Collective Information Practices to Sustain Knowledge Work Over Time

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To sustain their collaborative activities, members of knowledge-building teams must engage in a set of interactional practices to "bridge" the discontinuity of their multiple episodes of collaboration over time, their multiple knowledge tasks, and the naturalistic changes in group participation over time. The central goal of our research involves understanding such information practices and the role that "bridging activity" might play in the building of collaborative knowledge over time. In addition, we reflect on the design of collaboration support tools related to bridging information practices. Here we present an analysis of the collective information practices of virtual teams engaged in sustained collaborative problem-solving as part of the Virtual Math Teams (VMT) online community. Our analysis shows that all virtual teams, although with some variation, oriented to the discontinuity of their multiple episodes of collaboration over time, their multiple tasks, and the various participating collectivities, and engaged in a range of related bridging practices. These information practices appeared to be central to constituting both the *diachronic* continuity of the knowledge work of an individual virtual team and the *expansive* continuity of a larger collective of virtual teams.

Knowledge Building - the creation, testing, and improvement of conceptual artifacts (Scardamalia & Bereiter, 2006), is essentially information activity carried out through a set of practices aimed at developing and advancing a person or a group's understanding of a question, a problem, a decision, or any other knowledge gap. Knowledge building is at the core of many human contexts including, for example, learning (Scardamalia, 2002; Stahl, 2006a) the use of digital libraries (e.g., Bearman, 2007; Fox & Urs, 2002) and participation in virtual communities (e.g., Barab, Kling, & Gray, 2004; Ellis, Oldridge, & Vasconcelos, 2004; Renninger & Shumar, 2002). Naturally, knowledge building is a complex and challenging enterprise whether conducted online or not. Divergent perspectives often lead to problems of understanding; different work styles can result in interactional breakdowns, while the distributed nature of joint action over time usually leads to gaps of awareness and problems of coordination. To sustain their collaborative activities, members of knowledge-building teams must engage in a set of interactional practices to "bridge" the discontinuity of their multiple episodes of collaboration over time, their multiple tasks, and changes in group participation. The longitudinal engagement that knowledge building usually requires, adds a very particular set of interactional challenges.

Discontinuities emerging from long-term knowledge building have been studied from a number of different perspectives, including, the study of individual and group creativity (e.g. Amabile, 1983; Sawyer, 2003) , the fields of Small-group Research (Arrow et al., 2000; Bluedorn & Standifer, 2004) and Computer-supported Cooperative Work (CSCW), as well as in Knowledge Management (Greenberg & Roseman, 2003; Ishii et al., 1993). Despite the widespread interest in this crucial topic, most studies have concentrated solely on characterizing the outcomes of groups and communities who successfully overcome discontinuities but few descriptions have been offered of the information practices that lead to such outcomes. Among these outcomes we can list the existence of "information bridgers" in group-to-group collaboration (Mark, Abrams, & Nassif, 2003), the use of boundary objects in interdisciplinary collaboration (Star, 1989), the emergence of "shifting epistemologies" (Bielaczyc & Blake, 2006), and the growing orientation to collective knowledge advancement in communities (Scardamalia, 2002).

Our interest lies in characterizing specific information practices used to overcome relevant gaps in collective knowledge building that is sustained over time. In fact, by pursuing the study of virtual teams we capitalize on the ways in which online contexts make the information practices of knowledge building more visible. This represents a very unique opportunities to advance our understanding of how individuals, small groups and the larger community build, evolve, and expand knowledge. The central goal of our research involves understanding the information practices of virtual teams and the particular role that "bridging practices" might play in the building of collaborative knowledge over time. In addition, we explore the design of collaboration support tools related to bridging information practices. Next we present an analysis of the collective information practices of virtual teams engaged in sustained collaborative problem-solving as part of the Virtual Math Teams (VMT) online community.

The Math Forum (http://mathforum.org) is an online community, active since 1992. It promotes technology-mediated interactions among teachers of mathematics, students, mathematicians, staff members and others interested in learning, teaching and doing mathematics. The Virtual Math Teams (VMT) project at the Math Forum investigates the innovative use of online collaborative environments to support effective mathematical work by small groups. In the VMT project, small groups of students come together to work through a special online environment that provides them with an array of tools to conduct their collaborative problem-solving activity, sustain it over time, and interact with other interested individuals and groups (Wessner et al., 2006). In order to explore issues of continuity and sustainability of collaborative knowledge building online, we conducted two case studies within VMT. In each one, five virtual teams were formed with about four non-collocated secondary-school students selected by volunteer teachers at different schools across the United States. The teams engaged in online math discussions for four hour-long sessions over a two-week period. They used the VMT virtual room environment (Wessner et al., 2006) which combines a persistent chat tool with a shared whiteboard in addition to some other interactional supports. At the start, the teams were given a brief description of an open-ended mathematical situation and were encouraged to generate and pursue their own questions about it. Later on, the teams were given feedback on their prior work and the work of other teams and were encouraged to continue their work. A combination of synchronous team work and asynchronous team-to-team interaction using a Wiki was available to participants in the second case study.

The goals of our analysis were to understand how teams of participants in the VMT online community managed the apparent discontinuity of their interactions (e.g. multiple collaborative sessions, teams and tasks), and to explore the relationship between such activity and the teams' knowledge building over time. We employed the approach of ethnomethodology (Garfinkel, 1967) to examine the sequences of events by using recordings and artifacts from each team sessions. As part of the phenomenological perspective, ethnomethodology is based on naturalistic inquiry to inductively and holistically understand human experience in context-specific settings (Patton, 1990). For our purposes, we examined each of the 37 sessions recorded, paying special attention to the sequential unfolding of the problem-solving episodes in which each team participated. Constant comparison through the entire dataset led to our refinement of the structural elements that define the information practices presented in the remaining parts of this paper.

Our analysis revealed a series of information practices which allowed the teams to cross over the boundaries of time and link together different episodes of collective action. All VMT teams, although with some variation, oriented to the discontinuity of their multiple episodes of collaboration over time, their multiple tasks, and the various participating collectivities, and engaged in a range of related "bridging" practices. These "bridging" practices can be characterized as collective information activities that integrate, as resources for action, (a) the establishment and use of the temporal or sequential episodes of problem solving, (b) bridging knowledge artifacts, and (c) the positioning of actors in expanded participation frameworks. Four main types of interactional practices were identified, by means of which co-participants created and maintained a joint interactional "space:" Reporting, Collective Re-membering, Projecting, and Bridging across teams.

Bridging practices are central to the creation and maintenance of a "Joint Knowledge Field" —an extended interactional space of collaborative knowledge building with three dimensions that are of

primary concern to participants: knowledge, participation, and the sequential or temporal unfolding of experience. The first two dimensions have previously been identified in the literature, while the third one has not been explicitly analyzed previously. The temporal structure of the interaction is constituted by the bridging activities of the participants. Bounded episodes and sequences of interaction are extensively used by participants as resources to manage the other two central dimension of their joint interaction: knowledge and participation. Through bounded episodes and sequences participants get positioned in particular participation frameworks and knowledge artifacts get constituted in networks of meaning. The use of reporting, collective re-membering and projecting bridging practices allows a virtual team to purposefully constitute its interactions as part of a punctuated but diachronic trajectory of building collaborative knowledge. Bridging across teams allows a virtual team to constitute its interactions in a field of expansive continuity that attempts to connect the activities, artifacts, and situated actors of multiple virtual teams.

Our analysis suggests that collective bridging practices allow team members to reconstruct their perception of their individual and collective trajectories of participation and plays a central role in helping individuals unite the elements of their own past and present experience with the present and future possibilities for action in their ongoing interactions with others. The configurations of positions and resources that co-participants put forward through interaction often change within one collaborative session as well as across a team's trajectory over time. These changes constitute and are sensitive to the participants' evolving sense of agency and represent the evolving co-construction of reasoning routines and other forms of joint participation uniquely related to the local and longitudinal knowledge-building goals. Finally, the range of bridging practices deployed by virtual math teams appears to be sensitive to different configurations of elements in the VMT activity system. Particularly relevant to bridging are the changes in team membership, the interconnectedness of the different knowledge tasks that teams worked on, the type of feedback provided to teams, and the interactional possibilities for intra-team and inter-team communication afforded by different online environments.

The successful construction and maintenance of a joint problem space constitutes a central challenge of effective collaborative knowledge building (Roschelle & Teasley, 1995; Stahl, 2006b; Suthers, 2005). Several studies in the field of computer-supported collaborative learning have shown that the interactional manner in which this intersubjective problem space is created and used determines the success of the collaborative experience (e.g., Barron, 2003; Chi, 2000; Dillenbourg et al., 1995; Hausmann, Chi, & Roy, 2004; Koschmann et al., 2005; Wegerif, 2006). Our present analysis has shown that this challenge escalates in contexts characterized by longitudinal activity across multiple collectivities but that specific information practices can be deployed for teams to manage this complexity. To establish continuity and sustainability, virtual teams and online communities "bridge" multiple elements of their interactions continuously a very consequential undertaking that lies at the core of effective collective knowledge building.

References

Barab, S. A., Kling, R., & Gray, J. H. (Eds.). (2004). Designing for virtual communities in the service of learning. Cambridge, UK: Cambridge University Press. Barron, B. (2003). When Smart Groups Fail. *Journal Of The Learning Sciences*, 12 (3),307-359.

Bearman, D. (2007). Digital libraries. In B. Cronin (Ed.), Annual review of information science and technology (pp. 223-272): American Society of Information Science and Technology (ASIS&T). Chi, M. (2000). Self-explaining expository texts: The dual processes of generating inferences and repairing mental models. In R. Glaser (Ed.), Advances in instructional psychology (pp. 161-238). Hillsdale, NJ: Lawrence ErlbaumAssociates.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1995). The evolution of research on collaborative learning. In P. Reimann & H. Spada (Eds.), Learning in humans and machines: Towards an interdisciplinary learning science (pp. 189-211). Oxford, UK: Elsevier.

Ellis, D., Oldridge, R., & Vasconcelos, A. (2004). Community and virtual community. In B. Cronin (Ed.), Annual review of information science and technology (pp. 145-186): American Society of Information Science and Technology (ASIS&T).

Fox, E. A., & Urs, S. R. (2002). Digital libraries. In B. Cronin (Ed.), Annual review of information science and technology (pp. 503-589): American Society of Information Science and Technology (ASIS&T).

Garfinkel, H. (1967). Studies in ethnomethodology. Englewood Cliffs, NJ: Prentice-Hall.

Hausmann, R., Chi, M., & Roy, M. (2004). Learning from collaborative problem solving: An analysis of three hypothesized mechanisms. Paper presented at the 26nd annual conference of the Cognitive Science society Proceedings pp. 547-552.

Koschmann, T., Zemel, A., Conlee-Stevens, M., Young, N., Robbs, J., & Barnhart, A.(2005). How do people learn? In F. H. R. Bromme & H. Spada (Eds.), Barriers and biases in computer-mediated knowledge communication. Amsterdam: Kluwer Academic Press.

Mark, G., Abrams, S., & Nassif, N. (2003). Group-to-group distance collaboration: Examining the 'space between'. In K. Kuutti, E. H. Karsten, G. Fitzpatrick, P. Dourish & K. Schmidt (Eds.), Proceedings of the 8th european conference of computer-supported cooperative work (ecscw 2003) (pp. 99 - 118). Helsinki, Finland.

Renninger, K. A., & Shumar, W. (2002). Building virtual communities. Cambridge, UK: Cambridge University Press.

Roschelle, J., & Teasley, S. (1995). The construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), Computer-supported collaborative learning (pp. 69-197). Berlin, Germany: Springer Verlag.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), Liberal education in a knowledge society (pp. 67-98). Chicago: Open Court.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In R. K. Sawyer (Ed.), Cambridge handbook of the learning sciences. Cambridge, UK: Cambridge University Press.

Stahl, G. (2006a). Group cognition: Computer support for collaborative knowledge building. . Cambridge, MA: MIT Press.

Stahl, G. (2006b). Sustaining group cognition in a math chat environment. Research and Practice in Technology Enhanced Learning, 1 (2), 85-113.

Suthers, D. (2005). Technology affordances for intersubjective learning: A thematic agenda for cscl. Paper presented at the international conference of Computer Support for Collaborative Learning (CSCL 2005), Taipei, Taiwan.

Wegerif, R. (2006). A dialogic understanding of the relationship between cscl and teaching thinking skills. International Journal of Computer-Supported Collaborative Learning (ijCSCL), 1 (1), 143-157.

Wessner, M., Shumar, W., Stahl, G., Sarmiento, J., Muhlpfordt, M., & Weimar, S. (2006). Designing an online service for a math community. Paper presented at the International Conference of the Learning Sciences (ICLS 2006), Bloomington, Indiana.