Task and Interaction Regulation in Controlling a Traffic Simulation

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ABSTRACT

In collaborative problem solving, metacognition not only covers strategic reasoning related to the task but also reasoning related to the interaction itself. The hypothesis underlying this work states that regulation of the interaction and regulation of the task are closely related mechanisms and that their co-occurrence facilitates coordination. These assumptions are tested experimentally with a traffic simulator. The results show that co-occurrence of task and interaction regulation allows quicker solving of the problem, thus better performance. The experimental treatment aims at observing the effects of interaction meters on the accuracy of subjects' estimation of their participation. Interaction meters are visualization tools that represent the number of contributions related to the discussion and to the implementation of the solution.

Keywords

Metacognition, task regulation, interaction regulation, reflective tools, interaction meters

INTRODUCTION

In this paper, we present results from an experimental study investigating two aspects of metacognition at work in collaborative problem solving, namely, task and interaction regulation. The task we used consists of controlling a traffic simulation by tuning the green-red periods of traffic lights in order to reduce waiting time at intersections.

Task regulation is one aspect of metacognition as defined by Schoenfeld (1987) and Brown (1987). It includes knowledge about one's own cognitive processes, action regulation and control, as well as intuitions and conceptions about the context the activity takes place in. We focus here on the second aspect, which includes planning forthcoming actions, supervising current activities and evaluating past actions. In its initial formulation, metacognition is described as a mechanism in individual problem solving. Does the concept of metacognition scale up to a group of individuals who solve a problem? Nickerson (1993) asks this question in the context of the distributed cognition approach (Salomon, 1993). This approach considers a group of persons and the tools they use as a single cognitive system and the question is if such a system also has metacognitive skills.

Interaction regulation consists of organizing work inside a group by defining roles or defining and assigning sub-tasks to participants. We make the general hypothesis that simultaneous regulation of task and interaction is more efficient than regulation of the task alone because it leads to a better coordination of actions.

In order to address the question of the conditions that foster integration of task and interaction regulation we designed a tool that functions like a mirror for the pair's activity. This approach consists in coaching and regulating the interaction as it unfolds (Jermann, Soller & Muelhenbrock, 2001). Subjects are presented a constantly updated visualization of their participation while they solve the task. We refer to these dynamic visualizations as interaction meters. They represent participation in talk and task related actions through bar charts that show the number of messages and the number of problem solving actions. The design rationale of interaction meters is that they might give subjects a better representation of their participation as well as of the role they play in the problem solving process. Interaction meters reify participation and work organization. Our hypothesis is that interaction meters help subjects build and maintain a more accurate model of interaction.

METHOD

In order to test our assumptions, we designed two types of interactions meters. The first compares subjects by representing their participation side by side as two bars ('comparative' condition). The second represents participation cumulated across subjects, i.e. one bar chart represents the sum of the subjects' contribution to discussion and another bar chart represents the sum of the subjects' problem solving actions ('cumulated' condition).

Subjects were recruited through the subject pool associated with introductory psychology classes offered by the University of Pittsburgh. 98 undergraduate students participated in the experiment that was held at the Learning Research and Development Center (LRDC). The pairs were assigned randomly to either the control condition (without interaction meter) or one of the two experimental conditions. The complete duration of an experimental session was about two hours including a 40 minutes long tutorial and a 60 minutes long collaborative problem solving phase.

A snapshot of the simulation tool can be found online at http://tecfa.unige.ch/~jermann/sputnik/snapshots.html

RESULTS

The goal of the subjects was to bring the average waiting time of cars below 20 seconds and maintain it below this limit for 2 minutes. After examining dialogues produced by the 49 pairs, we decided to drop 6 pairs from the analyses. Out of 43 pairs, 39.5% (N=17, referred to as 'failed') failed and 60.5% succeeded (N=26). Due to the high percentage of successful pairs, we further distinguished between the pairs that reached the objective in less than half an hour (N=10, 23.3%, referred to as 'super') from those who succeeded in more than half an hour (N=16, 37.2%, referred to as 'normal').

Pairs that solved the problem in less than half the time allocated are differing from others by several simple traits: they talked relatively more than they executed problem solving actions (F=6.137, p=0.05 with LSD post hoc test; 'super' > 'normal', p=.020 and 'super'> 'failed', p=.001); they produced elaborated plans more frequently (F=2.915, p=.066 with LSD post hoc test; 'super' > 'failed', p=.021). But most important, and supporting our hypothesis that the co-occurrence of task regulation and interaction regulation would lead to a better performance, 'super' successful pairs more frequently produced planning sequences containing explicit references to one member of the group (F=4.233 p=.022 with LSD post hoc test; 'super'>'failed' p=.01 'super'>'normal' p=.015). In other terms, when deciding "what to do", these pairs also tend to decide "who does what".

The results concerning estimation of participation in problem solving actions were compatible with our hypothesis, suggesting that the 'comparative' version of the interaction meters is more helpful than the 'cumulated' version and than the absence of interaction meter. The correlations between the estimation of participation in tuning and the effective participation are r=.744 (p=.000, N=26) for the 'comparative' interaction meter, r= .404 (p=0.41, N=26) for the 'cumulated' interaction meter and r=.403 (p=.018, N=34) for the condition without interaction meter. There is no difference between the comparative and cumulated conditions when comparing the number of times subjects visited the interaction meters. However, on a 7 point lickert scale from very often to very rarely, subjects in the comparative condition stated that they looked up the interaction meter more often (m=3.1, sd=1.4704) than the subjects in the cumulated condition (m=4.23, sd=1.3309) (F=9.797 p=.003). Results for the estimation of participation in discussion were less clear maybe due to the fact that discussion, by essence, requires both individuals to participate, and estimating a difference in participation for such a collaborative activity might sound misleading.

So far, we focused the analysis of results on subject's estimation of participation in the interaction, but other components of a psychological model of interaction would be interesting to investigate. For instance, we might investigate whether subjects are able to perceive roles and what kind of tool would be useful to raise their awareness about their function in the group.

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