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Information Sharing is Incongruous with Collaborative Convergence: The Case for Interaction

Daniel Suthers, Richard Medina, Ravi Vatrapu, Nathan Dwyer
Laboratory for Interactive Learning Technologies
Dept. of Information and Computer Sciences, University of Hawai`i at Manoa
collaborative-representations@hawaii.edu

Abstract: Various authors have placed information sharing at the core of successful collaborative problem solving and learning. In this paper we report analyses of an experimental study that bring the sufficiency of an information sharing account of collaboration into question. One treatment group achieved greater convergence and integration of information in their handling of a complex problem, yet this same group shared *less* information in a hidden profile design. The pattern of convergence is more closely mirrored by *interactivity* quantified as the number of "round trips" addressing the same information items.

Introduction

A central tenet of much research on group problem solving and learning in CSCL and related fields is that information sharing is the primary operative mechanism of effective group performance. For example, contribution theory (Clark & Brennan, 1991) postulates processes by which interlocutors verify that they have successfully shared information. A productive research strategy in social psychology involves the "hidden profile" (Stasser, 1992) in which information is distributed across participants and then group processes are tracked and evaluated in terms of how this information is shared. Common findings include the failure to share information and the failure to use information effectively once it has been shared (Dennis, 1996). In CSCL, Pfister (2005) tells us that "going from unshared to shared information is the gist of cooperative learning," yet Fischer and Mandl (2005) find that the relationship between information sharing during collaboration and individual learning outcomes is not correlative. Their results suggest that information sharing does not sufficiently explain outcome measures of convergence, although differences were seen between factual and "application oriented" information. The present paper also questions the adequacy of information sharing as the basis for understanding collaborative outcomes.

The analyses presented in this paper were motivated by an interesting combination of empirical results obtained in an experimental study that was based on the hidden profile paradigm (Suthers, Vatrapu, Medina, Joseph, & Dwyer, 2007). Pairs in one treatment condition performed better on outcomes measures related to collaborative knowledge construction: integration of multiple sources of information and convergence on similar solutions. From this, one would expect that the pairs in this treatment condition also shared more information. Problematically, the treatment conditions did not differ in information sharing as evidenced by the information that participants referenced in their essays, nor on their memory for facts one week later. Those measures of information sharing were based on the products of the experimental sessions (essays and a post-test): more direct measures of information sharing were needed. In the follow-up study summarized in the present paper, we measured the information sharing that took place in the sessions themselves by tracing information that was given to only one or the other participant at the outset. Surprisingly, we found that pairs in the higher performing condition shared *less* information in the session: a serious challenge to the information-sharing explanation of group performance. An alternative explanation was needed, for which we turned to interaction. In information sharing, a participant expresses something in some medium and another participant accesses this expression. The smallest interactional extension of this basic act is a "round trip" of uptake: the second participant takes up that which was expressed by the first participant by forming a new, related expression, which then is accessed by the first participant. Accordingly, we measured interaction in terms of these round trips. By this measure, participants in the higher performing treatment condition (which shared less information) interacted more than participants in the other conditions. The incongruence of the distribution of information sharing together with the congruence of the distribution of round trips suggests that it is worth examining the practices by which participants integrate multiple sources of information and converge on common solutions. This paragraph has outlined the entire argument of the paper. Below we summarize the key analyses before concluding with a brief discussion.

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Prior Results on Convergence and Integration

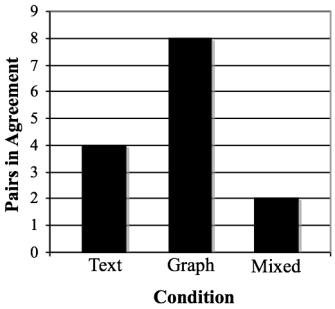

Figure 1. Pair agreement

The present paper is concerned with how well information sharing and interaction account for a pattern of results found in a prior study, rather than with the specific question addressed by that study. See the companion paper in this volume (Suthers, Vatrapu et al., 2007) for details. The primary result of interest is that pairs in the Graph condition were more likely to converge on the same conclusion than pairs in the other conditions ($\chi^2(2, N=30)=7.5$, p=0.025): see Figure 1. This suggested that Graph users may have shared more information, but analysis of essay contents did not back up this interpretation: participants in all conditions were equally likely to cite information that was originally given to their partner. Also, Graph users performed significantly better than Mixed users on the "high integration" questions of the post-test ($F(2,57)=4.40$, $p=0.0167$), suggesting that they were able to more effectively bring relevant and distributed information together. However, comparison of participants' performance on memory for information that they received versus memory for information given to their partners yielded no significant difference, again suggesting that information sharing was not the operative mechanism.

The Information Sharing Analysis

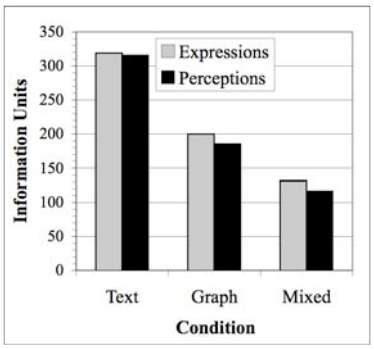

Figure 2. Information sharing

The essays and post-test are only indirect measures of information sharing. We undertook an analysis to test the possibility that Graph participants achieved integration and convergence by sharing more information *during* the session. This analysis was based on tracing information distributed according to a hidden profile in materials given to participants (Suthers, Vatrapu et al., 2007). An information sharing event consists of the sequence in which (1) P_a (participant A) perceives information that had been given uniquely to him or her, (2) P_a expresses that information in a shared workspace, and (3) P_b (participant B) perceives that expression (objects required a specific action in order to be read). The total number of such events was summed for each pair (the dyad is the unit of all analyses). The 401 information units that were uniquely provided to only one participant define the total number of information sharing events possible under this analysis. Results (Figure 2) show that more *expressions* (2) of the information units and more *perceptions* (3) of these expressed information units were made in the Text condition compared to Mixed and Graph conditions. A one-way ANOVA of perceptions of information units indicates that this data would be highly unlikely if there were no differences on information sharing ($F(2, 27)=13.54$, $p<0.0001$). The difference between Text and Graph falls within a Bonferroni 95% confidence interval. From this analysis, information sharing cannot account for the convergence and integration outcomes. The distributions in Figure 1 and Figure 2 are completely different. It would have been problematic enough if there were no differences between groups, but the result that the Graph users actually shared *fewer* information items than Text users completely invalidates an information sharing account.

The Round Trip Analysis

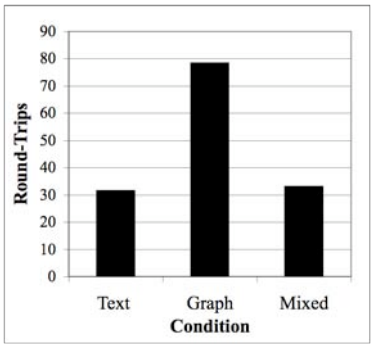

Figure 3. Round trips

Process analyses in the prior study showed that Graph users elaborated on hypotheses significantly more than Text users (Suthers, Vatrapu et al., 2007). Although these analyses counted individual acts in isolation, the results suggest that Graph participants are achieving integration and convergence through continued interaction around previously expressed ideas. "Interaction" is potentially a complex idea: it includes the basic act that we are calling "information sharing" and extends to diverse forms of discourse. To conduct a quantitative analysis we need to identify the simplest possible unit of interaction that is distinguishable from information sharing. Given that we have defined information sharing as including (2) the expression by a participant P_a of an idea related to a topic that is (3) perceived by P_b, the next interactive step that can be taken beyond information sharing is for (4) P_b to express a related idea that is then (5) perceived by P_a. In this "round trip," intersubjectivity forms: P_a has expressed and seen his or her expression interpreted by P_b. In order to place this analysis on the same foundation as the

information sharing analysis, we decided to include only round trips that involved an information item that was (1) uniquely given to P_a. The results (Figure 3) showed that more round trips were made in the Graph condition compared to Mixed and Text conditions, following the pattern of Figure 1. A one-way ANOVA on number of round trips suggests that these results are not likely if the groups were equivalent on interactivity ($F(2, 27)=3.03$, $p=0.0648$), but pairwise differences did not fall within a Bonferroni 90% confidence interval. This study was limited to tracing round trips addressing factual knowledge: further work could trace the development of hypotheses.

Discussion

This work does not take a stance on whether convergence is desirable. Rather, the point is that a difference in convergence and integration was observed that cannot be accounted for by information sharing, but the simple addition of a reply changes the picture entirely. Although the last test reported does not meet the traditional cutoff of $\propto \leq 0.05$, following Gigerenzer (2004) we view probabilities as properties of the data to be reasoned about in context, rather than as input to a mechanical decision procedure. The combination of results—more elaboration in the graph condition, a pattern of round trips that is unlikely yet congruent with the pattern of convergence we seek to explain, and an incongruent pattern of information sharing—rules out information sharing as an adequate explanation and is sufficient to suggest that interaction is worthy of further study as the basis for knowledge integration and convergence in collaborative learning. Currently, much empirical work in CSCL (as well as some of its sister fields) remains focused on information sharing, while we lack an equally comprehensive research program on whether and how interaction adds value for collaborative learning beyond information sharing. The strategy taken by this paper as a contribution to the ongoing methodological and theoretical dialogues within CSCL is to demonstrate that it may be profitable for those working in an experimental paradigm to examine interaction in order to account for quantitative results. Further, we advocate alliances with those who work in analytic paradigms that delve systematically into interaction (e.g., Stahl, 2007; Suthers, Dwyer, Medina, & Vatrapu, 2007 in this volume). As a topic of study, interaction has potential to unify our field by being the shared object of analysis between researchers in multiple methodological traditions.

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