The student satisfaction and effect of group discussion on networked cooperative learning with the portfolio assessment system

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***Abstract*—**This study examined social talks in the group discussion and group-task-related dialogue in the group discussion as the predictors of students' satisfaction and their learning outcome and the students' overall learning satisfaction about cooperative learning activities and networked cooperative learning with portfolio assessment system, an instructional method that emphasizes idea expressing via writing and oral presentation, accumulated dialogues through inquiries between peers, critical thinking via peer assessment, and knowledge construction via doing a practical assignment. In this study, thirty-six juniors enrolled in a course Introduction to Computer Science and were assigned to twelve teams. Each team was assigned to design a combined Intranet and Internet computer network for a fictitious company. Quantitative results showed that social talks and group-task-related dialogue are useful predictors for students' satisfaction and learning outcome. In the other hand, descriptive statistics results indicated that students' overall learning satisfaction is high and 86% students willing to join the learning activities that similar to this study in the future.

***Keywords*—**Cooperative learning, portfolio assessment, team composition, peer assessment, social talk, group-task-related dialogue

I. Introduction

THE research on cooperative learning claims that students are able to learn better when they learn together as a team [1]. Cooper and Mueck [2] defined cooperative learning as a structured and systematic instructional strategy in which teams work together towards a common goal. Further, the learning activities of cooperative learning include 1) negotiating a common goal with team members, 2) being responsible for the learning of individual members as well as that of the team members, 3) assigning complementary roles and tasks to individuals within each group, and 4) cultivating social skills for effective cooperative learning. Springer, Stanne and Donovan [3] claimed that the learning activities of cooperative learning require a more authentic assessment of higher order thinking and problem solving. Therefore, portfolio assessment and cooperative learning should be combined to mutually enhance each other and to form a brand new cooperative learning with portfolio assessment [4].

Johnson and Johnson [5] stated that there exists a natural relationship between technology and cooperation. The use of cooperative learning with computers tends to increase cooperative behaviour and facilitate positive attitudes toward cooperative learning. Therefore, this study would measure students' learning satisfaction. The learning satisfaction was divided into four categories in this study: satisfied with cooperative learning, satisfied with the task, satisfied with system use, and satisfied with outcome.

The use of portfolio assessment with computers tends to increase the student's satisfaction with his/her learning process and positively influences the learning outcome [6]. However, few studies examine the predictors of students' satisfaction and their learning outcome related to networked cooperative learning with the portfolio assessment system. Therefore, this study uses two variables—social talks in the group discussion and group-task-related dialogue in the group discussion, as suggested by a previous study [7]—as the predictors of students' satisfaction and their learning outcome.

Manuscript received June 18, 2007; Revised received October 14 2007. The author would like to thank the National Science Council of the Republic of China for financially supporting this research under Contract Nos. NSC 94-2520-S-008-007, NSC 96-2520-S-008-003, and NSC 96-2524-S-008-002.

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II. Literature Review

A. Portfolio and Networked Portfolio

Paulson, Paulson and Mayer [8] said that a portfolio is a purposeful collection of a student's work that tells the story of a student's progression of achievement, and a collection of items that reveal different aspects of an individual's growth and development over time. Shores and Cathy [9] have divided the portfolio into three types: 1) Private portfolio: It is one you probably already keep (e.g., photographs of some academic activities). 2) Learning Portfolio: It will encourage richer reflection and communication within your program, and is the most fun and the most rewarding to implement. 3) Pass-along Portfolio: Condensed version of the first two.

Russell and Butcher [10] have analyzed the use of portfolios in educational technology courses, and have concluded its advantages. For example, it is more interesting for students to learn, portfolios allow each student to determine what they want to learn and how they demonstrate their knowledge and skills, portfolios include a lot of information and artifacts, and portfolios provide a method for students and instructors to do

outcome assessment and for students to reflect on their assignment and abilities. They [10] have also indicated the limitations of portfolios. For example, portfolios requires more time from the students and the instructors than other evaluation approaches, the benefits of portfolios are not appreciated and understood by some students and lack of research evidence in value of portfolios.

In a previous study [11], researchers have implemented a networked portfolio system, composed of two distinct functions that one focusing on peer-assessment with the other focusing on portfolio-assessment. Functions designed to facilitate peer-assessment include on-line submission of assignment, on-line marking and the ability to view suggestions from peers. At the end of a semester, the function of portfolio-assessment allows students to select their best assignment. However, the functions for cooperative learning under networked portfolio system have not been considered.

Cooperative learning with portfolio-assessment can be implemented as a networked system [4]. The networked system composed of three distinct functions: the first sub-system focused on the management of portfolios (e.g., students can collect, search, and make selections from and reflect on themselves assignment and team's assignment), this function was extended from networked portfolio system [11], the second sub-system focused on peer-assessment and self-assessment (extended from networked peer assessment system [12]), and with the third sub-system focused on facilitating cooperative learning (e.g., the function of team composition for teacher to use and the discussion forum for team members).

B. Cooperative Learning and Team Composition

Cooperative learning can be divided into four types: formal cooperative learning, informal cooperative learning, cooperative base groups, and academic controversy [5]. In formal cooperative learning, the student work together from one class period to several weeks to reach each team's shared learning goals and accomplish assigned tasks [13], [14]. The teacher may transform any course requirement into cooperative learning activity. In informal cooperative learning, the student are assigned into some particular teams and each team works together to complete a shared learning goal from a short period of time to one class period [14], [15]. In cooperative base groups [13], the student work together in heterogeneous groups with stable membership and in a long term. Each member in a base group needs to give the support, help, encouragement, assistance, and make academic progress. In academic controversy [16], the teacher organize some academic controversies by choosing an important issue, assigning students to groups of four, dividing the group into two pairs, assigning one pair the pro position and the other pair a con position. Then each pair takes one side and prepares the best case for their position. After a period of time, each pair presents their viewpoints to the opposing pair. After the presentation and discussion, the pairs reverse roles and develop an understanding of both perspectives.

Many studies of cooperative learning conducted with diverse subject areas and a wide range of tasks provide evidence that cooperative learning is an effective learning and teaching approach [13]. Previous studies showed that cooperative learning benefits students in terms of achievement, motivation, critical thinking, metacognitive thought, job satisfaction, and social skills [5], [13]. Previous studies also pointed out some important factors that may affect the effectiveness of cooperative learning, including positive interdependence, individual and group accountability, promotive interaction, appropriate use of social skill, resources, and group processing [5], [17]. In sum, there is a solid stepping-stone for teachers to apply cooperative learning in the in classroom activities and online learning activities.

However, it's hard for the teacher to manage cooperative learning activities [5]. For example, the team composition is composed of two important decisions. First, teachers need to consider students' characteristics: there are race, gender, ability, and many psychological features. Second, teachers also must consider the type of grouping is either heterogeneous or homogeneous. Some studies showed that students in heterogeneous ability groups tend to learn more than students in homogeneous ability groups [18], [19]. The academic discussion and peer interaction in heterogeneous groups promote the development of more effective reasoning strategies [17], [20]. Hooper and Hannafin [21] found that low-ability students' interaction was 30% more when placed in heterogeneous pairs and the student in heterogeneous pairs achieved and cooperated significantly more than the student in homogeneous pairs. The last problem is that teachers who are willing to use ability variable for heterogeneous grouping and then they must deal with major computation requirements. Therefore, this study implemented a team composition program [22] for this task.

III. Data Collection

A. System Design

This study presents a web-based system, Networked Cooperative Learning with Portfolio Assessment System (hereinafter referred to as NetCoP), that coordinates student learning in a manner similar to researchers, scientists and practitioners that have learned from doing. Author has utilized the Windows 2000 server to be the operating system, Internet information system 5.0 to be the web server, and SQL server 7.0 to be the database management system. Author has implemented the functions of NetCoP by using server-side programs to retrieve and store database information. These server-side programs were coded with ASP (active server pages). Students can turn in their assignment directly through this online system. Because the assignment is in the same format as a HTML (hypertext markup language) file, the assignment can be stored directly into the file system to be read by the reviewers through the web browser.

System administrator of all classes can create a new class through the administration program. Once the class is created, the system establishes a new directory using the ID (e.g., course001) assigned to this class. The pre-defined programs are

generated as well. Meanwhile, the new directory is attached with some programs. Doing so makes each class independent in that it has its own directory. The teacher of this course can manage the students' learning activities through the administration program, news program, and team composition program. Class management includes student's enrollment information, assignments, assessment, and team composition. The enrolled students can turn in their assignment, modify their assignment afterwards, receive and give grades, receive and give suggestions, and view assignment of other students. When a student has turned in his (or her) assignment, this assignment will be assigned a random number by the system together with a directory established. This assignment is therefore stored in the directory. In doing so, each assignment can be recorded distinctly before and after each round of modification.

B. Participants and Course Content

The participants comprised thirty-six juniors enrolled in an introductory computer science class, Introduction to Computer Science, at a technical university in northern Taiwan. These students were divided into twelve heterogeneous groups of three individuals; the groups were assigned using a team composition program with ability variable (ie, entrance examination score) according to the suggestion of previous study [23]. All teams were presented with a cooperative design assignment for the entire semester. The course covered the following ten topics during the eighteen weeks: Basic concepts of computers, Digital representation, Boolean expressions, Operating systems, Application software (eg, Word, PowerPoint and Excel), Introduction to the Internet, World wide web, Websites, Web pages, and Designing web pages.

C. Group Task

The participants were required to design a combined Intranet and Internet computer network for a fictitious company. Each team was given a company floor map and some computer network security considerations. The teams were expected to discuss the assignment, cooperatively invent a solution, and write down the cooperative process while making design decisions on hardware and software requirements. Further, the assignment had to clearly identify the responsibility and outcome of each student in this group task.

D. Measurement

In this study, the social talk in the group discussion is comprised of positive subjective comments toward the group's learning process, members and learning outcome. The group-task-related dialogue in the group discussion is comprised of constructive subjective comments toward the group's project schedule, goals and problem-solving capabilities. Both the social talk and group-task-related dialogue of a student in the group discussion forum are rated by class teacher on a ten-point scale, ranging from 1 (not at all) to 10 (very positive or constructive).

Perceived satisfaction was measured using a questionnaire that contained twenty-five items regarding the students' perception of cooperative learning, the task, the system used and the group learning outcome in NetCoP in addition to the students' willingness to participate in learning activities using NetCoP in the near future. The students were required to rate their satisfaction level on a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). Participants that responded positively to items 3 and 4 on the questionnaire were categorized as 'satisfied' students; all others were categorized as 'unsatisfied'. An open-ended question was attached to each statement to elicit free opinions or suggestions for modifications with regard to NetCoP and cooperative learning activities.

The group learning outcome marked by the class teacher is based on the extent to which the group has completed the task. The group learning outcome is rated on a ten-point scale, ranging from 1 (extremely poor) to 10 (excellent).

IV. PROCEDURE

The students were instructed to do the following procedures:

- Instructor demonstrates the educational objectives of cooperative learning, portfolio-assessment, peer-assessment, and self-assessment in the beginning and uses some real samples from previous semester to prepare students for later activities. (This step done in the first of this semester and lasts about 3 hours)
- Instructor coaches a part of teaching materials covered in this semester. (Each topic was scheduled about 1~2 weeks)
- Instructor assigned three students [24] into a team through the simulated annealing K team-forming algorithm for heterogeneous grouping [22] and the entrance examination score as the input of above algorithm. The students were asked to become acquainted with each other and seat themselves together during class time.
- Students and the instructor collaboratively discuss the assignment and the criteria to make corrections via NetCoP and face-to-face (This step lasts about a week).
    1. The instructor discusses the criteria to mark an assignment with students in classroom teaching.
    2. Students still can discuss this assignment with the instructor informally via NetCoP after classroom teaching.
    3. The criteria for this assignment are creativity, feasibility and correctness. The range of rating is divided into ten categories from "extremely excellent (10)" to "extremely poor (1)".
- Instructor gave students one or two hours of class time per week for group work. To emphasize the need for personal accountability and cooperation, group members took turns organizing their assignment, recording their cooperative process, and correcting some possible mistakes in team members' work. Students should submit their work in group discussion forum in class and continue their discussion after class.
- The assignment and documents about cooperative process as they made any specific design decisions on hardware and software requirements completed by the teams is uploaded to the system.

1. Teams have completed the assignment by themselves.
2. Teams were instructed to complete the work and submit it to NetCoP within a week; otherwise they receive no credit on this assignment.

- The system randomly assigns reviewers (each reviewer grades three to four assignments).
  1. The procedure is automatically done by system after all of the teams have uploaded their own assignments to NetCoP.
  2. In this study, three other teams' assignments were assigned to each reviewer according to past experiences [12].
- Reviewers grade and comment on themselves' and peers' assignments (This period lasts about a week).
  1. Students can assess each assignment in a day to alleviate their loading.
- The system notifies the students of their grades and comments.
  1. NetCoP instructs automatically each student to browse the results of peer-assessment and self-assessment via e-mail after the review process.
- Based on the comments on each team's performance, their must make corrections or modifications. (This period lasts about a week).
- The above steps are repeated one more time, twice or not all (researchers can select times of repetition based on their needs).
  1. In this study, teams were requested to re-submit their assignment again.

Each team must present their assignment orally in the front of other teams and instructor after this assessment procedure.

V. DATA ANALYSIS

A. Evaluation of Satisfaction with Regard to Cooperative Learning under NetCoP

- I am satisfied with the team members selected by the team composition program: The result indicated that 86% of the students were satisfied.
- I am satisfied with the team members' contribution to the assignment: The result showed that 89% of the students were satisfied.
- I am satisfied with the team members' attitudes towards completing the assignment: The result indicated that 94% of the students were satisfied.
- I am satisfied with the team members' feedback and assistance: The result showed that 92% of the students were satisfied.
- I acquired considerable interpersonal and small group skills during this course: The result suggested that 94% of the students agreed with this statement.

B. Evaluation of Satisfaction Pertaining to the Task under NetCoP

- This task motivated me to do more work than did the requirements of other courses: The result showed that 83% of the students agreed with this statement.
- This task is important to me: The result showed that 92% of the students agreed.
- I am satisfied with the workload of this assignment: The result showed that 86% of the students were satisfied.
- I am able to follow my team's schedule: The result indicated that 83% of students agreed.
- I can exercise more control over my task in this assignment than I am able to in traditional assignments: The result indicated that 92% of the students agreed with this statement.

C. Evaluation of Satisfaction with Respect to the System used, NetCoP

- In general, I am satisfied with NetCoP: The result showed that 89% of the students were satisfied.
- I find the process of submission of the assignment easy: The result showed that 86% of the students agreed with this.
- I am satisfied with the user interface with regard to the presentation of an assignment on the browser: The result showed that 92% of the students were satisfied.
- I think that the assignment assessment is easy to use: The result showed that 86% of the students agreed.
- I am satisfied with the user interface with respect to the presentation of reviewers' evaluation on the browser: The result indicated that 89% of the students were satisfied.
- I consider the portfolio management system easy to use: The result showed that 86% of the students agreed with this.
- I think the portfolio management system is useful: The result showed that 89% of the students agreed.
- I think the discussion forum program is easy to use: The result showed that 89% of the students agreed with this.

- I find the discussion forum is useful: The result showed that 89% of the students agreed.
- I am satisfied with the user interface with regard to the presentation of course information on the browser: The result showed that 94% of the students were satisfied.

D. Evaluation of Satisfaction Related to the Learning Outcomes under NetCoP

- I should adopt my team's network design at my workplace: The result showed that 86% of the students agreed.
- I am proud of the completed assignment: The result indicated that 94% of the students agreed with this statement.
- I earned the respect of my team members during this learning activity: The result showed that 97% of the students agreed.
- I am more confident now than I was before: The result showed that 94% of the students agreed with this.
- I am satisfied with the outcome of my team: The result showed that 94% of the students were satisfied.

E. Prediction of the Students' Satisfaction by Social Talk and Group-Task-Related Dialogue

Regression analysis showed that students' social talk (β = .89***, t = 13.85, Mean = 7.31, SD = 1.1) affects their satisfaction toward NetCoP (Mean = 3.68, SD = .49). Thus, it can be said that as the students' social talks get more positive, their satisfaction with NetCoP increases.

F. Prediction of the Group Learning Outcome by Social Talk and Group-Task-Related Dialogue

Regression analysis showed that students' group-task-related dialogue (β = .78***, t = 7.16, Mean = 7.42, SD = 1.1) affects their learning outcome on NetCoP (Mean = 7.33, SD = .96). Thus, the result of regression analysis showed that as the group-task-related dialogues demonstrated by students in their group discussion get more constructive, their learning outcome improves.

G. Evaluation of Willingness to Join Similar Learning Activities

I am willing to join learning activities using NetCoP in the near future: The result indicated that 86% of the students were willing to join such learning activities. Feedback from the structured interviews indicated that most of the students regarded the learning activities as being effective and that they benefited from networked cooperative learning with portfolio assessment.

VI. DISCUSSION

The limitations of NetCoP with regard to learning activities, as pointed out by 14% of the students, are as follows: 1) more peer pressure in comparison to other courses, 2) the learning procedures are time consuming, 3) some other teams gave extremely low scores to assignments, and 4) suggestions from other teams were of no use to the assignment. Some of these drawbacks may be regarded as being advantageous for instructors in that the students actively revise their own assignment due to the increased peer pressure. Undoubtedly, the learning activities and the team-forming algorithm should be revised to increase the satisfaction level of the students. In conclusion, the findings of this investigation generally support the prior studies that argued for the importance of cooperative learning and social interaction in increasing students' satisfaction and learning outcome [5], [7].

VII. CONCLUSION

This study examined the students' overall learning satisfaction about NetCoP and cooperative learning activities, and social talks in the group discussion and group-task-related dialogue in the group discussion as the predictors of students' satisfaction and their learning outcome. First, students satisfied with cooperative learning under NetCoP. Most students satisfied with the team members' attitudes toward finishing assignment (94%), the team members' feedback and assistance (92%), the team members' contribution to assignment (89%), and the team members dispatched via team composition program (86%). Many students (94%) also said that they learn a lot of interpersonal and small group skills in this course.

Second, students satisfied with the task under NetCoP. Many students agreed that they have more control over their own work than traditional assignment (92%), this task is meaningful to them (92%), this task interested them to do more work than other courses' requirement (83%), and they can follow their team's schedule (83%). Many students (86%) also satisfied with the load of this assignment.

Third, students satisfied with NetCoP in sum (89%). The shortage of our system, as pointed out by some students, was that speed of uploading and downloading is too slow. Speed of uploading and downloading is related to the outdated network devices. One way to improve this problem is to upgrade those outdated network devices in the near future, or indicate the response times of the download next to the hyperlink to make the response time more predictable (Nielsen, 1999). Many students also satisfied with the user interface of presenting an assignment on the browser (92%), agreed to the usefulness of portfolio management (89%), satisfied with the user interface of presenting reviewers' evaluation on the browser (89%), agreed to ease of use in submitting an assignment (86%), agreed to ease of use in assessing peers' assignment (86%) and so forth.

Fourth, students satisfied with the outcome under NetCoP. Many students agreed that they won the team members' respect during this learning activity (97%), they are proud of the completed assignment (94%), they are more confident than

before (94%), and they should use their own team's network design in their workplace (86%). Many students (94%) also satisfied with the outcome of their own team.

Fifth, regression analysis showed that students' social talk affects their satisfaction toward NetCoP and students' group-task-related dialogue affects their learning outcome on NetCoP. Thus, it can be said that as the students' social talks get more positive, their satisfaction with NetCoP increases and as the group-task-related dialogues demonstrated by students in their group discussion get more constructive, their learning outcome improves. Finally, there are 86% of students do willing to join learning activities via NetCoP in the near future.

Although this study applies heterogeneous ability team composition, the team composition program can be revised to assist with other team composition needs. In some cases, instructors have to compose teams with various homogeneous or heterogeneous characteristics. Therefore, an efficient team composition program may reduce instructors' teaching load in the cooperative learning process. In the future, researchers should continue to design some suitable programs to help instructors assign various types of teams and continue to evaluate the students' satisfaction with cooperative learning activities and students' learning outcome.

ACKNOWLEDGMENT

The author would like to thank the National Science Council of the Republic of China for financially supporting this research under Contract Nos. NSC 94-2520-S-008-007, NSC 96-2520-S-008-003, and NSC 96-2524-S-008-002.

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