

Computer-Supported Collaborative Problem Solving in the Home Environment

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Abstract: Home is the place where children eagerly seek collaborative activities and friendship that are out-of-reach in their physical environments. A Virtual Homework Center (VHC) is invented for high school students to carry out computer-supported collaborative problem-solving activities in the home environment. VHC gives great importance to interests and preferences of participants. Students can choose a subject or topic in which they are interested, they can invite people of whom they are fond, or join the group with which they feel comfortable. They can set their group work in either collaborative or competitive mode, depending on the preferences of participants. VHC aims at optimizing some of the important conditions for efficient network-based collaboration in the home environment: (a) supports students' self-initiated collaborative problem-solving activities, (b) embeds rich, yet natural, interactions within the system, (c) enables participants to create groups for collaborative work along with a set of collaboration parameters, (d) accounts for the action of each individual and the state of the collaboration in relation to the goal of tasks and, (d) promotes collaborative problem-solving and dialogue among participants in real-time. The main driving element of the collaboration within VHC is to bring the group into a state where a common answer is agreed upon. When this happens, convergence has been attained and the group has reached their collaborative goal.

Keywords: home schooling; computer-mediated communication; high school; mathematics education.

Computer-supported collaborative learning (CSCL) systems are rarely designed to be used outside of the school environment. However, home is the place where children frequently engage in self-directed exploration and thereby develop their curiosity and interest about the world. It is also the place where children eagerly seek collaborative activities and friendship that are out-of-reach in their physical environments. There are three major difficulties in using typical CSCL systems to support collaborative learning activities in the home environment. First, most CSCL systems are developed in the classroom context, the successful implementation of most CSCL systems requires teachers to provide task scenarios, to define goal or purposes, and, to outline rules for dialogue exchange. Such a requirement is rarely met in the home environment. Secondly, the typical functions of the Internet-based CSCL applications remain restrained to *knowledge-transmission* (using the Internet as on-line resources and communication channels) and *knowledge-building* (allowing people in different communities to build a well-structured knowledge database in the forms of text and graphics). However, in order to stimulate and sustain the interests of children, a CSCL system must afford interactive collaborative activities in real-time, more importantly, offer the kinds of fun and challenges that children enjoy. Third, the protocols for establishing typical CSCL systems are not capable of accounting for each individual's actions and the state of the collaboration in relation to the goal of the task, thus, limiting the types of collaborative problem-solving and dialogue among the participants. A Virtual Homework Center (VHC) is invented to meet such challenges.

The VHC is designed for students to carry out collaborative problem-solving activities outside the school environment and independently of their classroom activities. By logging into the VHC, students can find peers with similar interests to chat with, and can do school-related learning activities in game-like fashion. VHC gives great importance to interests and preferences of participants. Students can choose a subject or topic in which they are interested, they can invite people of whom they are fond, or join the group with which they feel comfortable. They can set their group work in either collaborative or competitive mode, depending on the preferences of participants. To support students' spontaneous collaborative problem solving in real-time, VHC aims at optimizing seven important conditions for efficient network-based collaboration: (a) to support students' spontaneous collaborative

problem-solving activities and dialogue among participants in real-time and in game-like fashion; (b) to embed rich, yet natural, interactions within the system; (c) to enable participants to create groups for collaborative work and to set their group work in either collaborative or competitive mode, depending on the preferences of participants; (d) to allow a natural shift in the balance between individual work and group collaboration in function of problem difficulty; (e) to account for each individual's actions and the state of the collaboration in relation to the goal of the task; (f) to allow collaboration to take different forms (discussion, demonstration, sharing of work space), depending on the needs of participants, and, (g) to minimize the need of unnecessary interactions when all participants agree on a solution. The main driving element of the collaboration within VHC is to bring the group into a state where a common answer is agreed upon. When this happens, convergence has been attained and the group has reached their collaborative goal. It speculates that the collaborative activities such as articulation, questioning, demonstration, clarification, argumentation, and critiquing that are anchored in the context of solving specific problems are important for the development of scientific understanding. Thus, the combination of the computer-supported collaborative problem-solving activities and dialogues may enhance student's understanding of scientific concepts and principles more effectively, overcoming difficulties encountered by students learning alone with computers. The VHC presented in this paper is an attempt to combine the interactive multimedia technology with network capacity to build an environment what affords rich student-computer interaction and productive real-time peer collaboration. The below is a brief description of the four basic components and features of VHC:

(1) *The problems format*: VHC is designed to solve a series of short word problems that are suitable to the dynamic nature of the collaborative problem-solving in real-time rather to accomplish a global complex task. These problems are organized by grade level (grade 8 to 12) and by subject matter (e.g., math, history, literature). At present, only one math module is developed. This module is designed to teach algebra to grade-nine students. Each subject matter consists of topics that are represented as lists of problems. Each problem includes a html page which contains a problem scenario, and an input type for the answer (which could be in the forms of text, table, or graph, etc).

(2) *The rules for creating and managing collaborative groups*: When enter the system, a participant can create a new group on a given topic, ask to join a group that is in action, or wait for other's invitation to join the group. When a group is first created, a series of parameters must be defined. The parameters define the rules for controlling the group activities. For instance, the moderator can decide whether a single or multiple groups can be created on a given list of problems (when multiple groups are created, the competitive aspect is added to group work. In this case, the participants within a group must help each other to come up with the correct answer as fast as possible in order to compete with other groups). The moderator can also decide the minimum and maximum number of participants in the group and all decisions concerning the group (accepting participants, changing parameters, continuing to next problem, etc.).

(3) *The nature of logical spaces available for collaborative problem-solving*: In the VHC, the learning environment is divided in several logical spaces to support student's individual work and group collaboration. These logical spaces consist of (a) *an individual workspace* (i.e. each individual has an area to type in the answer, a control to submit the answer, and a control to share this workspace with others), (b) *view workspace* (i.e., this will allow the participants to select and view the work of other if one or more participants have explicitly indicated to share their work), (c) *collaboration status space* (i.e., this consists of the list of all participants with markers indicating if the participant has already submitted an answer or not), and (d) *discussion space* (i.e., this is a standard chat window through which participants can send messages to either the whole group or selected individuals).

(4) *The types of possible collaborative interactions*: In VHC, each participant is located at a different computer and all are trying to come up with the correct answer to the same problem by a combination of individual and group efforts. VHC does not require participants who are working on the same problem to follow the same steps at the same time, rather, it allows participants to try to achieve a solution at their own until the interaction with the group is needed. Therefore, collaboration is required only when necessary or desired by participants. When collaboration is desired by the participants, they can use a white board for discussion and make their individual work public in order to demonstrate their work to the others.

VHC has a facility to keep a trace of all interactions and actions. A natural continuation of the work presented here will be to collect trace data of collaborative work using VHC and to analyze how the variations in group control parameters affect the overall collaborative processes.