

From Comments to Dialogues: A Study of Asynchronous Dialogue Processes as Part of Collaborative Reviewing on the Web

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Abstract

When working together on a common document, collaborators frequently share and discuss their ideas about further revisions. Collaborative writing might, therefore, be thought of as a process of negotiating what changes to make among co-authors. The World Wide Web is an easily accessible infrastructure to facilitate such a communication process over documents. This paper explores the dialogues formed by comments exchanged among co-authors in a Web-based collaboration tool, Col•laboració. A case study was performed where a small group of writers discussed and revised a common document, using this system. In the paper, I demonstrate how these dialogues are structured and what properties they have in relation to the context of collaborative reviewing processes. The analysis of dialogues is also used to reflect on design issues with regard to dialogue support and comment categorization.

1. Introduction

Commenting functions in collaborative writing serve as important tools for communication between collaborators. In order for these tools to be usable, they should be based on an easily accessible infrastructure for collaboration [7]. The Internet and World Wide Web have a significant potential as such an underlying environment for collaboration. Today, it has already become easy for writers to share common documents and communicate about their writing tasks on the Web.

Col•laboració is a tool to support distributed and asynchronous collaborative writing on the Web, allowing writers to access, comment on, and modify HTML documents [10]. Comments are displayed chronologically and grouped by individual sections, and writers are notified via email whenever a comment is made.

This paper discusses the effect of this Web-based collaboration tool on the interaction between collaborating writers. Especially, it emphasizes aspects of *dialogues* formed by comments that co-authors contribute. The view of comments as elements of dialogues, not simply as annotations on documents, has been paid relatively little

attention. However, understanding dialogues is of importance for obtaining knowledge about potential impacts on the interaction between people working under new conditions of ways of communicating through the Web. Certainly, new communication tools may change conversational activities in various aspects such as turn-taking strategies, patterns of responding to others, and ways of organizing discourse topics.

Further, human discourse is context-dependent. What task members perform greatly influences conversational activities. The special context that this study concerns is collaborative reviewing of documents. During the reviewing process, collaborators constantly share, discuss, and negotiate their ideas about further revisions as well as revisions made in the text. Interestingly, these activities often occur as forms of text-based dialogues, when collaborators write comments on-line. Therefore, this study explores how both a Web-based co-authoring tool and a specific context of collaborative reviewing shape dialogues between members.

A case was investigated where a small group of writers made use of Col•laboració to communicate about revisions on a common document. The primary data in analyzing this case was written comments made by the members. During the course of investigating the case, I have also developed a framework for coding dialogues. In that respect, this study should be considered as descriptive and explorative, aiming to reveal dialogue strategies in collaborative writing.

Finally, the analysis is used to reflect on two design issues. First, I discuss how to support dialogues by commenting functions. Aspects of annotation rather than dialogue in relation to the usage of commenting functions have long been emphasized. This is perhaps why commenting tools are understood as a synonym of annotation tools. However, highlighting dialogic aspects that designers may consider as an important factor in developing commenting tools, this paper compares them with aspects of annotation in the design.

Second, I deal with the issue of how to categorize comments. Computer-mediated written communication has certain advantages such as the ease of recording written dialogues and reusability of them. With these advantages,

writers have an opportunity to read and review recorded dialogues or comments. Importantly, each piece of written dialogues can be categorized. Without proper categorization of comments, they might become messy information when the number of comments increases. What categories systems provide is, thus, crucial for writers in helping to access, organize and understand dialogues, and develop their further conversations. Based on the analysis, this paper discusses ways of categorization of comments including section-based classification of comments supported by Col•laboració.

The paper is organized as follows: Section 2 characterizes the discourse analysis carried out in this study. Section 3 provides an overview of Col•laboració. In section 4, a case of a small group writing is described, and what data were collected is presented. Section 5 describes a framework for coding dialogue, which is a basis for the analysis of dialogue data. Section 6 presents basic properties of written dialogues investigated. In Section 7, selected results of the analysis are presented, which may be associated with the two design issues mentioned previously. Section 8 discusses these design issues, followed by a conclusive section.

2. Characterizing discourse analysis in this study

Several models have been introduced to describe conversational interaction patterns, e.g. Adjacency Pairs [11], Initiation-Response-Feedback [14], and Presentation-Acceptance [6]. Similarly, this study adopts an 'Initiation-Response' model for minimal dialogue interactions. This structure by its name assumes that dialogues consist of initiations from speaker which have specific dialogue expectations associated with them, followed by responses to fulfill these expectations.

Clark has viewed language use as a form of joint action [5, 6]. From this point of view, discourse is an activity of coordinating both the content and process of what people are communicating. While describing coordination activities of collaborating writers, the current study has employed the notion of language games, assuming an underlying principle of Wittgenstein [15] that dialogues should be understood in terms of the context and activities where they are used. Language games represent types of social interaction between conversants. Levin and Moore have suggested that discourse is built up by *dialogue games* [8]. Later, Severinson Eklundh has suggested *language game* as an analytic unit of discourse [12].

Each participant in dialogue either speaks to or listens to someone else. Taking a careful look at cases where three, four, or even more people take part in a dialogue, one finds two types of listeners, as Clark noticed [5]. One is an *addressee*, and the other is a *side participant*. When

Person 1 says to Person 2, "I saw your poster", and another participant Person 3 hears it, Person 1 is a speaker, Person 2 is an addressee, and Person 3 is a side participant with a potential of taking the next turn in response to Person 1's words. Clark's definition of these three roles is worthwhile adopting for the analysis in the present study, since a group of four participants collaborated in the case examined here.

While *sequentiality* is a fundamental property in most forms of oral discourse, computer-mediated asynchronous discourse often has *multiple threads* [1]. For example, when a person writes an email message, it may deal with multiple topics rather than one. An important point in studying asynchronous dialogues, therefore, lies in understanding of how people handle multiple threads. This has been a primary concern in the current study.

3. Overview of Col•laboració

The interface of Col•laboració consists of four frames relating to the document, one on the left side and three on the right side (see Figure 1). The left frame, *index frame*, displays titles and links of different sections. When users select a section by clicking on it, its content appears in the top right frame, *document section frame*. The middle right frame, *comment frame*, shows comments associated with the selected section. The bottom right frame, *command frame*, contains buttons that perform the system's actions: Add Comment, Edit/Create/Delete Section, Overview, Change Order Sections, and Create Version.

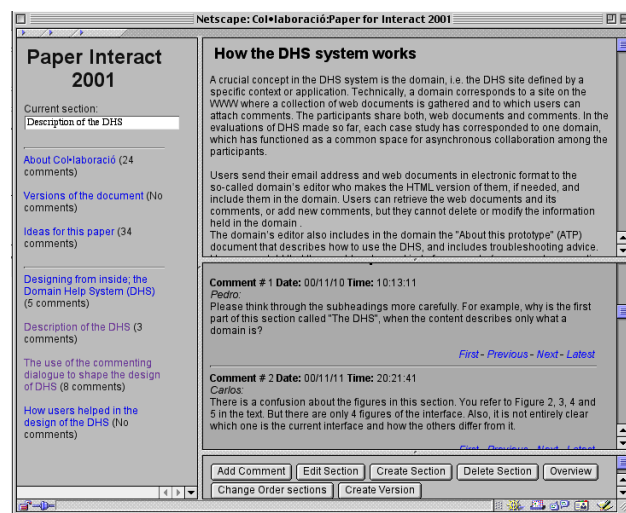


Figure 1. Screen layout of Col•laboració

'Create Section' is a command for generating a new section, 'Edit Section' allows for revising an existing section, and 'Delete Section' for removing a section. By

selecting 'Overview', writers can see and print out the document presented as a whole or with selected sections in a separate window. 'Change Order Sections' enables users to switch the order between sections. 'Create Version' is useful in saving a version of the whole document or selected sections of it when a new version is to be created.

When users push the button 'Add Comment', a window opens in which they can write a comment. Immediately after they submit a comment, it is shown in the list of comments made so far, chronologically ordered. Apart from comments pertaining to each section, the system also allows writers to comment on the document as a whole by clicking the 'Ideas for the document' link in the index frame.

Since Col•laboració is a Web-based tool, an obvious advantage is that writers are able to exchange comments at any time and at any place. Apart from this advantage, however, there are more important and subtle characteristics that the system has.

First of all, most commenting functions support annotations linked to specific parts in a document, e.g. [3, 4, 9], while comments in Col•laboració are visible in a separate frame from the text. Naturally, the former interface provides writers with a better sense of integration between each comment and its related text, whereas the latter gives a better overview of all comments made.

Second, comments in Col•laboració are grouped by individual sections. Thus, when a section is selected, only comments connected with this section are shown in the comment frame. Note that Col•laboració users can also see or print out all comments together in a common place by using the function 'Overview'.

Third, each time a comment is made, the system automatically sends an email message to every member of the group including the content of the comment. By email notification, writers are made aware of the progress of their partners' on-going activities, without necessarily entering the system.

4. A case: writing a conference paper

The case study involved four authors (Ralf, Eva, Luke, and Mona under pseudonyms) who produced a conference paper, 4 pages long in A4 size. All writers were HCI researchers, working in the same building. The author (Luke) was a member of the team, and one member (Ralf) was the developer of the system Col•laboració. While Eva had never experienced the system, other three members had used it in real writing tasks at least once before. The members had cooperated for one or more research projects.

The team first had physical meetings to plan what and how to write the document. Afterwards, Ralf and Eva made the draft consisting of three sections (one written by Ralf, and the other two by Eva). Therefore, Luke and

Mona were mainly reviewers, while they wrote some paragraphs during the reviewing process. When the draft was ready, all members agreed to use Col•laboració for reviewing it. A reason for this was that it was hard to have a physical meeting where all writers would meet only for discussing a document and because of time constraints. Also, all members wanted to acquire some experience of the use of the system.

While they worked together using the system, the document evolved substantially and the abstract of the document was created during the reviewing process. The elapsed time for the reviewing process was three weeks. During this period of time, they mainly used the system for communicating about the text. However, they did not only rely on the system for communication, but subsets of them also had meetings to discuss the text.

All comments made in Col•laboració and different versions of the document produced were analyzed. The collaborators sometimes used email, and I afterwards collected these email messages. I also examined the log file in which information of writers' actions was recorded such as when they revised text, when they made comments, etc. However, collecting the data from the log file was only a complementary procedure to the analysis of comments, since the purpose of the study was primarily to analyze writers' dialogues¹.

5. A framework for dialogue analysis

As mentioned previously, the framework utilized in this study has not been devised to test the case dealt with in this study before observing it, but was developed while I investigated the case so as to describe and explore interactions in collaborative reviewing.

5.1 Dialogues formed by comments: comments, moves, and language games

A *comment* in the analysis is a message that a user writes on one occasion. It can consist of one or several topics. Technically, the user generates a comment by writing it and then pushing a submitting (or sending) button for it. A comment contains one or more '*moves*', which are basic meaningful units for analysis. Here, the notion of move is best understood in the context of *language-games*, as Severinson Eklundh mentioned [13]:

¹ The case that the paper deals with was not originally considered as a research object. A year after the co-authoring task was completed, however, the author found the case interesting to analyze dialogues and so collected the data. Since the system stores all comments made, the logging data, and different versions of the document, the study was made possible even a year after the case took place.

“That such a notion (a game) is relevant for describing communicative activities is being recognized by an increasing number of researchers. ... In fact, a notion of language game has also been implicitly assumed by many authors, who have seen the need for a concept of *move* as a unit for analyzing discourse. In a general way, all these approaches to the analysis of conversation are dependent on the insight of Wittgenstein that utterances must be viewed in terms of the activity in which they are used.” (p. 30)

In her earlier work, dialogues are interpreted as consisting of moves in games [12]. A move is an action specified by the rules of a given language game. A game starts when a speaker takes an initiative, e.g. suggesting an agenda, continues by another participant’s response, and ends when the purpose of the game is either achieved or abandoned. In the *action-seeking* game, for example, a person communicates with another in order for him to perform a specific action until he does so.

5.2 Taxonomy of moves

The analysis differentiates between *initiations* and *responses*. Initiations are divided into two categories, *Request* and *Announcement*. Here, ‘Announcements’ refer to declarations or assertions that do not necessarily require a next move, while ‘Requests’ are initiations that demand a certain response.

Request	RCT:	Problem Specification Suggestion Reformulation Question Repeated request
	RGC:	Problem specification Suggestion Question Repeated request
Announcement	AT	
	ACT:	New Version Notification Change Notification Plan for Changes
	AGC:	Information Activity Planned Activity

Figure 2. Initiation moves

Similarly, Responses are classified into *Response* and *Responsive Announcement*. A taxonomy of moves, which will be soon explained in detail, is summarized in Figure 2 and 3. The taxonomy reflects the fact that collaborating writers usually communicate about two topics: the text itself and group coordination.

Response	SR (Simple Response) CR (Complex response)	
Responsive Announcement	R-ACT	New Version Notification Change Notification Plan for Changes
	R-AGC	Information Activity Planned Activity

Figure 3. Response moves

(1) **Initiations.** Within a Request, ‘Request for Changes of Text – RCT’ means that reviewers request further changes of text to the writer. There are five more specific moves within this category (see Table 1).

Table 1. Move category in RCT

Moves	Meaning	Examples
Problem Specification	Pointing out certain problems in text	“Well, the next one is too technical.”
Suggestion	Providing opinions of how to change the text	“Your sentence sounds general to me. I suggest something like: ...”
Reformulation	Formulating exact words for changes as a special kind of ‘Suggestion’	“I revised your text this way: This scenario is commonplace in every ...”
Question	Asking questions not necessarily requiring changes of text	“Is it a message about the organization, or a part of it?”
Repeated Request	Requesting again things that have been mentioned before	“As I said before, there’s a lack of consistency between these two.”

‘Request for Group Coordination – RGC’ has the same moves as RCT except for a move ‘Reformulation’. The only difference between them is that RGC is a request related to group coordination, separated from the text, e.g. participants’ roles and scheduling (see Figure 2).

With respect to ‘Announcement’, first, ‘Assertion about Text – AT’ is a move of expressing opinions about text, e.g. positive evaluations of text, explanations of changes made. Second, ‘Announcement of Changes of Text – ACT’ is an activity to let other members know that revisions to text have been made (‘New Version Notification’ or ‘Change Notification’), or will be made (‘Plan for Changes’). Third, the writers may announce things connected with team coordination, ‘Announcement about Group Coordination – AGC’. For example, they can provide certain information (‘Information’), e.g. “The deadline for submitting the paper is Dec. 10th”, or report their activities, either that they have done or that they will do something (‘Activity’ and ‘Planned Activity’).

(2) **Responses.** ‘Simple Responses’ refer to a response of yes/no or an agreement/disagreement with no further explanations, while ‘Complex Responses’ are answers to questions, suggestions, and explanations, e.g. “If we cut down on the space, the last sentence could be omitted, because it is duplicated with its previous sentence” (see Figure 3). ‘Responsive Announcement’ is an announcement as a response, e.g. “Ok, everyone is happy with the abstract. I’ll give you paper copies soon”.

5.3 Phases of analysis

In the course of the analysis of the data, three different phases were demanded. First, each move was analyzed in terms of both category of moves (see Figure 2 and 3) and the roles of speaker, addressee, and side participant. Second, with respect to each topic discussed, I analyzed how interaction goes on according to chronological order of moves (e.g. see Figure 4). A topic is a particular subject that members share with each other. Third, at each moment of time, I analyzed what topics remained unresolved and what were resolved. This was carried out to understand how people handle multiple threads.

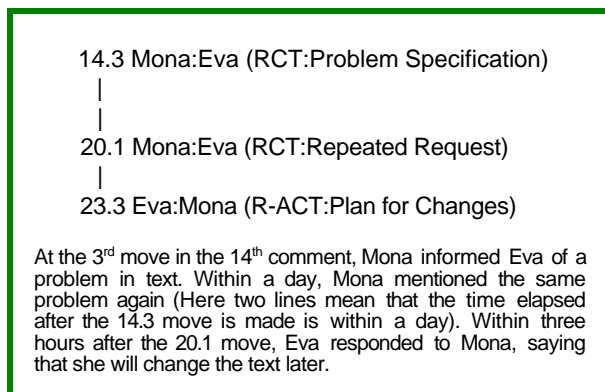


Figure 4. An example of a topic discussion

6. Basic properties of dialogues

A main purpose of the study has been to understand the structure and properties of dialogues formed by written comments. This section presents basic characteristics of these dialogues with quantitative information.

6.1 Statistics

The team members produced 134 moves in 64 comments during the task. Of these moves, 109 were initiations, and 37 were responses (Here, 12 moves were counted both as initiations and responses). The detailed analysis is given in Table 2 and Table 3.

Table 2. Statistics of initiation moves

Types of moves		No	Types of moves		No
RCT	Problem Specification	21	RGC	Problem Specification	2
(69)	Suggestion	17	(9)	Suggestion	5
	Reformulation	16		Question	2
	Question	4		Repeated Request	0
	Repeated Request	11			
ACT	New Version Notification	6	AGC	Information	5
(16)	Change Notification	4	(8)	Activity	2
	Plan for Changes	6		Planned Activity	1
AT		7			
Total		92	Total		17

RCT: Request for Changes of Text, ACT: Announcement of Changes of Text, RGC: Request for Group Coordination, AGC: Announcement for Group Coordination, No: number of occurrences of each move.

Table 3. Statistics of response moves

Types of moves		No
Pure Response	Simple Response	16
(28 moves)	Complex Response	12
Responsive Announcement	R-ACT	New Version Notification
(9 moves)	(6 moves)	Change Notification
		Plan for Changes
	R-AGC	Information
	(3 move)	Activity
		Planned Activity
Total		37

R-ACT: Responsive Announcement of Changes of Text, R-AGC: Responsive Announcement of Group Coordination, No: number of occurrences of each move.

6.2 Structure of dialogues

Severinson Eklundh has observed that asynchronous computer mediated dialogues are typically 2-part in structure, i.e. there are only an initiation and a response in dialogues [13]. This means that the third part of an independent feedback move in an interaction, which serves as confirming and evaluating previous moves, is often missing. According to the data in this study, among 60 topics discussed, i.e. 60 interactions, only three instances included feedback moves, i.e. the majority of dialogues is 2-part. Thus, the present study supports previous research in terms of the minimal format of dialogues.

Based on this conclusion, the current study defines *minimal interactions* as interactions containing only an initiating move and a response to it. I also define *extended interactions* as other interactions than minimal interactions. An extended interaction is more complex, in that there are more moves committed than the minimal ones. This in many cases occurs due to a third person's involvement in the dialogue between two participants. In particular, some interactions include revisions of text themselves as responses, instead of responding by making comments. I call these interactions *request-revision interactions*. They occur extensively in the context of collaborative writing.

The distribution of interactions by these categories is shown in Table 4. In total, 55 of 60 topics appeared in the case were properly discussed, while 5 topics remained unresolved, which are felt to be *dangling* to members because responses to their requests are missing. That is, 55 completed and 5 dangling dialogues have been developed. The statistics shows that 41 of 55 completed dialogues (74.5%) were either minimal or request-revision interactions, while 14 (25.5%) were extended ones. This result shows that a major pattern of interaction with respect to its length is short, i.e. minimal.

Table 4. Frequency of occurrences of different types of interaction

Types of interaction	No. of dialogues
Minimal interaction	18
Request-revision interaction	23
Extended interaction	14
Dangling interaction	5
Total	60

6.3 Multiple threads and density of information

Black et al. have claimed that strict sequentiality is not a universal feature of discourse [1]. Rather, they have argued that asynchronous discourse has multiple threads:

“When communicating through a medium which was not temporally bound, individuals adapted by increasing the density of information in each message to help to compensate for the lag between messages, using timesaving devices.” (p. 75)

In our the data, writers discussed one to 11 topics in each comment. They treated on average 2.09 topics per comment. When it comes to the number of words written, 4,765 words were produced during the whole reviewing process. This means that on average, 74.5 (= 4,765 / 64) words per comment were produced.

The results suggest that multiple threads and density of information are common features in asynchronous written communication. In fact, because tools for asynchronous communication do not impose any rush on users over a very limited time, different from synchronous ones such as text chat, they can write comments in more elaborated way without time pressure. However, Severinson Eklundh has reported that most messages in an asynchronous message system dealt with only one topic in her study [13], which is an opposite result to this study. Therefore, we need to be cautious to generalize the results obtained in the study. Instead, factors such as the tools used for written communication and the nature of collaborative tasks can affect the results.

7. Selected results

A purpose of the study was to relate results of the analysis to two design issues of dialogue support and comment categorization. In this section, I present only a selection of the results that I think are most important with respect to the purpose.

7.1 Dialogue support: temporarily scattered comments

Collaboració allows users to write a comment at any time. Therefore, comments do not appear in the system at one time, but are gradually accumulated over a period of time, which means that different comments are dispersed in time. Such *temporarily scattered comments* form dialogues where there are initiations and responses, as we have seen in the previous section. This section presents results concerning how writers cope with scattered comments.

(1) Statistics: Four writers exchanged 64 comments that formed many dialogues. Whereas dialogues about the abstract were carried out intensively, comments were largely scattered in time while they revised other sections. Table 5 shows how they are dispersed over a period of three weeks of reviewing of the document (The first row represents elapsed days during the reviewing process).

Table 5. Distribution of comments

Day	1 st -4 th	5-8 th	9-12 th	13-17 th	18-22 nd	Total
Abstract	0	0	0	0	13	13
Ideas ...	4	3	6	6	3	22
Section1	4	6	2	1	1	14
Section2	2	3	3	2	1	11
Section3	1	1	2	0	0	4
Total	11	13	14	9	19	64

(2) Email notification and response time: Provision of automatic email notification of comments in Col•laboració leads writers to sense the on-going activities of others. In addition, it may bring about fast responses that facilitate the process of dialogues by comments, because usage of email is part of everyday life for participants. Amongst 51 initiation moves requiring responses, 28 were responded to within three hours, 16 within a day, 2 within a week, and 5 were forgotten (see Table 6). Thus, the result may suggest that email notification promotes immediate response, and mitigate the dangling communication.

Table 6. Number of responded initiation moves by each elapsed response time

<i>Elapsed response time</i>	<i># of responded initiations</i>
Within 3 hours	28
Within a day	16
Within a week	2
No response (Dangling)	5
Total	51

(3) Suppression of responses: A crucial activity within collaborative writing is reviewers' act of commenting, which is according to the data mostly connected with request for further changes. However, writers' responses to these are, in many cases, suppressed until a sufficient number of comments are gathered. A typical scenario from the data is this:

Luke specified a problem in a part of the introductory section written by Eva. Five days later, agreeing with him, Mona made the first comment pointing out that some important aspects of the paper were missing. 6 minutes later, she also sent members the second comment where problems of choosing inadequate words were handled. 13 minutes later, she again submitted the third comment dealing with a problem of a sentence. Three hours later, Luke showed his assent to Mona's points in her first comment. By that time, the writer of the section, Eva, had not responded yet to comments made, but had just reflected on them. Finally, one and a half hour later, she wrote, "Taking account of your comments, I will revise the introduction and ..."

As we see in this scenario, the writer does not respond to every comment made by reviewers. At a certain point in time, the writer instead answers all comments generated at one time. Particularly, announcement of changes in text is an efficient technique to respond to all previous comments, because the writer conveys the intention to reviewers that he or she has considered their comments, even without substantial efforts to respond to each comment. I found 6 instances of this in the data.

(4) Request-revision interaction: I have previously mentioned the request-revision interaction where the writer responded not by making comments or announcing (a plan of) changes, but by revising text, reflecting many accumulated comments. This interaction was extensively found, and is similar to the phenomenon of suppression of responses, in that the writer does not respond until a certain number of comments are gathered. In fact, revision is a good method of reacting to multiple comments.

7.2 Comment categorization

The better comments are organized, the easier writers can understand and access comments. In particular, comment categorization is critical when writers work with temporarily scattered comments. Here, I present some interesting observations from participants' ways of commenting in relation to comment categorization.

(1) Section-based classification: As mentioned before, Col•laboració presents comments grouped by individual sections. This means that each section is a criterion for categorizing comments. According to the data, most response moves (34 of 37 response moves) were made under the same section that was linked to their associated initiation moves. This may imply that writers were well-adjusted to section-based classification of comments. If they had not been so, many response moves would have appeared in a different category from their related initiation moves. Particularly when participants had a difficulty of finding where a comment should be put, they tended to use a special link (or section) of "Ideas for the paper" which is a place for discussions of the document as whole, apart from that of individual sections.

(2) Text vs. coordination: Two important objects of dialogues are the text itself and team coordination for the production of the text. 24 moves (17 initiation and 7 response moves) were found related to group coordination. To discuss it, writers mainly used the link of "Ideas for the document". 15 of 24 moves were linked there, while 9 other moves were distributed in different sections.

Writers sometimes used email alone to discuss their group coordination. However, there seems to be a difference between the usage of emails and of the commenting function. Of all 7 emails exchanged, 5 were about scheduling of meetings, and 2 were about the distribution of paper copies of the document. However, writers utilized the commenting function in other contexts, e.g. discussing a particular role assignment, discussing coordinating strategies, informing members of certain activities, and of a new participant.

(3) Role fuzziness. While analyzing dialogues in terms of roles of participants, there was a great difficulty in identifying their roles between addressees and side participants. Take a look at the following interaction:

Eva: Ralf, ... I have in mind two options based on your text. Option 1 ... Option 2 ...

Ralf: I don't like the second option. ... I made changes, and there are three options on line.

Mona: Possibly though, ... in this respect, I liked Eva's short version (Option 2).

Ralf: This is a new version for the abstract.

In this interaction, Eva's first move was a request for changes, suggesting two alternatives of the abstract of the document. Then, showing an objection to the second option, Ralf changed the text based on Eva's first option. However, Mona expressed her preference of Eva's second option that had been previously opposed by Ralf. After that, Ralf made and announced another version. Though Eva designated Ralf as addressee explicitly at her first move, it is actually uncertain to judge if Ralf alone is the addressee and other two members are just side participants. This is because all four participants were actively engaged in discussions concerning the abstract of the document.

Interestingly, collaborators tended to omit the names of addressees when writing a comment. In only 12 of 64 comments, they designated addressees explicitly. This indicates that they have assumed either that all members are addressees, or that addressees are understood by context. Lack of explicit designation of addressees may stem from a vague borderline between addressees and side participants.

(4) Language games: multiple meanings of a dialogue. The most frequently occurring kind of games is the *change-request* game consisting of two moves, a request for changes of text and a response. A typical pattern of responding in this game is to announce either that the respondent plans to revise text later on, or that he or she has already revised. There were several *question* games identified, where a question and a response are exchanged. Some *announcement* games were also found in the data. In these games, a speaker asserts something such as a fact, belief, opinion, etc, and a listener shows reactions to it. Participants often discuss together how to coordinate their work during the writing process. A typical game in relation to it is the *action-seeking* games mentioned earlier. The *voting* game where there are an initiation move suggesting different alternatives, and related response moves from participants is an example of all members' participation in a dialogue.

However, while our use of language games has been to identify typical games, or interaction patterns, possibly providing a taxonomy of them, the analysis reveals that a move cannot be always categorized as an element constituting only a single game, but has multiple expectations in it. Let us take an example for this as follows:

Mona: "Something strange has happened to this section. There seems to be both the old and the new text, pasted onto each other."

Ralf: "... the problem was when Eva updated the last version. Maybe she included the new section, but the old one was deleted only in part. ..."

This is an example of the *announcement* game. In the example, a participant (Mona) first reported an error of the mingling of the old and the new text, and then the respondent (Ralf) explained why it happened. On the other hand, the game could be interpreted as a question game, in that Mona asked a question about why the old and the new text appeared together. The example is also to be viewed as a change-request game, since Mona's intention might be to let someone else make changes to the document where the old and the new text were strangely arranged.

As we see in the example, an interaction is not confined to a single purpose. It rather conveys several possible intentions that participants may have. Taking the complexity behind the classification into account, I would like to point out that the meanings and expectations of an interaction are ambiguous, and that it could be often represented by a number of language games.

8. Discussions concerning the design

This section discusses the two design issues of dialogue support and comment categorization in relation to the results obtained.

8.1 Dialogue support: scattered vs. packed comments

By writing a comment at any time when they want to, collaborators are free from time pressure in doing their tasks. However, while freedom can be a blessing to reviewers, it may not be so to writers. Considering the traditional way of reviewing, by which reviewers write comments by pen on paper copies of documents, and pass them to the writer, writers usually obtain comments at one time, rather than over a period of time. Getting comments at one time has the advantage that writers are able to reflect on all comments together, structuring further revisions of text.

On the other hand, when comments are delivered one by one, writers face new problems: they can be distracted due to temporally scattered comments, or wonder if they should revise text based on comments collected so far or wait for more comments to come. As the data obtained from the case showed, comments were largely dispersed in time in all sections but the abstract of the document. A member, Mona, said: "I felt we were spending much time working on this paper ... In a way, the system may actually make people communicate too much about writing instead of thinking ...". This may have been related to some inefficient aspects of working with scattered comments. The two observed phenomena of "Suppression of responses" and "request-revision interaction" also provided evidence that writers encountered those problems, while revealing how they coped with the problems. Ironically, the freedom that Col•laboració provides may reduce the efficiency of revising text compared to the traditional way.

This is actually a matter of decision in designing a system either to support '*scattered comments*' to offer co-authors freedom from intensive workloads, or to lead to '*packed comments*' at one time to bestow them efficiency. On the other hand, writers can discuss these problems with reviewers and ask for comments before a certain time, which implies that some problems can be solved not only by designers, but also by social interaction.

Col•laboració is a typical system that promotes comments dispersed temporarily. Interestingly, scattered comments as well as email notification about them that can reduce response times are deeply related to aspects of dialogues. According to the data, scattered comments produced with Col•laboració formed 55 completed dialogues. This is because participants can react to a comment freely at any time by using Col•laboració.

On the other hand, packed comments are more adequate for annotations, which means that communication by them is more one-sided than conversational. Since packed comments are given to the writer at one time, they can mean delivery of a set of annotations on the text, and may reduce chances of dialogues. Importantly, designers may choose between two rationales of the design, either supporting dialogues or supporting annotations.

8.2 Comment categorization

As the number of comments increases, writers need a good organization of comments so that they will not be overwhelmed by a large number of comments. When comments are categorized well, it is certainly easy to access necessary comments, to be aware of an overview of comments in an organized way, and to develop further discourse, mitigating some problems caused by scattered comments.

(1) The ease of categorizing comments. Most response moves (34 of 37 response moves) were made linked to the same section under which their associated initiation moves were recorded. Therefore, participants have matched comments properly with their related sections, which may be a sign that section-based classification is acceptable for writers.

While Col•laboració does not support it, a possible way of categorizing comments can also be achieved by roles in dialogues, speakers (senders of comments), addressees, and side participants. People often want to look at comments directly related to their interests, not wasting time reading other unnecessary comments. Then, they may want to collect comments that they themselves have made and/or comments that they have to read as addressee, rather than as side participant.

However, the results of the study show that writers are likely to omit the names of addressees when writing a comment. It is often difficult for writers to decide who are addressees when more than three people work together. This is in part because there is a fuzzy borderline between addressees and side participants. Thus, it may not be a good design decision to build a mechanism to make writers designate addresses explicitly. Rather, addressees can be understood by context.

An initial intention that I had was to try to identify typical language games was to see if they could be applied to the design in terms of comment classification. However, the fact that an interaction has multiple meanings is a barrier for building criteria of comment categorization. When a comment is understood in more than one way, writers would feel a difficulty of categorizing a comment.

A crucial design principle about comment classification is that when writers make or access a comment, it should be easy to decide on how it is categorized, avoiding ways of categorization where there are ambiguous and multiple interpretations. Believing that section-based classification is a reasonable way of placing different comments, I think that we need more studies to examine what categorizations are easy to grasp and adequate for given tasks.

(2) Support for flexibility: It is often hard to find a way of categorization that can completely reflect reality [2]. If so, when people have difficulty assigning something to a category, what do they do? Col•laboració provides places for commenting on text, but not those for discussing team coordination. Therefore, when writers want to discuss how to coordinate their work, they may hesitate in deciding where to write comments on it. According to the data, however, writers tended to make comments on coordination activities linked to a special section, "Ideas for the paper", provided for discussions of the document as a whole.

Based on this result, I believe that while section-based classification can be a plausible solution in organizing comments, addition of a separate section to discuss other topics than topics related to individual sections is desirable to provide flexible categorization of comments.

On the other hand, members did not deal with all coordination activities by the commenting function. They sometimes used email alone, e.g. for scheduling meetings, while other activities were discussed via Col•laboració, e.g. assigning a member to be editor to finalize the documentation work. This implies that a comment categorization that the system provides may not be adequate for certain issues like scheduling.

Human behaviors are flexible. When writers feel a difficulty in assigning a comment to a certain category, they try to match it with the most adequate category allowed by the system. If they still find it inadequate, they discuss the matter via other ways such as email and face-to-face conversation. Therefore, an important factor that designers should be aware of is flexibility support.

9. Conclusions

This study has emphasized that written comments in collaborative writing are not merely annotations of documents but form dialogues between writers, revealing the structure and properties of written dialogues. My emphasis on dialogic aspects in this paper hopefully helps researchers and designers understand the tradeoffs of dialogues versus annotations, and temporarily scattered versus packed comments. As the number of dialogues increases, the organization of dialogues is also necessary for facilitating further conversations. Supposing that comment categorization is crucial in that respect, I believe that when scattered comments are organized well by a nice categorization easy to understand and flexible to use, written dialogues through comments are more beneficial.

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