Colloquium

Designing a networked-sharing construction environment

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Introduction

Some Internet-based concept mapping systems, whether they emphasize cooperative or individual knowledge construction, have been developed to enhance knowledge construction. For example, in the study of Chiu, Huang, and Chang (2000), 3 to 5 students were grouped to cooperatively construct a concept map through a discussion on-line. Unfortunately, students could "hitchhike" on the work of others due to the innate drawbacks within groups. Many web-cooperative learning studies (eg, Sun and Chou, 1996) also reported when managing group learning on the Internet, that teachers might be confronted by some problems of unequal participation, such as free rider or dominance of any one member in a group. In sum, there is no easy way to ensure students' accountability of their work.

Cooperation may indeed come in different forms and group dynamics. In addition to constructing knowledge through a group discussion, students can share products of knowledge construction with one another: an act that was named "Sharing Construction" by Resnick (1996). To explore this innovative style of web cooperative learning, we thus design a *Net*worked *Shar*ing Construction Environment (NetShare) utilizing a cooperative-competitive learning strategy (hereinafter, CCL) to facilitates participants' equal contribution and interactively links their assignments for accumulative learning.

The cooperative-competitive learning strategy

The CCL strategy requests students, in an on-line learning community, to engage in both an individual and sharing knowledge construction. In implementing this strategy, the learning material must be divided into several units. First, several students are assigned to a group where the group is to learn one unit of the material. Second, students have to read through the assigned unit and individually construct their own concept map (Novak and Gowin, 1984). This stage is called the "Personal Construction Stage".

Then students are asked to integrate concepts of the entire material using the interlinking function of NetShare that is coined as the "Sharing Construction Stage." Through the integration of peers' works, we hope that students are able to gain a more

comprehensive understanding of the whole material. Thus, through the sharing construction process, a student composes his/her own and the peers' concept maps so as to represent the whole material that we define as cooperation. We claim that the CCL strategy is a sort of technologically enhanced, online version of the "jigsaw" learning method (Aronson *et al*, 1978).

Competition herein comes from students striving against each other (in the same group) to gain opportunities for being selected. Cooperation is not in the process of learning, but rather after the knowledge construction has been conducted. In addition, students have plenty of chances to model, compare, and evaluate one anothers' concept maps.

The concept map that is selected by more students can be ranked or scored with a higher grade. Actually, grading has always been a major problem for teachers using concept maps as a way of evaluating students' knowledge (Ruiz-Primo and Shavelson, 1996). For example, experts' concept maps are often used as the criteria in evaluation, but experts' concept maps in fact lack consistency. It also takes a very long time to rate one piece of concept map. We therefore provide an easy and time-saving peer assessment approach for evaluating a concept map. (Liu, Lin, Chiu and Yuan, 2001)

Web site design and technical specifications

The NetShare system is an Internet-based application that performs retrieving and storing information of Data Base Management System through interfaces developed using Microsoft Visual Basic. The NetShare includes two interfaces: personal construction and sharing construction.

While doing a personal concept map, students were not allowed to view others' works so as to prevent inadequate imitation. Before the beginning of the share construction, the personal construction interface can be closed. In a share construction interface, there could in fact be plenty of connections between any two concept maps.

Pilot test of the NetShare system and CCL strategy

Thirty-four computer science freshmen participated in a pilot test for the system. They enrolled in an "Introduction to Computer Science" class at a research university in northern Taiwan. Three groups comprised of 10 to 11 students were formed. For each group, one chapter was assigned for reading and concept mapping. The material was selected from a textbook of C++ and divided into 3 units: Function, Class, and Flow. To read the material, students only had to click a button on the homepage. The pilot test contained the personal and sharing construction stages. Everyone did their own concept map, posted it to the system, reviewed a gallery of all others' works, and then linked to their favorites. After these two stages, students were asked to fill in a questionnaire about subjective experiences and perceptions while using the system.

Preliminary results

The log record shows that the students spent an average of 2.15 hours to read and to construct their concept maps in the personal construction stage. Students responded

in the questionnaire that they invested plenty of mental efforts in constructing a concept map. They agreed concept mapping is an effective learning aide, though it is not easy and is time-consuming.

In the sharing construction stage, students interlinked the best concept maps of chapters other than their own and it took an average of 43 minutes. All students were able to link others' concept maps sophisticatedly: they linked not only the concepts of upper levels in a hierarchy but also the lower level concepts, such as examples. Students expressed a preference for adopting the sharing construction to learn and were satisfied with this functionality. Finally, the majority of the students perceived this innovative learning strategy as valuable.

If a concept map is connected by more people, then it gains a higher personal construction score. At the same time, if a student selects a concept map that has been selected by more peers as their best choices, then this student gains a higher share construction score. The personal construction and share construction scores were weighted 60% and 40% to form a student's achievement (mean = 72.5, SD = 9.94). Those high- ranking students performed remarkably well both in the personal and sharing construction stages. Two experts (the third author and a doctoral student in computer science) confirmed that the best concept maps, decided by the sharing construction community, were well constructed.

Summary and discussion

This study explores the feasibility of a web-based learning system, NetShare, and the cooperative-competitive learning strategy. During the learning process student must carry their responsibility to construct knowledge individually, and then share their products with peers. From preliminary analysis of students' concept maps, we confirmed that students could be taught to use concept map as learning aide. They could also appreciate and selectively use the concept maps shared by peers for the composition of broader knowledge. In addition, we provide an alternative way to evaluate concept map that is relatively easier and time saving.

Though we suggest that the share construction demonstrated in this study is a sort of technologically enhanced, online version of the jigsaw learning method, some people may argue that there is no any dialogue involved amongst the students during either the personal construction or sharing construction stages, so students are not engaged in cooperation. This question actually asks if sophisticated share of products of knowledge construction can be viewed as a form of cooperation? Can web cooperation learning be done without discussion? We must admit that neither social interaction nor discussion is actually happened during the CCL process. This style of cooperation is not typical and may not reach the ideal cooperative learning condition that Johnson and Johnson (1991) promoted in the past decade.

To bring more flavor of cooperation into CCL strategy, teachers can form groups and asking them to cooperatively construct team maps and selectively link products of

others groups though discussion. Future studies can take cultural and gender issues into consideration, because attitudes toward cooperation and competition can differ across cultural contexts.

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