Collaborative Learning in an Intelligent Tutoring System

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1 Introduction

Educational research has shown the value of peers learning in a group setting [1]. This educational value of student collaboration for learning purposes has led to the development of computer-supported collaborative learning (CSCL) tools [6] [7]. These tools foster learning in a setting where students are encouraged to communicate with their peers while solving problems. Although CSCL systems provide an exceptional learning environment, they impose an obvious restriction: there must be at least two participants using the system, both of whom are willing to learn through collaboration. In this paper, we will address the issue of providing the same learning experience for a single user that a student would attain from working with his peer.

2 A CSCL Environment for a Single User

Intelligent Tutoring Systems (ITSs) [8] provide students with tailored assistance and coached practice in an interactive environment that motivates active learning. An ITS is typically composed of a student model (containing information about the student that the system uses in making pedagogical decisions), an instructional component (which plans activities to present), a coaching component, and a model of the domain knowledge. Most ITSs are designed to emulate as closely as possible a one-on-one tutoring environment so the student's individual needs are met by the system.

At MITRE, we are incorporating a CSCL environment into our Intelligent Tutoring System (PROPA [3]) by including a learning companion, a simulated peer that collaborates with the student as he works through the exercises. This combination of student/learning companion collaboration and individualized coached practice will allow a student to obtain the help he needs from the tutor while learning by self-explanation – i.e., by explaining his decisions and justifying his actions to his peer (the value of self-explanation is discussed in section 3).

Our learning companion (LC) is an interactive peer who answers students' questions and offers suggestions much like a human peer would. The difference, however, is that LC is available at the student's discretion; the student need not worry about the availability of other student collaborators. LC shares the system's model of the student's knowledge, and therefore potentially shares the student's misconceptions. Consequently, her (LC's) answers and suggestions are sometimes incomplete or incorrect. Unlike other learning companion systems [2], however, she does have access to the expert model of the domain. This allows her to recognize the student's misconceptions, which may be useful to the coaching component for instructional purposes [9]. LC encourages the student to evaluate her sometimes misleading suggestions, justify his own decisions, and consider and analyze alternative courses of action.

3 The Value of Self-Explanation

Requiring a student to think about his past actions and explain their consequences, or further evaluate his proposals and future intentions through collaboration encourages him to learn from his mistakes and reconsider his decisions. Chi et al [4] showed that asking students to explain the solutions to solved physics examples helped them understand the sequence of steps needed to solve the problems, and later they became more efficient in solving similar problems.

A study Levi and Tetlock conducted during meetings by the Japanese high command during the year before the bombing of Pearl Harbor showed that the members explained and justified their decisions more during meetings in which the decisions needed to be communicated than in meetings where decisions were actually made [5]. These studies and others [10] [11] suggest that communicating ideas to a peer or in a group setting encourages self-explanation and justification, both of paramount instructional value.

In PROPA, after LC engages in a dialogue with the student, she often encourages him to justify his decisions or to explain his proposals. The following describes a typical interaction with LC. The student asks a question, using a menu-driven interface, and LC responds to the question based upon her current knowledge (partly determined by the student model). The student must then evaluate LC's response by agreeing, disagreeing, inquiring as to why LC responded the way she did, or offering an alternative suggestion. LC will respond either by evaluating the student's response, or by requesting a justification or explanation. After the student explains his position, LC will comment on his argument. An actual example dialogue between LC and a student is shown below.

Student:	Do you think my last action was appropriate? *(Last action was finding some data to support a proposed hypothesis)*
LC:	No. I think your last action was inappropriate.
Student:	I disagree with you.
LC:	Why do you think it was appropriate?
Student:	The data supports some evidence related to the hypothesis.
LC:	I think that's a good reason.

Table 1: Example Dialogue between Student and LC

4 Conclusions and Future Work

A learning companion such as LC in an intelligent tutoring environment both ensures the availability of a collaborator and encourages the student to learn through self-explanation, while utilizing the instructional advantages that ITSs provide. This paper outlines only the skeleton of possibilities a simulated peer could offer for a student. Since the peer is controlled fully by the ITS, it could be designed to suggest interesting ideas the student hadn't considered, or intentionally make mistakes and then assess the student's response. A simulated peer with these capabilities could provide similar value in a CSCL environment working with groups of students.

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