Coordinating Collaborative Action in Online Math Problem Solving

Alan Zemel, Gerry Stahl
Drexel University, 3141 Chestnut St. Philadelphia, PA 19104,
Email: arz26@drexel.edu, gerry.stahl@ischool.drexel.edu

Abstract: Collaboration is understood as a central theme in CSCL studies. In this paper, collaboration is explored in terms of the ways that interactants in a CSCL setting transition from one activity to a next. Rather than simply initiate a next activity upon completion of a current activity, students using the Virtual Math Teams (VMT) environment initiated next-sequence selection sequences, making the choice of a next activity a collaborative matter. While differences in skill and competency may mask the collaborative orientation of actors engaged in math problem solving, the way actors transition from a completed activity to a next activity will demonstrate their orientation to collaboration. In this paper, different next-sequence selection sequences as they are deployed in VMT sessions are identified, described and examined for how they support collaboration.

Collaboration and the Coordination of Action

Social interaction is comprised of sequences of actions (Schegloff & Sacks, 1973; Sacks, 1992; Schegloff, 2007). When one interaction sequence is completed, a transition to another sequence becomes relevant. How the transition between sequences is accomplished is both consequential for and a consequence of the way participants conduct themselves within sequences. In face-to-face interactions, turn-taking mechanisms and next-actor selection procedures regulate the manner in which sequential interactions are conducted and the manner in which transitions between sequences of interaction are achieved. Since the affordances of online chat environments are different from those in face-to-face interaction, intra-sequential conduct and transitions between sequences will be different as well.

Collaboration is foundational to CSCL as an essential component in the production of shared knowledge. One way that groups do 'being collaborative' involves the way they organize themselves to accomplish learning tasks (Cakir, Zemel & Stahl, 2009; Sarmiento & Stahl, 2008). There are a number of different ways that CSCL construes collaboration. According to Lipponen (1970, p. 73), collaboration can be considered "a special form of interaction or as a process of participation." Rochelle and Teasley (1995) define collaboration as "*a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem*" (p. 70, emphasis original). Alternatively, "[c]ollaboration can be defined as a *process of participating in knowledge communities*" (Lipponen, 2002, p. 73, emphasis original). The challenge for CSCL is to specify in detail how such coordination of activity achieved, how shared conceptions are accomplished, how participation in knowledge communities is done and of what that participation consists. One way to do this is to describe in detail the way actors coordinate and manage the sequence of their activities in CSCL environments. From a CSCL perspective, the problem of initiating a next sequence raises interesting issues about collaboration, decision-making and the way learning's work is organized and accomplished. When, upon completion of a current sequence, the initiation of a next sequence becomes a decidable matter for the assembled participants in CSCL setting, the process by which actors participate in the choice of a next sequence is evidence of and informed by their commitment to collaboration.

The transition from one sequence to a next is a concern both to CSCL and to Conversation Analysis (CA). In CA, such transitions have been discussed in terms of the organization of long sequences (Sacks, 1992) or sequences of sequences (Schegloff 2007). While the sequential organization of action has been the principal object of conversation analytic research, the detailed interactional procedures by which actors initiate next-sequences of action upon the completion of a current action sequence is an underdeveloped arena of investigation. CSCL environments provide CA analysts with the opportunity to examine the manner by which actors transition from one activity to another (Zemel, 2009). CA provides CSCL with the opportunity to understand the procedural organization of collaboration as a methodical set of shared procedures of interaction to which participants orient in the conduct of their affairs.

In this paper, CA methods are used to identify four procedures by which transitions between sequences of actions are accomplished. One of these procedures is an example of what might be seen as a non-collaborative method of next sequence selection. Three of these procedures can be considered collaborative in the way they organize the participation of actors in the accomplishment of next sequence selection. These four examples provide a basis for making certain preliminary observations regarding what is collaborative about collaboration.

Data and Methods

The data consist of time-stamped chat logs and whiteboard displays of math problem solving sessions among middle school students. Specific excerpts were taken from the chat sessions of Team B in the VMT Spring Fest 2006. This event featured four teams (Teams A through D) who participated in four consecutive sessions over a two-week period. The chats were sponsored and conducted by the Math Forum of Drexel University as part of its participation in the Virtual Math Teams (VMT) research project, an NSF funded project at Drexel University (Stahl, 2009). Analysis was conducted using complete logs of the chat sessions in conjunction with a software "player" that affords the possibility of reproducing the display of VMT activity as delivered from the servers. The player displays the integrated and coordinated use of chat and whiteboard technologies incorporated into the VMT system. Additionally, this player software permits the various "speeds" of playback as well as the ability to step through actions one at a time.

CA is the specific analytical methodology applied to the data. Sacks (1992) and his students developed this analytical approach in the 1960's and 1970's. It shares a phenomenological orientation with ethnomethodology, presuming that the analytical task is to identify and describe in detail the shared methods and procedures by which people engage in interaction. CA is principally concerned with sequence in talk-in-interaction. A central assumption of CA is that when people interact, their actions occur as a series of related, orderly and ordered actions. The notion of conditional relevance provides the link between one action and a next action in face-to-face interaction. A series of ordered and related actions, linked by the fact that a first action makes conditionally relevant a second action of a particular sort, are identified as action *sequences* in CA.

As has been already noted the principal analytical task of CA is to describe the organization of action sequences. Minimally, sequences are pairings of actions where a first action makes conditionally relevant the occurrence of a subsequent action (Hutchby, 2001, p. 66). A great deal of analytical attention has been given to describing various kinds of sequential phenomena, for example question-answer pairs, telephone openings, report-assessment pairs, etc., (Schegloff & Sacks, 1973; Schegloff, 1968; Heritage, 2002; Pomerantz, 1984). Relatively little work has been done to describe how actors transition between sequences. Sacks (1992) and Schegloff (2007) take up discussion of long sequences but this remains a relatively underdeveloped area of investigation in CA studies. One phenomenon we have identified in our data is a set of sequentially organized procedures by which multiple actors explicitly effect a transition between sequences. These procedures form the object of analytical interest for this study.

Transitions between Sequences

A central assumption of CA is that when people interact, their actions occur in the form of a sequence of related, orderly and ordered actions. When a sequence is completed, interactants face the problem of "what to do next." Consider as an example the following question-answer adjacency pair sequence:

Table 1: Adjacency-Pair Completion.

Line	Name	Post	dd-mm-yyyy	Time
217	Quicksilver	Did you guys discuss the problem like it said to?	09.05.2006	07.08.16
218	Aznx	Yeah.	09.05.2006	07.08.21

Upon receipt of the response at line 218, the issue for chat participants is to figure out (a) what can follow as a next posting at line 219 following the apparent completion of the question-answer sequence and (b) who will perform that next action? What happens next is a complex matter that depends on the nature of the question, the answer, what has happened in the interaction up to that point, the task at hand, etc.

How interactants elect to proceed may be constrained in various ways that result from and instantiate relationships among interactants, participants' relationship to the business at hand, institutional affordances, the affordances of the interactional modalities deployed, etc. In this example, the response proffered does not make conditionally relevant any particular kind of next action, making it possible for any participant to potentially initiate a new sequence of some sort.

If we consider an activity to be something like a coherent sequence of action sequences, then there may be certain, more loosely organized constraints on (a) what sequences can be performed as part of an activity and (b) the sequence of those sequences by which the activity is constituted in the first place. According to Schegloff (1990), the coherence of long sequences is a structural feature of the way they are opened, expanded and closed (p. 73). In one study of long sequences in chat interactions, Zemel et al. (2007, p. 407) write: "Among the regularities observed and studied by conversation analysts are the ways that long sequences begin and end. Participants in conversations engage in recognizable boundary-producing activities to which participants orient and by which participants initiate conversations and bring them to a close. These are referred to as openings and closings (Schegloff, 1968; Schegloff & Sacks, 1973). These activities are used to display that some activity in which participants had been engaged is completed or suspended and another is starting. As

such, they serve to mark interactional boundaries between long(er) sequences in an ongoing interaction. This permits participants wide ranging opportunities to manage, regulate and build their interaction to become coherent long sequences of recognizable activity."

There are a number of kinds of sequence selection sequences that can be distinguished by the way they are initiated. In this section, four such next-sequence selection sequences are considered:

- Proposal-ratification-uptake (PRU) sequences,
- Yes-no query request sequences,
- Suggestion-initiated selection sequences, and
- Directive-compliance-report (DCR) sequences.

PRU Next-Sequence Selection Sequences

One particular sequence of actions that marks an interactional boundary between activities construed as long(er) sequences, or sequences of sequences is the proposal-ratification-uptake (PRU) sequence in which a formulation of a next activity is put forward for ratification and uptake. Specifically, interactants in problem-solving chats can select a next sequence to take up by:

1. Proposing a next sequence or activity for others to ratify and take up,
2. Ratifying the proposed next sequence, and
3. Taking up or initiating the proposed next sequence.

PRU sequences are often deployed to do work other than next-sequence selection. For example, in problem-solving work, an actor will propose a possible solution in a way that calls on recipients to ratify its correctness and to accept the proposed solution as the solution of endorsed by the collectivity.

Even though PRU sequences are available to accomplish a variety of interactional outcomes, they display an orientation toward recipient participation in the ratification and uptake of the proposed matter. It is this orientation toward recipient participation that distinguishes the PRU sequence as a method for accomplishing next-sequence selection because it may also be a way by which participants can demonstrably display their collaboration. Next-sequence selection is occasioned in various ways by the completion of a prior sequence or activity and by members' achieved understandings of the ways they are entitled and expected to participate in the ongoing interaction. The proposal-ratification-uptake organization of next-sequence selection sequences is consequential for the way they project how actors in a group are to participate in making decisions regarding the subsequent actions of the group, and when relevant, how actors are to participate in the proposed sequence or activity taken up by the group.

Even though a proposal is put forward, there is no necessary requirement that a proposal always lead to ratification and uptake, even though ratification and uptake are made conditionally relevant by the production of a proposal. A proposal may be rejected or ignored, an alternative proposal may be put forward, etc. Also, ratification may not be done explicitly but may be achieved implicitly through uptake of a proposed next activity.

"Let x y"-initiated PRU Next-Sequence Selection Sequences

One kind of PRU initiation is constructed in the form "Let x y" where x is the subject of the transitive verb *to let*, and y is a proposed next action. These are frequently produced as "Let's y" or "Let me y." Examples of this kind of sequence selection initiation include:

Table 2: "Let x y"-initiated PRU Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
53	Aznx	Let's start this thing.	09.05.2006	06.32.10

Table 3: "Let x y"-initiated PRU Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
393	Quicksilver	Let's go back to original idea: the flat face	10.05.2006	07.21.02
394	Quicksilver	then we can try and get this from that	10.05.2006	07.21.08

Proposal initiators of this sort are constructed with two components. The first component is the transitive verb "let" in an imperative form. The second component is a verb phrase that projects a proposed next action or activity. For example "Let's" + "start this thing" (Table 2) or "Let's" + "go back to the original idea" (Table 3). The particular construction of the first component using the verb *to let* includes a subject portion as in "let me" or "let us" or "let's." When presented in the first person plural form, viz. "let's y," *all* recipients, including the actor posting the proposal, are addressed as recipients of the proposal and are thus made

accountable for (a) ratification of y as the next activity and (b) the uptake of y. This construction is routinely treated as a way of putting forward the object of the proposal, i.e. the proposal next action, to a set of recipients for their ratification. Furthermore, since it is addressed to the collectivity, it implies that all recipients are included as participants in the uptake of the next matter or the conduct of a subsequent projected action. In Table 3, recipients of the PRU next-sequence selection sequence are identified as persons who would ratify this next activity and take up this activity upon ratification.

A typical example of a PRU sequence used for next-sequence selection is shown below in Table 4.

Table 4: "Let x y"-initiated PRU Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
331	Aznx	So let's brainstorm through some problems that we think are challenging.	10.05.2006	07.09.33
332	Quicksilver	yes...new topic	10.05.2006	07.09.40
333	bwang8	Ok	10.05.2006	07.09.42
334	Quicksilver	3-d figures?	10.05.2006	07.10.20
335	Aznx	I think we should discuss on the different methods.	10.05.2006	07.11.06
336	Aznx	So that we can easily apply our thoughts quickly when seeing a problem.	10.05.2006	07.11.24
337	Quicksilver	Yes....but we must find a question or problem to investigate	10.05.2006	07.11.30
338	Aznx	Yeah.	10.05.2006	07.11.37
339	Aznx	I think we should start off with a conjecture, that we need to prove.	10.05.2006	07.11.50

This Table displays the basic organization of next-sequence selection PRU sequences which displays the following three-part organization:

1. A proposal (line 331),
2. Ratifications by recipients (lines 332 and 333) and
3. Uptake of the proposed activity (lines 334 through 339).

Ratification of a "let x y" proposal may be explicit (as in Table 4) or implicit, as in the following excerpt:

Table 5: Implicit Ratification Example.

Line	Name	Post	dd-mm-yyyy	Time
884	Aznx	Well, let's look at their problem.	16.05.2006	07.29.00
885	bwang8	open browser	16.05.2006	07.29.05
886	bwang8	and click on the link	16.05.2006	07.29.13

Here we see that Aznx proposes that all the participants look at a problem (line 884). Instead of giving an explicit ratification in line 885, Bwang8 implicitly ratifies the proposal by providing instructions for how to accomplish the proposed action.

Ratification of a "let x y" may not always be forthcoming which may cause a proposal to be dropped. In the following example, Aznx proposes that participants solve the formula at line 808. This is not taken up in subsequent postings and Aznx does not recycle his proposal.

Table 6: Dropped Proposal Example.

Line	Name	Post	dd-mm-yyyy	Time
808	Aznx	Let's sovle it. :P	16.05.2006	07.16.10
809	Quicksilver	Excuse my poor drawings	16.05.2006	07.16.20
810	Gerry	What does the feedback say about the difference this would make?	16.05.2006	07.16.47
811	Aznx	There would be a similar sharing in between the layers.	16.05.2006	07.17.17
812	Aznx	So the number would technically be bigger.	16.05.2006	07.17.26

Alternatively, failure to ratify a proposal may cause an interactional escalation to a ratification question, as in the following excerpt:

Table 7: Escalation Example.

Line	Name	Post	dd-mm-yyyy	Time
393	Quicksilver	Let's go back to original idea: the flat face	10.05.2006	07.21.02
394	Quicksilver	then we can try and get this from that	10.05.2006	07.21.08
395	Quicksilver	So we are going back to the flat faced one? Agree?	10.05.2006	07.22.06
396	Aznx	Agree.	10.05.2006	07.22.39
397	bwang8	we can first figure out the bottom level	10.05.2006	07.22.46

In this instance, Quicksilver initiates a PRU sequence with a "let x y" proposal at line 393 and 394. There is no ratification or uptake following the presentation of the proposal. Almost a full minute goes by without a response. This duration gives respondents ample opportunity to ratify or reject the proposal, or proffer an alternative proposal. When no response of any sort is forthcoming, Quicksilver escalates from a "let x y" proposal to a direct request for agreement in the form of a question in line 395. After half a minute agreement is proffered by Aznx in line 396 and taken up by Bwang8 in line 397.

Query-prefaced "Let x y"-initiated PRU Next-Sequence Selection Sequences

A variation on the "let x y" PRU next-sequence selection sequence involves soliciting a proposal in the first place. In this way the proposal is presented as a response to a question about what should be a next activity for actors to take up. In the following excerpt, Aznx at line 502 explicitly asks, "So what should we do next?" What follows at line 503 is an abbreviated version of the "let x y" PRU next-sequence selection sequence. Quicksilver responds with "[Let's] Continue and see if we find any patterns."

Table 8: Query-prefaced "Let x y"-initiated PRU Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
502	Aznx	So what should we do next?	10.05.2006	07.44.27
503	Quicksilver	Continue and see if we find any patterns	10.05.2006	07.44.42
504	bwang8	i think i got the equation for the middle sticks	10.05.2006	07.44.47
505	Quicksilver	All right...lets see	10.05.2006	07.44.55
506	bwang8	now we know the n by n blocks on the bottom	10.05.2006	07.45.43
507	Aznx	Yeah it seems so.	10.05.2006	07.45.50
508	Quicksilver	yes.	10.05.2006	07.45.57

In this excerpt, Bwang8's posting at 504 is uptake and thus constitutes an implicit ratification of the proposed course of action. An interesting feature of this organization of the next-sequence selection is that by calling for the initiation of a PRU in the first place, the actor making the next-activity query is presumed to be willing to accept a ratified next-activity proposal. By offering a next activity, Quicksilver can be seen to both propose and endorse this next course of action. Bwang8, by taking up the next activity, implicitly endorses the matter. Thus, a next-activity query addressed to a collectivity can be treated as a way by which the questioner can make relevant a PRU sequence without having to explicitly ratify the proposed next activity.

Yes-No Query Requests as Next-Sequence Selection Sequences

An alternative form of next-sequence selection is initiated with a yes/no query. As Koshik (2005), Heritage (2002), Raymond (2003) and others have observed, questions are capable of doing more things than just soliciting information, including making requests. Next-actions can be selected when a participant requests that others (possibly including the requestor as well) perform these actions. As with PRU next-sequence selections, the yes/no query request consists of three parts (1) a request in the form of a yes/no query, (2) acknowledgement of the request, followed by (3) uptake of the requested action.

As is shown in the following example, the yes/no interrogative calls on recipients to act as a collective to comply with the request to expand or extend their collaboration in the production of an answer:

Table 9: Yes-No Query Request Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
63	Aznx	Can we collaborate this answer even more?	09.05.2006	06.34.01
64	Aznx	To make it even simpler?	09.05.2006	06.34.05
65	bwang8	Ok	09.05.2006	06.34.15

66	Aznx	Because I think we can.	09.05.2006	06.34.16
67	bwang8	((1+N)*N/2+N)*2	09.05.2006	06.34.50

In this example, the request is addressed to the collectivity and it is this addressing that makes it relevant for recipients to act in concert to comply with the proffered request. By calling on recipients to act in a collective and concerted manner, Aznx is constituting the projected action as one in which all recipients are expected to participate and, by leaving the organization of the proposed tasks undifferentiated in terms of the specifics of recipient participation, implies a collaborative orientation toward the accomplishment of the proposed task. This is followed at line 65 by Bwang8's acknowledgement of the request and then his uptake at line 67.

Suggestion-initiated Next-Sequence Selection Sequences

Another procedure for selecting a next sequence is to make a suggestion. This form is very similar to the PRU next-sequence selection procedure and consist of:

1. A suggestion,
2. Ratification of the suggestion, and
3. Uptake of the suggestion as the next sequence.

Suggestion-initiated sequences explicitly foreground the authorship of the suggested next action, making relevant authorship as a consideration for recipients' ratification and uptake. This is shown in Table 10.

Table 10: Suggestion-initiated Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
339	Aznx	I think we should start off with a conjecture, that we need to prove.	10.05.2006	07.11.50
340	Aznx	Not a hard one, but one that can be challenging.	10.05.2006	07.12.03
341	Quicksilver	Maybe a row of blocks	10.05.2006	07.12.17
342	Quicksilver	Likethis	10.05.2006	07.12.27

In this instance, Aznx suggests starting off "with a conjecture" as a next sequence to take up, in line 339. At line 341, Quicksilver both ratifies and takes up Aznx's suggestion by offering a conjecture for recipients to consider.

Collectively-produced, Suggestion-initiated Next-Sequence Selection Sequences

In the data, there was one instance of a co-constructed suggestion-initiated next-sequence selection sequence. This is shown below in Table 11:

Table 11: Collectively-produced Suggestion-initiated Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
309	Aznx	So, I think we should focus on discussing on each step more.	10.05.2006	07.03.17
310	Quicksilver	and explain every answer thoroughly	10.05.2006	07.03.30
311	Aznx	Even if the answer was "obvious."	10.05.2006	07.03.40
312	bwang8	Ok	10.05.2006	07.03.48
313	Quicksilver	like i gave a wrong answer, but my explanations didn't come up on the computer because of the lag	10.05.2006	07.03.49
314	Quicksilver	so thats one thing	10.05.2006	07.03.58

Here, both Aznx and Quicksilver, two of three participants in the interaction, co-construct a suggestion in lines 309 through 311. This shared orientation toward the production of a suggestion also implies that both Aznx and Quicksilver ratify the suggestion they are making. Co-constructing a suggestion, or a proposal or request for that matter, serves to provide recipients with a stronger basis for ratification and uptake since the co-constructed suggestion itself displays multiple ratifications. The third participant then ratifies the suggestion in line 312.

Directive-Compliance-Report Sequences as Next-Sequence Selection Procedures

In contrast to PRU next sequence selection sequences, the initiation of a next-sequence selection sequence can take the form of a directive-compliance-report (DCR) sequence in which one actor tells another or a collectivity what they can do as a next activity. In common vernacular terms, this amounts to telling someone else what to

do as a next activity. This kind of next-sequence selection sequence seems to be a three-part sequence that consists of:

- A directive indicating a next sequence to be initiated, addressed to recipients,
- Compliance, consisting of (a) receipt of the directive followed by (b) performance of the directed next sequence, and
- A report on completion of the next sequence, when appropriate.

An example is shown in the next excerpt.

Table 12: DCR Next-Sequence Selection Sequence Example.

Line	Name	Post	dd-mm-yyyy	Time
110	Aznx	bwang you go first	09.05.2006	06.46.14
111	bwang8	Ok	09.05.2006	06.46.18
112	Aznx	tell me when you're done	09.05.2006	06.46.19
113	Gerry	Enter your team name and the values for sticks and squares	09.05.2006	06.46.37
114	Quicksilver	I tried, but it didn't work	09.05.2006	06.46.43
115	Quicksilver	Are we Team B?	09.05.2006	06.46.50
116	Aznx	TEAM B	09.05.2006	06.46.55
117	bwang8	i am done	09.05.2006	06.47.02

At line 110 , Aznx directs Bwang8 to be the first in making additions to a wiki page. This posting is concerned with a next matter to perform and who should perform that next matter. In response to this directive, Bwang8 produces an acknowledgement/agreement token at line 111. At line 112, Aznx expands his directive, telling Bwang8 to report on the completion of his task. At line 117, Bwang8 produces a task-completion report. Directives as initiators of next sequence selection sequences are substantially different in their organization from PRU next sequence selection sequences, especially with respect to the way participation in the selection procedure is accomplished.

Implications and Discussion

The examples in this paper show that actors routinely initiate next-sequence selection sequences as ways of selecting a next-sequence to perform. By doing so, actors are engaging in demonstrable and concerted actions to elicit the participation of other actors in the deciding what sequence to take up next. PRU sequences, yes/no query request sequences, and suggestion sequences call for ratification of the proposal or suggestion from recipients, thus procedurally and formally treating them as accountable for (a) their participation in the selection process and (b) the uptake of the next sequence. By ratifying a proposal or suggestion, participants do not act as individual actors but rather as a collectivity to endorse a possible next sequence. In this way, PRU sequences, yes/no query requests and suggestion sequences serve not only to constitute the assembled participants as a collectivity but also to constitute the collectivity rather than the individual participants as the 'actor' in the scene (Lerner, 1993). This contrasts with directive-compliance-report (DCR) sequences that treat individual actors rather than the collectivity as (a) accountable for the selection of a next action and (b) accountable for the performance of that next action. The DCR sequence seems to constitute and instantiate a non-collaborative orientation toward the performance subsequent action. In one version of this idea, one could argue that with PRU sequences it is the collectivity that decides and takes up a next activity and with DCR sequences, individual actors decide for other actors in the scene.

In the VMT data, we can see that actors organize themselves to transition between sequences in a variety of collaborative ways. A preliminary examination of the Team B data suggests that the collaborative options were far more prevalent than the non-collaborative one:

Table 13: Frequency Count of Transition Method Occurrence

	PRU Sequences	Query Sequences	Suggestion Sequences	DCR Sequences
Frequency	35	15	10	9

There were 60 combined occurrences of the collaborative procedures compared to 9 occurrences of the non-collaborative DCR procedure.

This orientation toward collaboration suggests that collaboration may be as important in the conduct of activities as it is in the transition between activities. If a group understands itself to be collaborative, then one

would expect that collaboration to be achieved as they work within an activity and as they transition between activities. Actors may occasionally display differences in learning competencies within learning activities, which may serve to mask the collaborative nature of their work. Thus examining the transitions between sequences is a perspicuous bit of interactional work for exploring the organization of collaboration in CSCL groups. This paper has described various methods whereby such transitions are accomplished and how, based on their design and achievement, they show an orientation toward collaboration.

References

Çakır, M. P., Zemel, A., & Stahl, G. (2009). The joint organization of interaction within a multimodal CSCL medium. *International Journal of Computer-Supported Collaborative Learning, 4*(2), 115-149.

Garcia, A. C., & Jacobs, J. B. (1999). The eyes of the beholder: understanding the turn-taking system in quasi-synchronous computer-mediated communication. *Research on Language and Social Interaction*, 32, 337-367.

Garfinkel, H. (1967). *Studies in ethnomethodology*. Cambridge: Polity Press.

Heritage, J. (2002). Ad hoc inquiries: Two preferences in the design of routine questions in an open context. In D. W. Maynard, H. Houtkoop-Steenstra, N. C. Schaeffer & J. v. d. Zouwen (Eds.), *Standardization and tacit knowledge: Interaction and practice in the survey interview* (pp. 313-334). New York: John Wiley & Sons.

Hutchby, I. (2001). *Conversation and Technology: From the Telephone to the Internet*. Cambridge, UK: Polity Press.

Koshik, I. (2005). *Beyond Rhetorical Questions: Assertive questions in everyday interaction*. Amsterdam/Philadelphia: John Benjamins Publishing Company.

Lerner, G. H. (1993). Collectivities in action: Establishing the relevance of conjoined participation in conversation. *Text, 13*(2), 213-245.

Lipponen, L. (2002). *Exploring foundations for computer-supported collaborative learning*. Paper presented at the CSCL 2002, Boulder, CO.

Luppicini, R. (2007). Review of computer mediated communication research for education. *Instructional Science, 35*, 141-185.

Maynard, D. W. (1984). *Inside plea bargaining: The language of negotiation*. New York: Plenum Press.

Pomerantz, A. (1984). Agreeing and disagreeing with assessments: some features of preferred/dispreferred turn shapes. In J. M. Atkinson & J. Heritage (Eds.), *Structures of social action: Studies in Conversation Analysis*. Cambridge: Cambridge University Press.

Raymond, G. (2003). Grammar and social organization: Yes/no interrogatives and the structure of responding. *American Sociological Review, 68*(6), 939-967.

Roschelle, J., & Teasley, S. D. (1994). The construction of shared knowledge in collaborative problem solving. *NATO ASI Series F. Computer and Systems Sciences, 128*, 69-97.

Sacks, H. (1992). *Lectures on conversation, Vols. I & II*. Oxford: Blackwell.

Sarmiento, J., & Stahl, G. (2008). *Extending the joint problem space: Time and sequence as essential features of knowledge building.* Paper presented at the International Conference of the Learning Sciences (ICLS 2008), Utrecht, Netherlands.

Schegloff, E. A. (1968). Sequencing in conversational openings. *American Anthropologist*, 70, 1075-1095.

Schegloff, E. A. (1990). On the organization of sequences as a source of 'coherence' in talk-in-interaction. In B. Dorval (Ed.), *Conversational organization and its development* (pp. 51-77). Norwood, NJ: Ablex.

Schegloff, E. A. (2007). *Sequence Organization in Interaction: A Primer in Conversation Analysis*. Cambridge: Cambridge University Press.

Schegloff, E. A., & Sacks, H. (1973). Opening up closings. *Semiotica*, 7, 289-327.

Schönfeldt, J., & Golato, A. (2003). Repair in chats: A conversation analytic approach. *Research on Language and Social Interaction, 36*(3), 241-284.

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

Stahl, G. (2009). *Studying virtual math teams*. New York, NY: Springer.

Zemel, A., & Çakir, M. P. (2009). Reading's work in VMT. In G. Stahl (Ed.), *Studying virtual math teams* (pp. 261-276). New York, NY: Springer.

Zemel, A., Xhafa, F., & Cakir, M. (2007). What's in the mix? Combining coding and conversation analysis to investigate chat-based problem-solving. *Learning and Instruction, 17*(4), 405-415.