCRIPT

Number of Students	About 300 people
Member of Groups	3 people
Learning Time	90min × 2
Design Guideline	Reciprocal Teaching

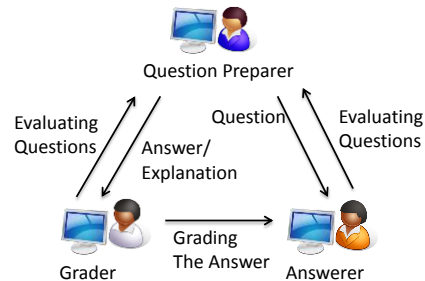


Figure 7. Group review

As Fig. 8 shows, the system has three distinct subsystems: student subsystem, teacher subsystem, administrator subsystem. Each subsystem also has its own subsystems. In the following subsections, their functions with webpage transition are described.

**A. Student subsystem**

The student subsystem is composed of the main system and the CSCL system. Fig. 9 is a page transition diagram of the main system. In this system for students, functions like student registration and student login are set up. In My Page after the login page, students can do course registration and respond to questionnaires. From the data collected in these pages, user model of each student is constructed for automated group formation. After these pages, students enter into the Forum Login Page which leads to the CSCL system.

Fig. 10 recapitulates the main steps by which students move from the student registration to the Forum login.

Fig. 11 shows the page transition of the CSCL subsystem after the Forum login which is opened to the students who have been assigned to a group after course registration. To execute the question-posing script explained in Section IV.A, this subsystem have main functions such as individual question submission, answer to question and evaluation, question grading and evaluation, question self-evaluation, group chat BBS, group assignment submission and so on.

Fig. 12 presents the flow of main student activities

defined by the script. But if necessary, students can return to prior activities.

**B. Teacher subsystem**

The teacher system consists of the main system and the group formation system.

Fig. 13 is a page transition diagram of the main system which has basic functions like teacher registration and teacher login. In My Page after the login, teachers can registrate their courses and make questionnaires. Since questionnaire items are shared by all teachers, it is necessary to check the list of existing items before the new items registration.

Fig. 14 shows the page transition of the group formation subsystem: teachers have roughly two possibilities in forming groups. The first possibility is to select questionnaire items and form groups on the basis of their result. The second possibility is to form groups from the result of test scores.

**C. Administrator subsystem**

The main system is the singular component of the administrator subsystem. Fig. 15 shows the page transition of this component. In the questionnaire classification registration, the administrator can determine what kind of subject (favorite subject, learning style, preferences, characters etc.) the questionnaire is addressing. In the questionnaire type registration, he can define the type of questionnaire (free writing, fill-in-the-blank, multiple-

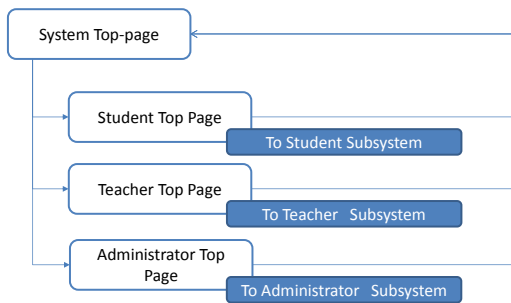


Figure 8. Webpage Transition Diagram

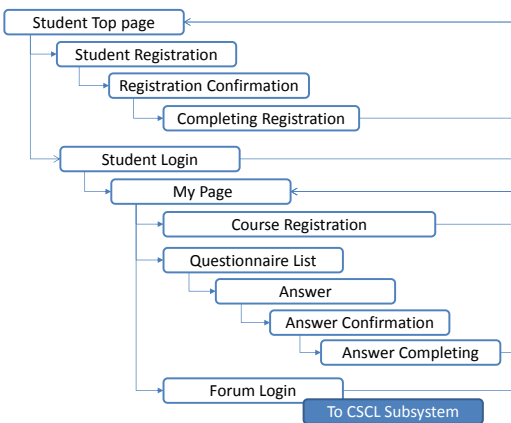


Figure 9. Student Subsystem



Figure 10. Steps of student activity

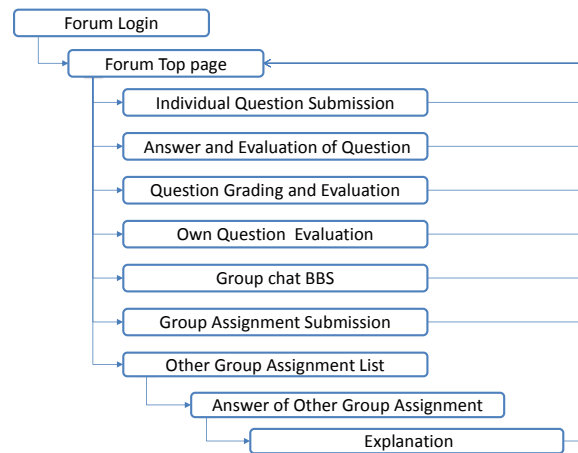


Figure 11. CSCL Subsystem

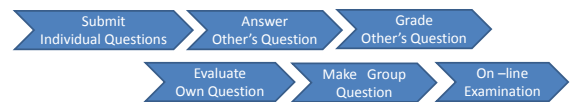


Figure 12. Steps of student activity in the CSCL Subsystem

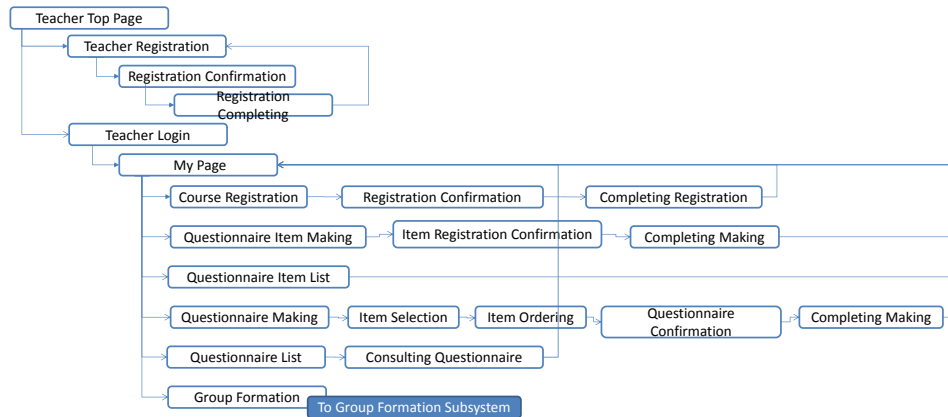


Figure 13. Teacher Subsystem

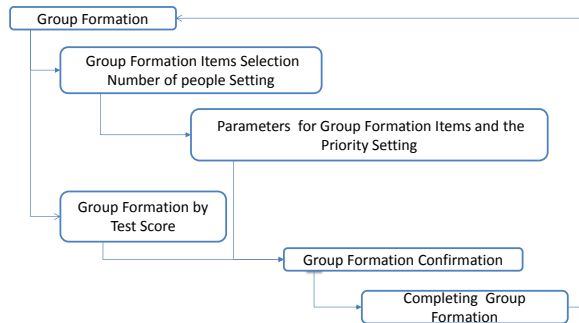


Figure 14. Group Formation Sub System

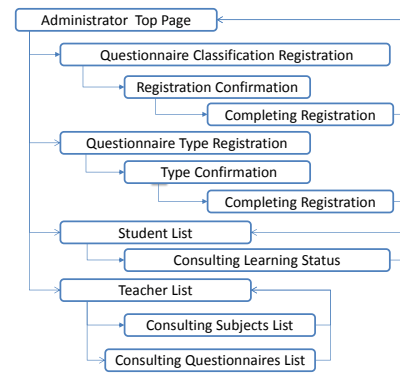


Figure 15. Administrator's Subsystem

choice, etc.). He can also consult the student list, the actual learning status of each student, the teacher list and all the data of questionnaires.

## VI. EXPERIMENT OVERVIEW

To assess this system, an experiment was carried out during a class at Tokyo University of Technology. The overview is as follows:

- Targets: Students at Tokyo University of Technology Freshman to Senior 298 students, 112 groups
- Dates for the experiment: January 10 (Tue) and January 18 (Wed), 2011
- Lecture: Basics of the logic
- Learning assignment: students prepare a question; the question has statements in Japanese that represent an deductive inference that contain several premises and a conclusion. The answer must have a well-formed formula that represents correctly the inference, and a truth table that verifies the validity/invalidity of the inference. For this assignment, several exercises had been done during previous lectures. Also, similar question were distributed and completed as a pre-test one week before the experiment. The pre-test was graded by the teacher in charge.

The experiment was carried out during 2 days in a 90 minute class. On day 1, 60 minutes were spent for answering/evaluating reciprocally within each group. On day 2, another 60 minutes were spent for posing questions reciprocally within each group. The flows for learning are shown in Fig. 16.

The group review phase for day 1 is for answering/evaluating questions, grading/evaluating questions and self-evaluation. Fig. 17 shows evaluations of a question by a grader's point of view.

The group review phase for Day 2 is for preparing group question. Using a group chat function, learners discuss how to pose the final question.

In this experiment, a number of group members was set to 3. But there were some groups of less than 3 group members due to no attendance of some members. Specially, since groups could not be changed on Day 1 and Day 2, there were many groups of less than 3 group members due to no attendance of group members on Day 2. For this reason, the evaluation of this experiment was done on only 93 groups with group members of 2 or 3 on Day 2. Table II shows changes in a number of group members.

Also, on Day 1 carry out a group review, group members of less than 2 members could not carry out a group review. In this case, the groups of 2 members continued the learning using a different script that allows the 2 members

solved questions and graded reciprocally. For a group of 1 member, the 1 member had additional members who came in late.

VII. EVALUATION

The aim of this section is to present the results of the experiment and their evaluation in different ways.

A. Automated Group Formation

In this experiment, groups were formed in a way that the academic level for each group is similar. Each group consists of equal numbers of learners who ranked top, middle and low in the pre-tests about the content of the lecture. The results of the pre-tests were total points (perfect score is 400 points) of 4 pre-tests that had been implemented according to the progress of the lecture. All the grading was done by the same teacher. Fig. 18 shows the distribution of individual score and average score within group. Because the average scores gather in the median, the automated group formation functions normally.

B. Question-Posing Script Evaluated by Learners

At the end of the experiment, we distributed a questionnaire to the students. Fig. 19 shows the responses to the question “Did you have a deeper understanding through posing questions?” Since many responded, “Deepened” and

few answered, “Not deepened” and “Not at all deepened”, the learners find the script effective.

Fig. 20 shows the degree of difficulty in posing questions. “Very difficult” (18%) and “Difficult” (68%) form a large majority. This result indicates the high degree of difficulty for students while posing questions. And between the degree of understanding deepness and the degree of difficulty, there is a very strong correlation ( $r=0.98$ ), which shows a trend that the higher is the difficulty, the deeper is the understanding.

Fig. 21 shows the degree of interest in posing questions. Almost half of responses are positive ones (“Very interesting” and “Interesting”). Between the degree of interest and the degree of understanding deepness, there is a strong correlation ( $r=0.82$ ), which shows a trend that the more interesting is the question-posing the deeper is the understanding.

Fig. 22 shows the responses to the question, “what was

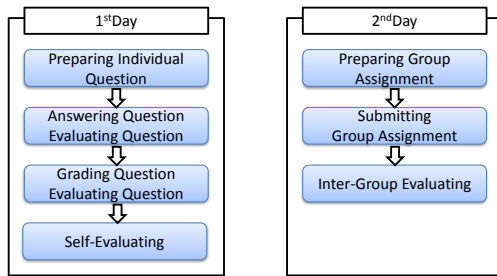


Figure 16. Flows of learning during experiment

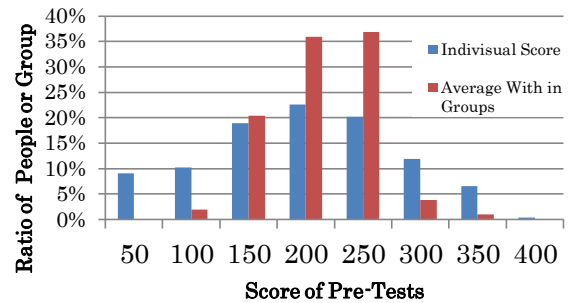


Figure 18. Distribution of individual score and average score within groups

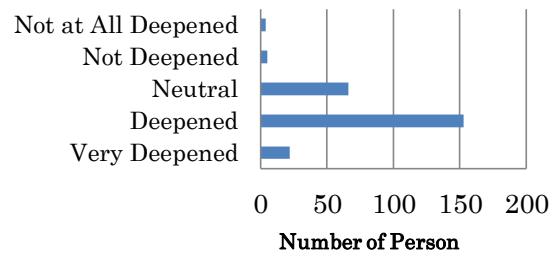


Figure 19. Responses to the question “Did you have a deeper understanding through posing questions?”

採点者用 問題評価シート  
(Question Evaluation Sheet for Grader)

問題と解答の整合は取れているか (Is the question consistent with the answer?)	はい ● いいえ ● (YES, NO)
とれていない場合、どのように改善すべきか (If not so, how do they remedy this inconsistency?)	<input type="text"/>
解説は適切か (Is the explanation appropriate?)	とれている ● とれていない ● (YES, NO)
「適切でない」場合、どのように改善すべきか (If not so, how do they improve the explanation?)	<input type="text"/>

Figure 17. Evaluations of a question by a grader’s point of view

TABLE II. CHANGES IN A NUMBER OF GROUP MEMBERS

Number of Members	Number of Groups	
	1st Day	2nd Day
3	77	40
2	32	53
1	3	15

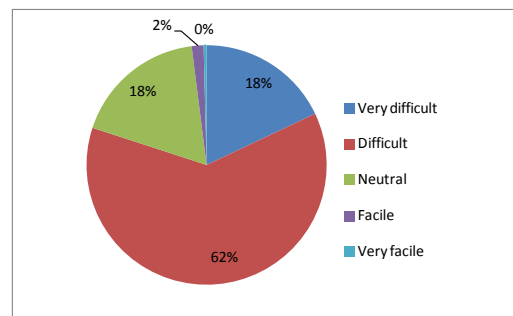


Figure 20. Responses to the question “Was it difficult to pose questions”

the most useful reference while question-posing?”. Responses as “Chat within Group”, “Evaluation on questions by answerers” and “Evaluation on questions by a grader”, of which teamwork take a large part, were highly evaluated.

C. Interaction within Groups

Contents of the chat were divided up into the following 5 categories: “Detailed discussion on important points”, “Discussion on important points”, “Discussion that often went off on a tangent”, “Discussion that were mostly chit-chatting” and “Pointless discussion”. The categories are shown in Table III. We fixed these categories after the attentive reading of the contents of the chat. The evaluation was executed by 1 person according to the evaluation standard while the other checked the result.

Tables IV to VI are extracted from the chat logs. Table IV shows a part of discussions that was evaluated as “Detailed discussion on important points”. It shows that 3 people consulted with one another on how to carry on.

Table V shows a part of discussions that was evaluated as “Discussion on important points”. It shows that only some casual conversations were the basis for making a decision to carry on. Even after the conversations, there were many communications to inform what had been decided and agreements on what had been decided. “Going off on a tangent” contained chit-chatting in the above conversations while “More chit-chatting” had more chit-chatting than discussions.

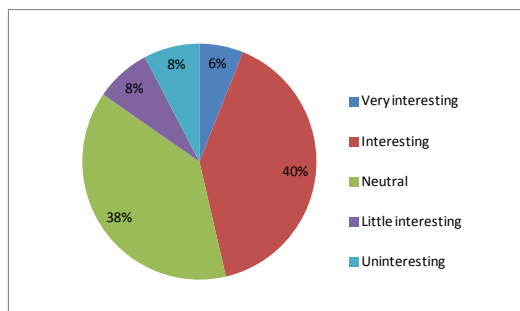


Figure 21. Responses to the question “Was it interesting to pose questions

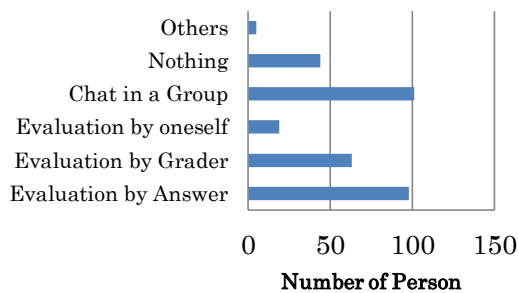


Figure 22. Responses to the question “What was the most useful reference while question-posing?”

Table VI shows a part of discussions that was evaluated as “Pointless”. It shows that the conversations were going into a direction of avoiding deep discussions.

Fig. 23 shows the quality of discussions by each group, of which chat logs were evaluated. In both groups of 2 or 3 people, more than 70% of all the groups fell into either one of the 2 categories, “Detailed discussion on important points” and “Detailed discussion”, meaning that many groups had good interactions.

Fig. 24 shows the number of statements made per person within each group. In the groups of 2 people, an average number of statements made per person is 26.2 while in the groups of 3 people, the average was 22.3. These results suggest that in both groups, relatively active discussions were held, and the interactions were sufficiently activated. Also, a number of statements was higher in the groups of 2 people rather than in the groups of 3.

Fig. 25 shows the comparison between the average scores of the pre-tests within each group and the qualities of the discussions. When the average scores were divided into

TABLE III. QUALITY OF DISCUSSION

Detailed Discussion on Important Points	Participants discuss carefully and meticulously to decide how to carry on.
Discussion on Important Points	Decision are taken by short discussions. Assignments are completed rapidly with modifications.
Often Went Off on a Tangent	Participants discuss on important points. But they chit-chat often.
Mostly Chit-Chatting	Participants chit-chat more often.
Pointless Discussion	Participants always chit-chat and don't try to complete the assignments

TABLE IV. EXAMPLES OF “DETAILED DISCUSSION ON IMPORTANT POINTS”

Talker	Contents
D	Where do you want to change?
E	That's right ... I guess, first of all, we definitely need to change the question, and then, what about the well-formed formula?
D	How is it that changes only the third line of the question?
D	Regarding the well-formed formula, it's the final part after ∩.
E	That's good idea.
F	I agree. How do we want to change that?

TABLE V. EXAPMPLE OF “DISCUSSION ON IMPORTANT POINTS”

Talker	Contents
G	Whose problem will we use?
H	How about I's Question? I don't have any particular reason for it though.
I	I think it's OK if it's corrected.
H	Then, let's make corrections on I's question and use it!
G	All right, let's work it out.

TABLE VI. EXAMPLE OF “POINTLESS”

Talker	Contents
X	It's difficult to make a new question, isn't it?
Y	Why don't we pick the best question among three of us and submit it?
X	I think that's great!
Y	OK, let's do so.



the 3 different levels, “100 to 150”, “150 to 200” and “200-250”, most of those groups that falls into the highest level, “200-250”, also falls into “Detailed discussion on important points”.

**D. Leader Function on Chat**

From the chat logs, learners who took a leader role in the chat were identified, and the relationship between the learners’ rank for the pre-tests within their group and the qualities of their discussions was evaluated.

Fig. 26 shows a result of the groups of 2 people while Fig. 27 shows a result of the groups of 3 people. Based on the results, in the groups of 2 people, when those who played a leader role have less academic ability than those who did not, their discussion tends to be well. In the group

of 3 people, on the other hand, when those who had the best grade within their group played a leader role, their discussion tends to be well.

**E. Evaluation of Group Assignments**

In this experiment, since the assignments that are submitted individually and by groups are the same, these 3 patterns can be possible as re-submitted assignments: “Re-submitted after improving individual assignment”, “Resubmitted the same individual assignments as is” and “Submitted completely new”. Those assignments that were made completely new include the ones that combined several different assignments. Fig. 28 shows a distribution of the ways each group made their assignment. In both groups of 2 and 3 people, the results indicate most groups “Re-submitted after improving individual assignment”.

“Re-submitted the same individual assignment as is” does not serve the meaning of collaborative learning, and it also means the collaborative script did not work well. Fig. 29 shows the quality of discussion being held by groups who

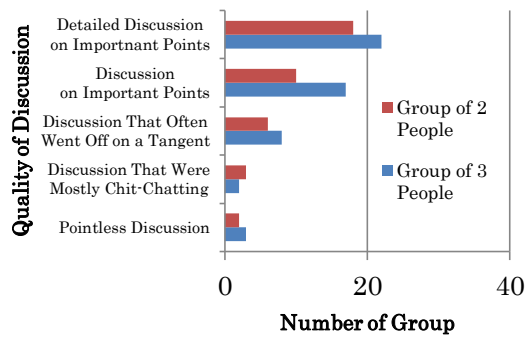


Figure 23. Quality of discussions and number of group

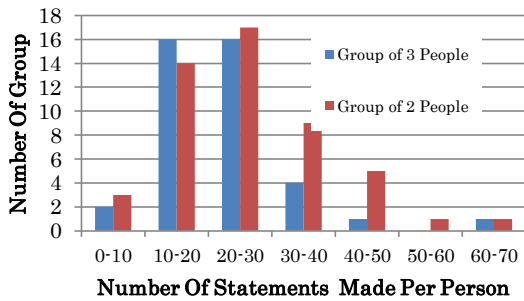


Figure 24. Number of statements made per person person within a group

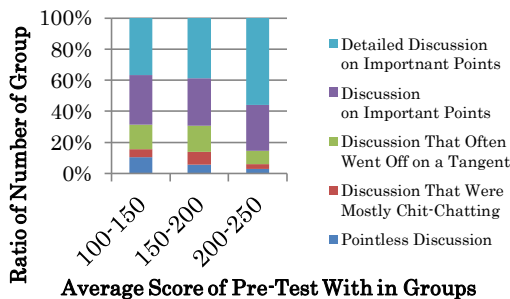


Figure 25. Pre-tests and quality of discussions

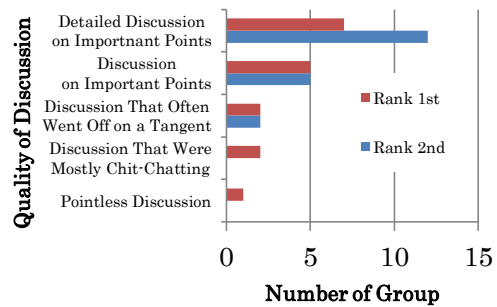


Figure 26. Leaders’ rank in the group of 2 people

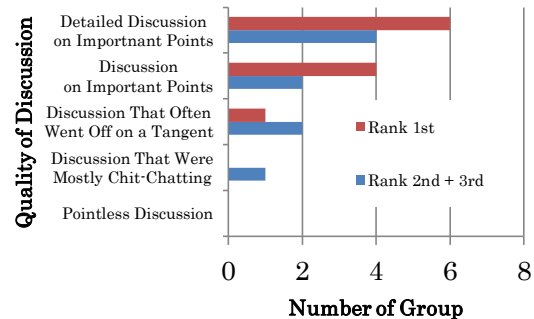


Figure 27. Leaders’ rank in the groups of 3 people

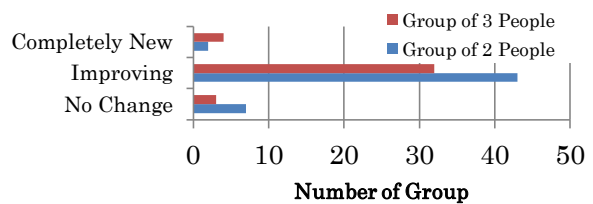


Figure 28. How they submitted group project

“Re-submitted the same individual assignment as is”. Many of these groups had a discussion that was “Mostly chit-chatting” and “Pointless”, so some type of scaffolding is necessary for them.

Table VII shows a standard for the group assignment, “Good”, “Average” and “Bad”, which are used for grading. Table VIII shows a comparison between the evaluation result and the qualities of the discussions. The evaluation was done by 1 teaching staff who carried out the experiment. There were 2 different evaluators for this evaluator and the one who evaluated the qualities of the discussions. The result shows that the better the discussion quality is, the higher the assignment evaluation is.

Also, Table IX shows a comparison between evaluation results and how discussions were carried on. “Made new” had a higher ratio of “Good” whereas “No changes” did not have any “Good”. As Fig. 18 suggests, “No changes” tends to result in “More chit-chatting” or “Pointless”. These points indicate that increasing a quality of discussion can lead to “Improvement” and “Make from scratch” with assignments highly scored.

VIII. SUMMARY AND FUTURE ISSUES

This section recapitulates the findings of this study and suggests briefly some future issues.

A. Summary

Supposing a situation where a face-to-face learning is impossible, we developed a CSCL system which can form many small groups for the online collaborative learning, and then the question-posing collaborative script based on the reciprocal teaching method was implemented in the system.

Then, in the environment with 300 people, the automated group formation and the collaborative script were proved executable and effective.

(1) The learners felt that the mutual work using the collaborative script was effective. In fact, discussions through the chat were activated while keeping their quality high.

(2) Many groups improved their submitted individual assignment through discussions online. Those groups that

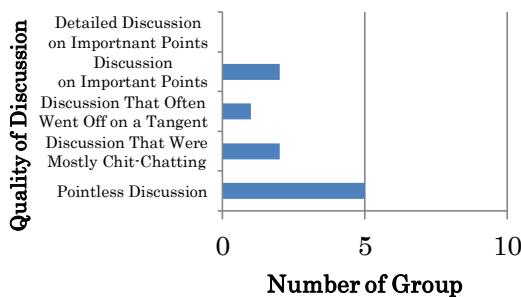


Figure 29. Quality of discussion held by groups without making changes

held high quality discussions scored high on their group assignment.

(3) It is suggested that the activation of discussions depends on an academic ability of the learners who play a leader role within their group. However, depending on a group structure, higher (academic ability) does not necessarily mean good.

First, according to (1) and (2), the results showed that the design of the collaborative learning in this study was mostly appropriate.

Also, according to (3), it is important to identify the most suitable learners to play a leader role and assign them in each group. However, the characteristics of learners who should play a leader role cannot be selected based on their academic ability, such as scores of pre-tests. To resolve such issue, in the future, it is important to develop a method to identify learners with an ability to take a leader role from a pre-survey and activity logs.

On the other hand, when the collaborative script is executed in a class, it is important to plan for exceptional cases, such as students’ no attendance. Collaborative script does not allow a progress of tasks to be flexible, so the script often gets non-executable when the learning environment is off from an original plan. In this experiment, there are learners who attended on the 1st day and missed the 2nd day, or learners who missed the 1st day and attended on the 2nd day, so there were many groups that could not make progress their learning as planned. Also, there were some time limitations, such as a deadline for submitting assignments, so there were groups that had to

TABLE VII. EVALUATION STANDARD FOR PROJECT

Good	Complicated Question than the exercise shown in advance and an answer is right.
Average	Similar to the exercise shown in advance or equivalent in complexity, and a Answer is right
Bad	Similar to the exercise shown in advance or below equivalent in complexity, and an Answer is mistake

TABLE VIII. QUALITY OF DISCUSSION AND EVALUATION OF PROJECT BEING SUBMITTED

	Evaluation		
	Good	Avg	Bad
Detailed Discussion on Important Points	13	18	9
Discussion on Important Points	3	18	6
Often Went Off on a Tangent	2	5	7
Mostly Chit-Chatting		3	2
Pointless Discussion		2	4

TABLE IX. HOW DISCUSSIONS WERE MOVED FORWARD AND PROJECT EVALUATION RESULTS

	Evaluation		
	Good	Average	Bad
Completely New	2	3	1
Improving	16	38	22
No Change		5	5

submit without having sufficient discussions. Based on the above, executing a collaborative script needs some degree of flexibility depending on a learning environment and conditions of learners.

### B. Future issues

In this study, the uniformed collaborative script was executed, but it is necessary to develop and practice collaborative script that is adaptable in groups in a way that the script changes flexibly depending on a group's characteristics and progress. In addition, future experiments have to examine what kind of difference manifests in the collaborative activities, depending on different communities or different learning agenda

Also, for the automated group formation, it is necessary to be capable of forming various groups based on learners' detailed characteristics being specified and to clarify characteristics of groups depending on learners included in the groups.

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