

## Flexible support for collaborative learning in the context of the Algebra I Cognitive Tutor

Nikol Rummel, Dejana Diziol, Hans Spada

Bruce McLaren, Erin Walker, Ken Koedinger

Our research investigates whether we can *improve learning with an intelligent tutoring system*, the Algebra Cognitive Tutor developed by Koedinger, Anderson, and others at Carnegie Mellon University and distributed to over 2000 US schools by Carnegie Learning, Inc., *by adding collaborative learning elements to the software*. Traditionally the Algebra Cognitive Tutor has been used in one-on-one (machine-to-student) fashion. As part of this research, we are developing a technical architecture that allows us to implement a *collaboration tutor module* supporting the students' interaction in combination with the domain tutor module of the existing Algebra Cognitive Tutor. This collaboration tutor module has two components. For one, it has a fixed *script component* that divides the collaborative problem-solving process in a number of steps/phases and designates particular activities and roles to participants for each step/phase. This tutor component listens for messages about the current state of the problem-solving process from the interface tools of the Algebra Cognitive Tutor and provides collaborative instruction based on those messages. For instance, after the students are finished graphing the lines corresponding to the equations of a given story problem, the script instructs them to mutually negotiate the meaning of the underlying concepts such as "slope" and "y-intercept" by comparing both the two lines and the two equations. The script component is flexible in that it reacts to the students' actual problem-solving progress. It is fixed, however, in the order of steps/phases that it follows, and in the instruction it provides for each of those. Secondly, the collaboration tutor module has an *adaptive component*. Similar to the Algebra Cognitive Tutor, this component reacts to specific student actions by comparing these actions to a model of good problem-solving and accordingly providing adaptive support. For example, following the first error made by students when answering a question, the tutor will ask them to consult with their partner. However, if repeated errors are being made on the same question, the collaboration tutor will instruct them to ask the domain tutor module for a hint to find the correct answer. This component is adaptive in that it only provides instruction if a particular student action indeed occur. In the longer run we plan to develop further elements of a Collaboration Tutor that can assess the collaboration process from student actions and provide adaptive support.