A Smart Method of Cooperative Learning Including Distant Lectures and Its Experimental Evaluations

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Abstract. Cooperative learning links students together to help them attain their learning objective under the guidance of teachers. With the spread of the Internet, cooperative learning has attracted educational technology interest, and research is proceeding into the use of bulletin boards, teleconferencing and chat rooms, etc., to support cooperative learning systems. However, cooperative learning systems tend to be used independently of distance learning, and very little work is being done on cooperative learning methods that include distant lectures. We believed that if remote lectures could be included in cooperative learning by students, the effectiveness of this cooperative learning could be improved. The article proposes a methodology for incorporating distant lectures in cooperative learning and provides an experimental evaluation. To evaluate this method we created a cooperative learning prototype and performed evaluations within our department.

1 Introduction

Distance learning may be divided into one of two categories: studies in which students access teaching materials asynchronously via the Internet, and those in which students interact directly with teachers at distant locations synchronously via teleconferencing functions. Cooperative learning links students together to help them attain their learning objective under the guidance of teachers. With the spread of the Internet, cooperative learning has attracted educational technology interest, and research is proceeding into the use of bulletin boards, teleconferencing and chat rooms, etc., to support cooperative learning systems.[1][2][3] This research frequently concentrates on the use of the worldwide web to grasp and control the progress of conversations and discussions.[4][5] However, cooperative learning systems tend to be used independently of distance learning, and very little work is being done on cooperative learning methods that include distant lectures.

The authors have proposed a distant-lecture system in which teaching materials are sent in advance to computers on the student side and teachers send editing commands to display the teaching materials to students.[6][7][8] We believed that if remote lectures could be included in cooperative learning by students, the effectiveness of this cooperative learning could be improved. The article proposes a methodology for incorporating distant lectures in cooperative learning and provides an experimental evaluation.

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To evaluate this method we created a cooperative learning prototype and performed evaluations within our department. The experiment was performed twice: the first time was to confirm and evaluate the basic functions of the system. Various problems centering around the system's chat functions were identified, and the result of the evaluation was unsatisfactory. The second experimental evaluation was performed after improvements to the system's chat functions, and repeated the evaluations addressing each of the problems.

2 A Cooperative Learning Method Including Distant Lectures

2.1 Basic Approach

The general flow of cooperative learning that includes distant lectures is shown in Fig. 1. At the initial asynchronous learning stage, the teacher sends the teaching materials with contents prepared for the course to the students in advance. The contents of the teaching materials are used when the distant lecture is given, but it is also possible for the students to use them in their preparation.

At the lecture stage, the teacher sends commands to display the teaching materials, and explains the theme of the studies. Those receiving the lecture see displays corresponding to these commands. Once the explanation of a particular topic has been

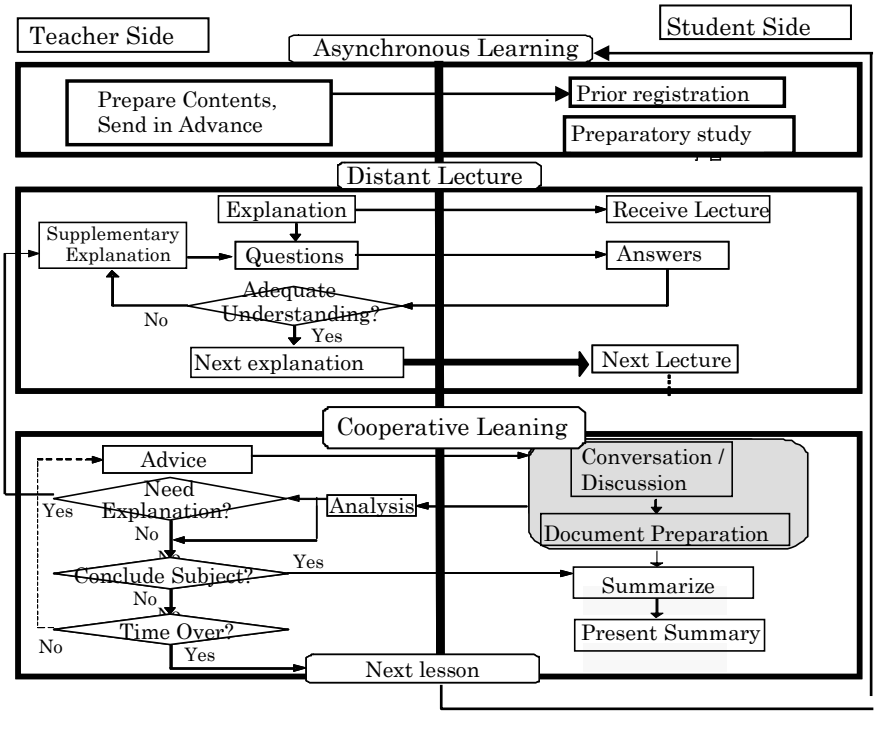

Fig. 1. Flowchart for the Learning Process

completed, the teacher sends a question command and checks the degree of understanding. If teachers feel that understanding is inadequate, they will give additional explanation(s) and check again. When adequate understanding has been achieved, the lecture can proceed. The cooperative learning stage begins once the lecture has been completed.

At the cooperative learning stage, students are divided into groups in which learning proceeds by way of conversations and discussions on the theme of the study and the joint creation of a document. The teacher watches the log of this process for each group, monitors the progress of document creation by group members and gives advice. If further instruction proves necessary, they revert to the distant lecture stage and appropriate additional explanations are given. As soon as the teacher feels that adequate understanding has been achieved by group members, they resume cooperative learning and further instructions are given.

Discussions on the study theme and document creation continue until the group is led to the right conclusions. Once the group has completed the study, the teacher confirms its completion, and the group uses the document(s) to prepare and submit a report. The study as a whole ends with the publication of these reports. The teacher refers to the results of the study, including chat logs and the data on the information shared, in preparing feedback for the next lecture.

2.2 Configuration of Cooperative Learning System

The system configuration is shown in Fig. 2. The cooperative learning system consists of the software for editing teaching materials in real time (abbrev. to R/SW below), the chat system, and the information sharing system.

R/SW has functions allowing commands to be sent during the lecture that cause the content of the teaching materials to be displayed to students. In addition to these content display commands, there are also commands allow the teacher to check the degree of student understanding. There are also functions to analyze the results of queries.

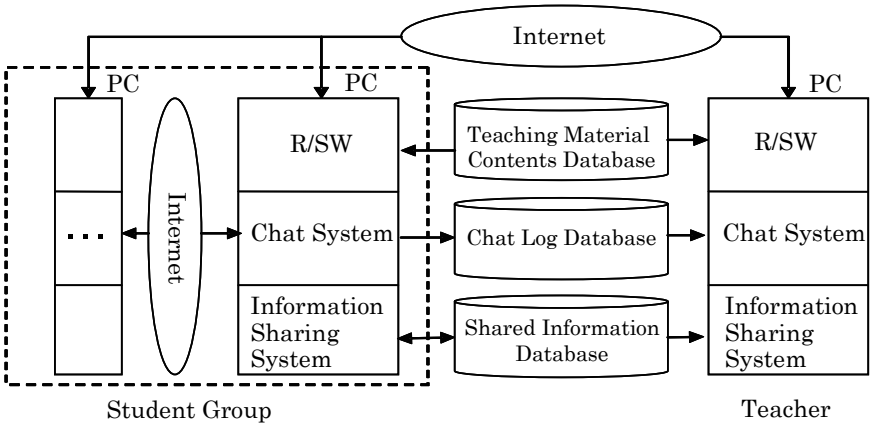

Fig. 2. System Block Diagram

The chat system uses NetMeeting chat, with tags that provide graphic identification of the kind of content that is being sent. This eliminates the misunderstandings that can easily arise in text-only chat sessions, and assists in judging what kind of discussions were being carried out by the group members as they followed the chat log. These tags also facilitate the investigation and analysis of the learning process from the chat log.

Because we considered that discussions would proceed by a repeated process of reaching agreements after exchanges of opinion between the participants, we set up tags to express "agreement," and "opposition," with "question" and "explanation" for questions and answers. Since conversations would not be confined to discussions, we also prepared an "other" tag.

We used a Wiki[9] as the system for sharing information. A Wiki is a web contents management system that facilitates access via a web browser, and allows freedom in issuing and editing pages.

2.3 System Support

The block diagram of the methods by which support was provided is show in Fig. 3. In order for students to follow the learning theme and achieve the objectives of the study, a document giving the results of their studies is prepared using discussions that proceed via chat and an information-sharing server. In this process, logs are accumulated of the chat conversations and the changes made to the document on the information-sharing server. Real time support during the lecture time is provided by analysis of the data on the server, R/SW is used to grasp the students' answers to questions, and provides the additional factor of distant lectures that are responsive to the students. It is very important, for the proper support of this kind of learning, that the process of distant cooperative learning should be analyzed, and this is done using the log of conversations and document creation.

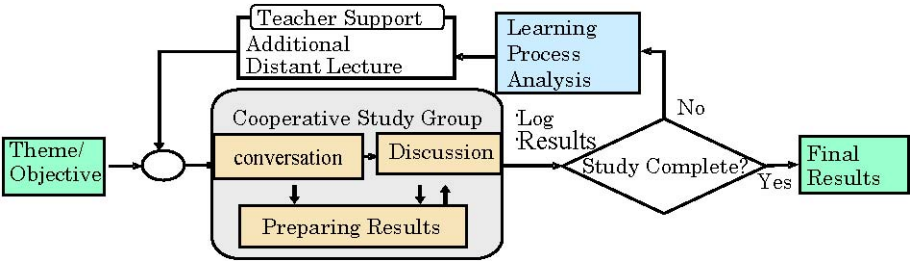

Fig. 3. System Support Methods

2.4 Grasping the Students' Responses

In order for the degree of understanding to be properly assessed in synchronous learning, R/SW commands are used to question understanding and R/SW analytical functions are used on the resulting answers. Here, the degree of student understanding is

assessed on the basis of multiple-choice Q&A forms and single-question answer forms for 20- to 40-word answers. Selection is performed in response to the teacher's questions by means of branching "radio" buttons.

The responses accumulated on the teaching side are checked to grasp the degree of understanding. The answers are totaled, and the average numbers of those selecting a particular branch option are ascertained. This provides a quantitative assessment of the overall level of understanding. The single-question answers are scanned for the keywords that they should contain to assess their correctness. For example, if asked what an interpreter language is, the answer is assumed to be correct if it contains the words "interpret" or "execute.".

3 Experiments and Evaluation

3.1 The First Test, Its Evaluation

3.1.1 The Experimental Environment Within the Department

The first experimental test was performed with ten fourth-year students in the department. They were divided into two teams, A and B, for the studies. Because the experiment envisages students at distant locations, the students were required not to sit next to one another in the lecture room, and not to communicate face-to-face. All students possessed notebook computers, and were connected via a wireless LAN. The students' computers had pre-installed R/SW, NetMeeting (used for chat) and the Wiki used as the shared information server.

3.1.2 Experimental Schedule and Study Theme

The experiment was performed over the period May 25 through June 8, 2004, during which there were four sessions, each of 90 minutes. In a fifth and final session, held on June 11, each team announced its results. The theme of the cooperative learning for this experiment was "An Investigation of the Suitability of Distance Learning Using the Internet for the Regions Surrounding the Takla Makan Desert and, if Suitable, of Problems Arising," and after the teacher lectured on the theme of the study, the group commented cooperative learning as discussions continued.

3.1.3 Results and Evaluation

For the first experiment, we performed analyses of the tags, the chat conversation flow, the Wiki information flow, the distant lecture itself, the questions and answers, the students' announced results, and the results of a questionnaire and opinion survey. As a result, we were able to confirm the overall flow of the cooperative learning process including distant lectures, but the following problems were identified. (1) Too much use was made of the "Other" tag (35.7%), making analysis of the discussion difficult; (2) the widely differing time lags between discussions and document preparation tended to disrupt discussion; (3) it was difficult to know the situation of other students, etc. We accordingly decided that satisfactory results could not be expected if the experiment were to be continued in its current form, and made improvements before carrying out the second experimental test and evaluation.

3.2 System Improvements

3.2.1 Improved Chat System

For this research, we developed a chat system with tags that would give simultaneous information on the state of discussions and document preparation. We have called this "semantic chat." A typical semantic chat screen is shown in Fig. 4.

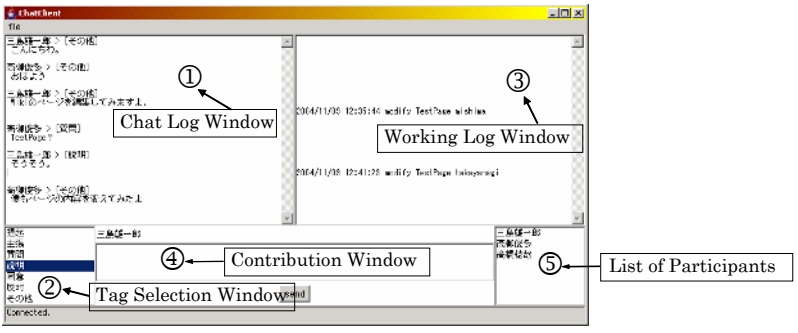

Fig. 4. Typical Semantic Chat Screen

The chat log with tags is shown in window (1), the tag selection list in window (2), the log of document creation in window (3), the area for entering contributions in window (4), and the list of participants in window (5). Meaningful tags are selected from the list in (2), and they are also allocated to function keys for selection and input without having to remove hands from the keyboard.

The chat log is on the left, but in the window on the right, Wiki changes are logged along the same time line. This means that as cooperative distance learning proceeds in parallel with document preparation, the progress of both discussions and preparation can be grasped simultaneously. We believe that this kind of environment, by providing a log of progress in documentation, will enable the teacher to distinguish between those students who are and are not participating in the study, whether or not they are actually participating in the active give-and-take of discussion.

3.2.2 Short Supplementary Lectures During Cooperative Learning

In the first experiment, we tried the method of having the students attempt to resolve among themselves any questions arising from the study theme during the cooperative learning process. However, analysis of the content of the discussions and the jointly prepared reports revealed that to some extent supplementary lectures from the teacher were necessary. In the second experiment, we therefore arranged to ascertain the student response and to provide appropriate supplementary instruction.

3.3 The Second Test, Its Evaluation and Consideration

3.3.1 Test Schedule and Content

In the second experimental test, nine of the department's fourth-year students participated on two occasions, Feb. 7 and 10, 2005. Nine of the participants in the previous test

were divided into two teams, Team A with four members and Team B with five. The study theme this time was different; "A Review of Policies to Encourage More Japanese Tourists to Visit the Autonomous Uighur Region of Xinjiang Province on China's Silk Road." There were two group discussions. One concentrated on what could be done to bring more Japanese tourists to China's Silk Road and the Autonomous Uighur Region, and the other concentrated on proposing appropriate measures to solve the problems involved. Participants were also pre-tested by E-mail before the experiment.

On February 7, the teacher gave the lecture on the study theme, then checked the degree of understanding, gave a supplementary lecture, and then rechecked understanding.

In the February 10 experiment, cooperative learning took place, with checks of student interest, additional lectures, checks of comprehensive, etc., and finally each team brought its document to a conclusion and submitted a report. The experiment was followed by a test and a questionnaire.

3.3.2 Experimental Results and Evaluation

On February 7, the students' reactions were ascertained after the distant lecture. Check points were displayed on the R/SW communications screen, and student understanding during the distant lecture was assessed by asking questions with the answers to be selected from four alternatives. This check was repeated four times. The results achieved by the students were assessed and additional lectures were given where this appeared to be necessary, and the same four questions were asked to check understanding. A comparison between the students' understanding before and after the additional lecture is shown in Table 1, from which it is clear that student understanding improved.

On February 10, during the cooperative learning, the teacher analyzed the semantic chat log and the document, and realized where students were experiencing problems and where more detailed explanations were necessary. First, the degree of student interest in this possibility was checked. Table 2 shows the results of two checks of student interest.

Table 1. Checks of Understanding Before and After an Additional Lecture

Item	Before				After			
No. of checks performed	1	2	3	4	1	2	3	4
No. answering correctly	7	7	8	7	12	11	11	12
No. answering incorrectly	5	4	2	5	0	0	0	0
No. of those not answering	0	1	2	0	0	1	1	0
Percentage of right answers	60.42%				95.83%			

Table 2. Degree of Student Interest

Check Necessary (Yes)or Unnecessary (No)	Team A (No.)			Team B (No.)		
	Yes	No	Either	Yes	No	Either
1st	4	0	1	4	0	0
2nd	4	1	0	3	0	1

3.3.3 Considerations

(1) Log Analysis and Semantic Chat

We compared the frequency with which the "others" tag was selected in the first cooperative learning experiment with that observed when the semantic chat system was used. This comparison is shown in Table 3. The table shows that when the semantic chat system is used, the "others" tag is used some 11.8 percentage points less than when NetMeeting was used. This suggests that the method of associating tags in the semantic chat system has become considerably more convenient, and that the students had become more familiar with their usage.

Table 3. Frequency of Tag Usage

Type of Chat System	"Others" (%)	Not "Others" (%)
NetMeeting Chat (1st experiment)	35.7	64.3
Semantic Chat (2nd experiment)	23.9	76.1

A questionnaire survey was carried our after the study. Divided into 15 categories, each with five levels of response, it also allowed for open-ended expressions of opinion. In response to the questions "Was the semantic chat system effective?" "Did the semantic chat window showing the updating of Wiki information prove useful?" and "Was the supplementary lecture helpful?" many students mentioned as positive factors that the semantic chat system was good in that it had simplified the input of tags, and that the Wiki update window facilitated progress by eliminating wasteful confirmations. However, there were also who indicated that although the display of information on the work of other students during the discussions was effective, there was also a need to display the status of the discussions with other students while the work was proceeding.

(2) Analysis of Supplementary Lectures

From Table 1 it is clear that the supplementary lecture improved student understanding, and from Table 2 that supplementary lectures are also necessary during cooperative learning. The results of tests of understanding performed after the supplementary lectures show that almost all students had understood their content.

(3) Pre-Test and Post-Test Analysis

The same test of the study theme was performed both before and after the cooperative learning. Fig. 5 shows the results of the group tests. The average scores show considerable differences before and after the cooperative learning. In terms of actual test scores, all students achieved higher scores.

Table 4. Pre-Test and Post-Test Results

Team	Pre-Test	Post-Test	Difference
A	22.75	69.5	+46.74
B	17.33	76.66	+59.33

(4) A Comparison of NetMeeting and Semantic Chat
NetMeeting was used for discussions in the first experiment and semantic chat was used in the second. Semantic chat dispensed with the need to enter tags manually, and we expected that this would affect the number of contributions. The number of contributions per unit time in the first and second experiments is shown in Fig. 5.

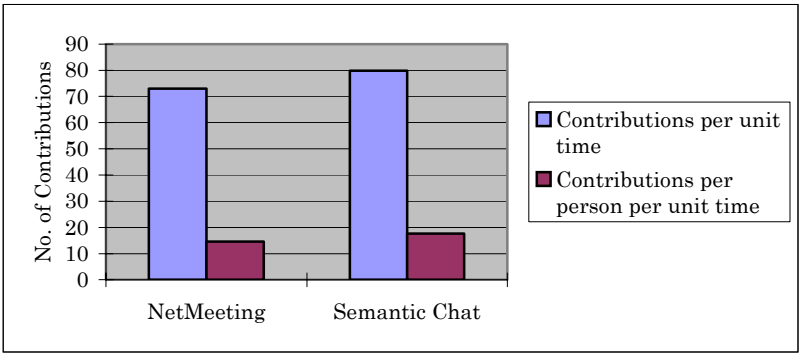

Fig. 5. A Comparison of the Number of Contributions Made Using NetMeeting and Semantic Chat

The comparison of NetMeeting and semantic chat given in Fig. 5 shows that both the total number of contributions to the discussion made per unit time, and the average number of contributions made by individuals per unit time, are both higher for semantic chat. This appears to be because dispensing with the need to enter tags by hand has encouraged more contributions.

4 Conclusions

This article proposes a method of cooperative learning that incorporates distant lectures and provides its experimental evaluation. The first experimental evaluation was performed for cooperative learning with the theme "An Investigation of the Suitability of Distance Learning Using the Internet for the Regions Surrounding the Takla Makan Desert and, if Suitable, of Problems Arising." As a result of analysis of the study process we encountered several problems. To solve these problems we developed the semantic chat system. In the second experimental evaluation, the study theme was "A Review of Policies to Encourage More Japanese Tourists to Visit the Autonomous Uighur Region of Xinjiang Province on China's Silk Road." As a result, a new problem of awareness was identified in this method.

Future issues to be resolved are the establishment of the parameters by which the effectiveness of studies performed via cooperative distance learning can be assessed. We also plan further practical testing and improvement of the developed system, and intend to perform experimental evaluation of the time lags between discussion and document preparation.

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