Chapter 21

# Studying Response-Structure Confusion in VMT

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**Abstract**:     Online text chat has great potential for allowing small groups of people in school or at work to build knowledge and understanding together. However, chat participants often post in parallel, making it difficult to follow the conversational flow and to identify who is talking to whom about what. The loosely ordered succession of turns contributes to "response-structure confusion." Parallel posting results in overlap of different topics; as a wave of discussion swells, another washes over it, causing ambiguity of linguistic references. Some chat environments implement tools to reduce the confusion. This paper presents an investigation into the effect of a graphical referencing tool for combating response-structure confusion. The paper documents the problem in a classroom setting and demonstrates the tool's effectiveness in a research lab.

**Keywords**:     Chat response structure, chat analysis method, chat tools

Communication across networked computers allows people to work and learn together despite being geographically distributed. In particular, text chat supports small groups to communicate by typing short messages synchronously. This has the potential to pool the creativity and understanding of several individuals to build knowledge through group interaction. Unfortunately, posting texts in parallel tends to intersperse threads of discussion and cause confusion concerning the references among postings, which are essential for making sense.

If several people are posting in parallel and some are contributing to a wave of ideas on one topic while others are discussing other topics, the various waves will

crash into each other, interfere and cause confusion. In face-to-face conversation, thanks to conversational conventions of turn taking, texts are connected sequentially and linearly by explicit and implicit references to each other. In text chat, these references may be inadequate and require special mechanisms or extensive repair interactions.

One mechanism for avoiding chat confusion was pioneered in ConcertChat (Chapter 15) and explored in the VMT Project (Chapter 17). The mechanism allowed chat participants to connect their postings to previous chat postings or other items by means of an arrow representing an explicit reference. In order to assess the effectiveness of this mechanism in reducing text chat, this chapter reviews the use of the mechanism in a set of VMT chats. This set involved the VMT staff, researchers and colleagues in a series of weekly chats about their academic papers on the project. These chats involved the largest groups of users in the VMT data corpus, making them particularly interesting for observing chat confusion from interference of messages posted in parallel.

## Chat Excitement and Confusion

Chat tools are increasingly being used in education, particularly as distance learning spreads (Fuks, Pimentel & Lucena, 2006). Conversation mediated by the synchronous chat tool is typically informal, providing a space for emotions and decreasing the feeling of impersonality. The situation in which several people communicate at the same time makes it possible for a learner to better perceive herself as part of the group, minimizing the feeling of isolation that is notoriously identified as one of the main causes of disappointment in distance courses. The lively exchange of messages among participants and the de-emphasis of expositive content lead to the displacement of the teacher as a controlling authority, who directs all discourse and assesses all knowledge. This creates opportunities for new forms of teaching and learning that represent alternatives to traditional instructional classroom models. These characteristics make learners regard chat sessions as interesting activities in online courses (Pimentel, Fuks & Lucena, 2003).

Unfortunately, chat conversation also has some characteristics that make it difficult to follow. This well-known problem has been variously referred to in the literature as "chat confusion," "chaotic flow of conversation," "mutual interactional incoherence" or "lack of coherence and understanding" (Cornelius & Boos, 2003; Garcia & Jacobs, 1999; Herring, 1999; McGrath, 1990; O'Neill & Martin, 2003; Pimentel, Fuks & Lucena, 2005; Pimentel et al., 2003; Thirunarayanan, 2000).

Participants in educational chat sessions frequently mention chat confusion. Interviewees typically complain about: the large number of participants typing at the same time; message overload; and parallel conversations. The mixing of messages on different topics causes participants to experience co-text loss (Pimentel et al., 2003). Then confusion moves in; learners report that a high level of attention is required to follow the conversation and that they feel disorientated, anguished, anxious and tired.

Chat conversation is particularly difficult to follow for beginner chatters. Over time chatters develop strategies that enable them to follow the conversation, such as: focusing on the messages addressed to oneself, on those from people with whom the chatter prefers to talk, and on those from the moderator; trying to pay attention to one subject at a time; and trying not to repeat what others have already said. These strategies point to the fact that over time users acquire experience and learn how to better interact, rendering the confusion less disturbing. On the other hand, these participation strategies also make it evident that there is an added effort that could be avoided if the confusion did not occur in the first place. Ideally, chatters should feel excitement and interest without also feeling disorientation, anguish, anxiety and fatigue.

## Response-Structure Confusion

This section discusses the phenomenon of response-structure confusion: its causes, its manifestation and mechanisms that could reduce it. We will consider in this section examples of chat sessions that originate from the 20 iterations of an online course entitled Information Technology Applied to Education (ITAE) (Fuks, Gerosa & Lucena, 2002). Analyses of logs of the ITAE 2000.1 edition (1st semester of 2000), which used the typical chat tool of the AulaNet LMS (Fuks, 2000; Fuks & Assis, 2001; Lucena et al., 2007) are presented. In these chat sessions, hour-long educational debates were conducted with 9 participants, discussing the subjects studied during that week in the ITAE course (Gerosa, Fuks & Lucena, 2003).

### Causes

From text that is "linear" and "well organized," as generally is the case in books, articles and magazine texts, one expects threading, concatenation, sequencing of information and cohesion (Halliday & Hasan, 1976; Herring, 1999; Sacks, Schegloff & Jefferson, 1974). Although a given text may be more than a mere chain of enunciations, it is this chaining that provides for a more legible text. Unlike linear and well-organized text, text from a chat session is non-linear. The majority of the messages are not related to the immediately preceding message. The high degree of non-linearity in a chat conversation is considered the main cause of response-structure confusion.

In order to characterize the non-linearity of a chat session it is necessary to identify the conversational sequences, as exemplified in Log 21-1. There is linearity when a message is related to the previous message. Log 21-1 is non-linear because message 4 is related to a message located three rows prior to it.

*Log 21-1.*

| Line | Nick | Message |
|------|------|---------|
| 1 | Pablo | I want to begin by asking you to comment about the observation I made about the Aulanet being or not being groupware. |
| 2 | Marcelo | Pablo, is there any doubt? |
| 3 | Pablo | If there are no doubts, let's go on to another point. |
| 4 | Geraldo | In my opinion, the aulaNET is groupware given that its objective is to facilitate communication, cooperation and coordination among people. |

The degree of linearity of a chat text is defined here as the percentage of messages related to the previous message. The degree of non-linearity of a chat session is its complement. As exemplified in Figure 21-1, a chat session has a high degree of non-linearity. This graph shows the distribution of relation distances in a chat debate (ITAE 2000.1, debate #1, 9 participants, 256 messages). Relation distance is the difference in position between related messages. Linearity takes place when the relation distance is equal to 1, as illustrated by the chaining between messages 2 to 1 and 3 to 2 of Log 21-1. Non-linearity takes place when the relation distance is higher than 1, as illustrated by the chaining of message 4 to message 1, presenting a distance equal to 3.
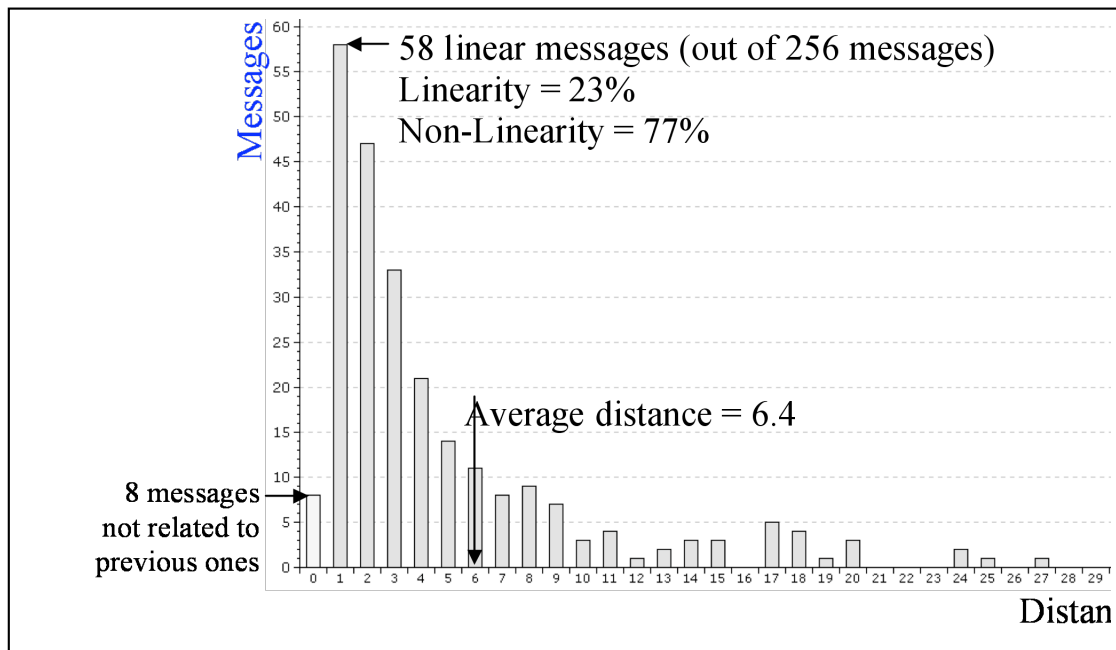


*Figure 21-1. Relation-distance distribution.*

Moreover, in a chat conversation, even the discussion of subjects is non-linear. According to the diagram presented in Figure 21-2, based on the subject analysis of the same chat session, it can be seen that different subjects are discussed in parallel.

SEGMENTS

SUBJECTS

Groupware
examples

Groupware
characteristic

**Characterizing AulaNet
as groupware**

**Other examples of group-
ware beyond AulaNet**

**Co-authoring systems**

**Using groupware**

**Is "Director" groupware
or authoring software?**

**Group memory**

SEGMENTS

SUBJECTS

THEMES

GROUPWARE

COURSE

ITAE
**(Information on
Technology
Applied to
Education)**

GROUPWORK

**Groupware
examples**

**Groupware
Characteristics**

**Commun. tools
*vs* groupware**

**Collaboration
and**

**"Idea alignment"
*versus***

**Coordination in
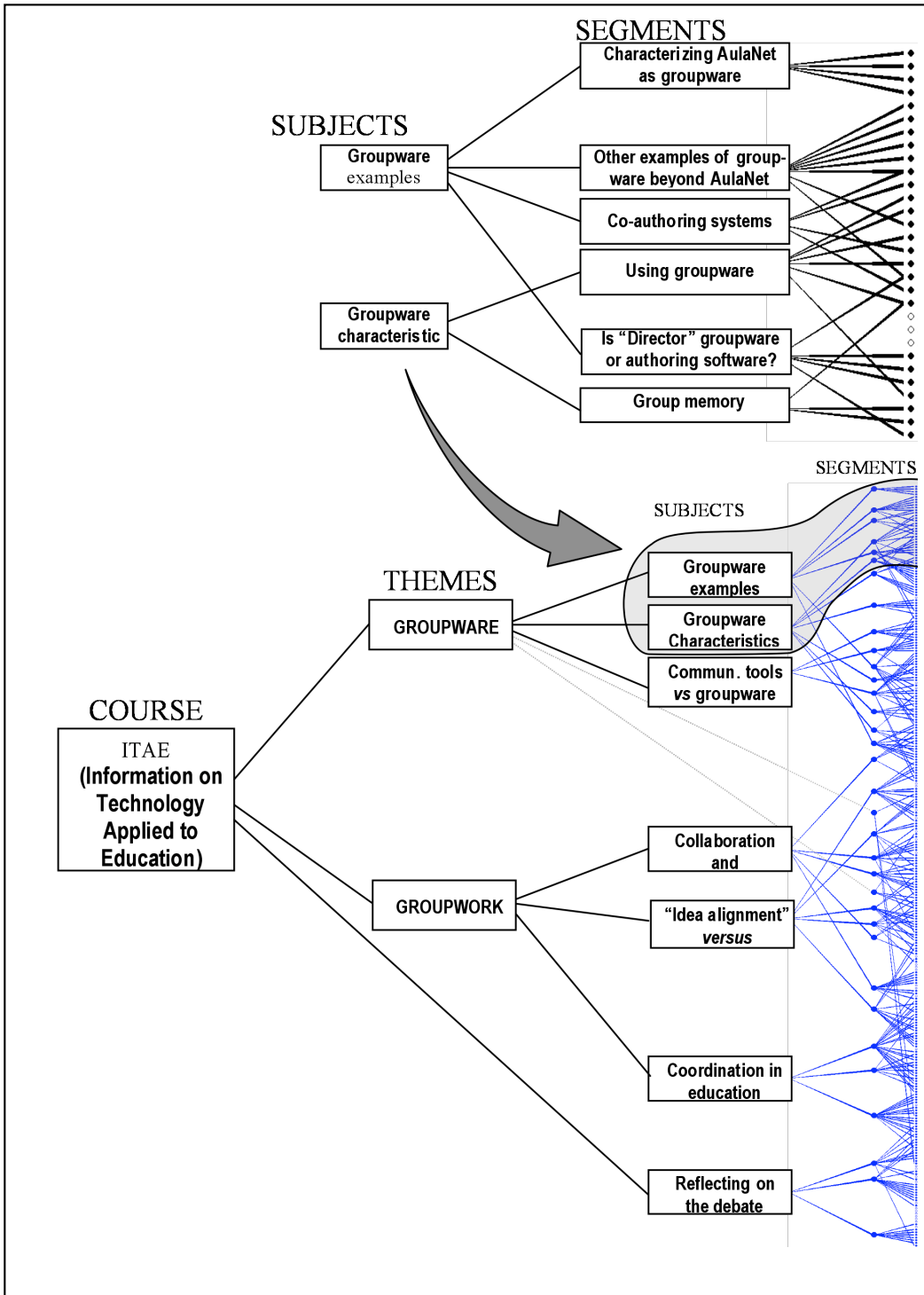education**

**Reflecting on
the debate**

*Figure 21-2. Subject distribution (first 30 messages in detail above).*

If each subject started after the end of the previous one, there would be subject linearity. However, what generally occurs is that different subjects are discussed at the same time, in parallel and alternately, as illustrated by the data presented in Figure 21-3 and Figure 21-4. In Figure 21-3, on average 2 subjects are being discussed in parallel. In Figure 21-4, subject alternation takes place every 2.8
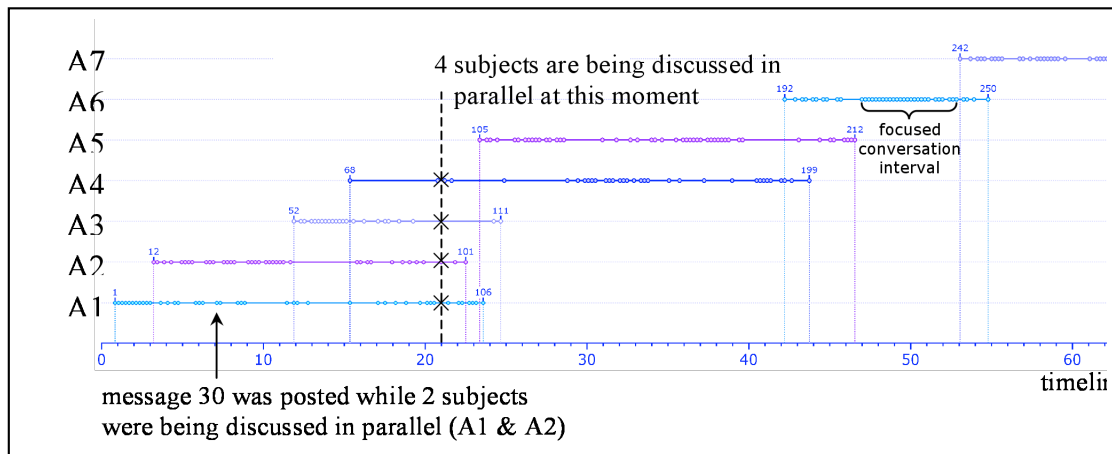


messages on average (91 changes in 256 messages).

*Figure 21-3. Subjects in parallel.*
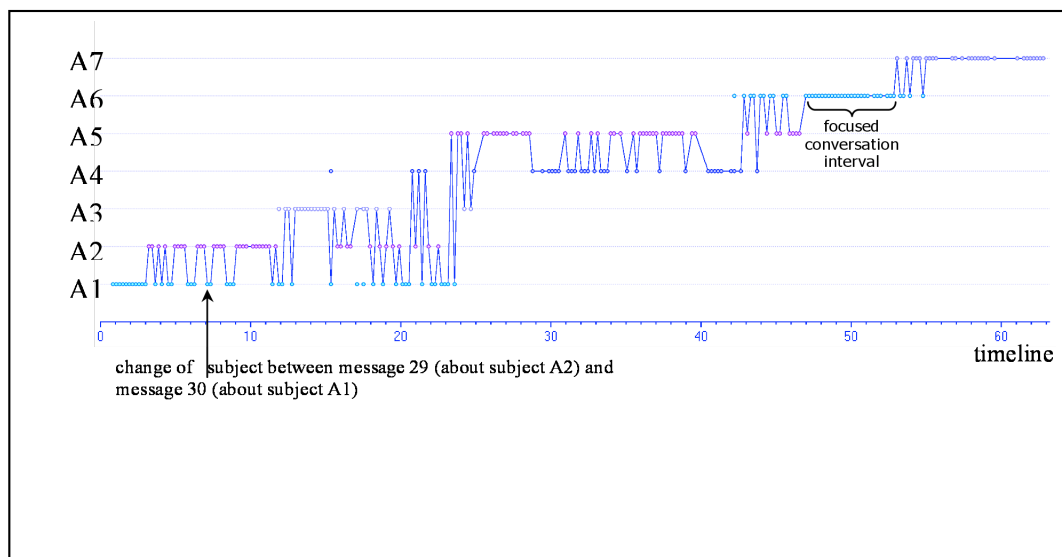


*Figure 21-4. Subject alternation.*

Unlike what occurs in a linear text, subjects in a chat conversation behave like waves. Participants start to discuss a subject—represented as a wave—which gains momentum until it reaches a peak, and then it tapers down until a new subject wave predominates, displacing the previous one. These waves are illustrated by the



diagram presented in Figure 21-5. As the subjects are discussed in parallel and alternately, there is a confluence of waves.

*Figure 21-5. Subject waves.*

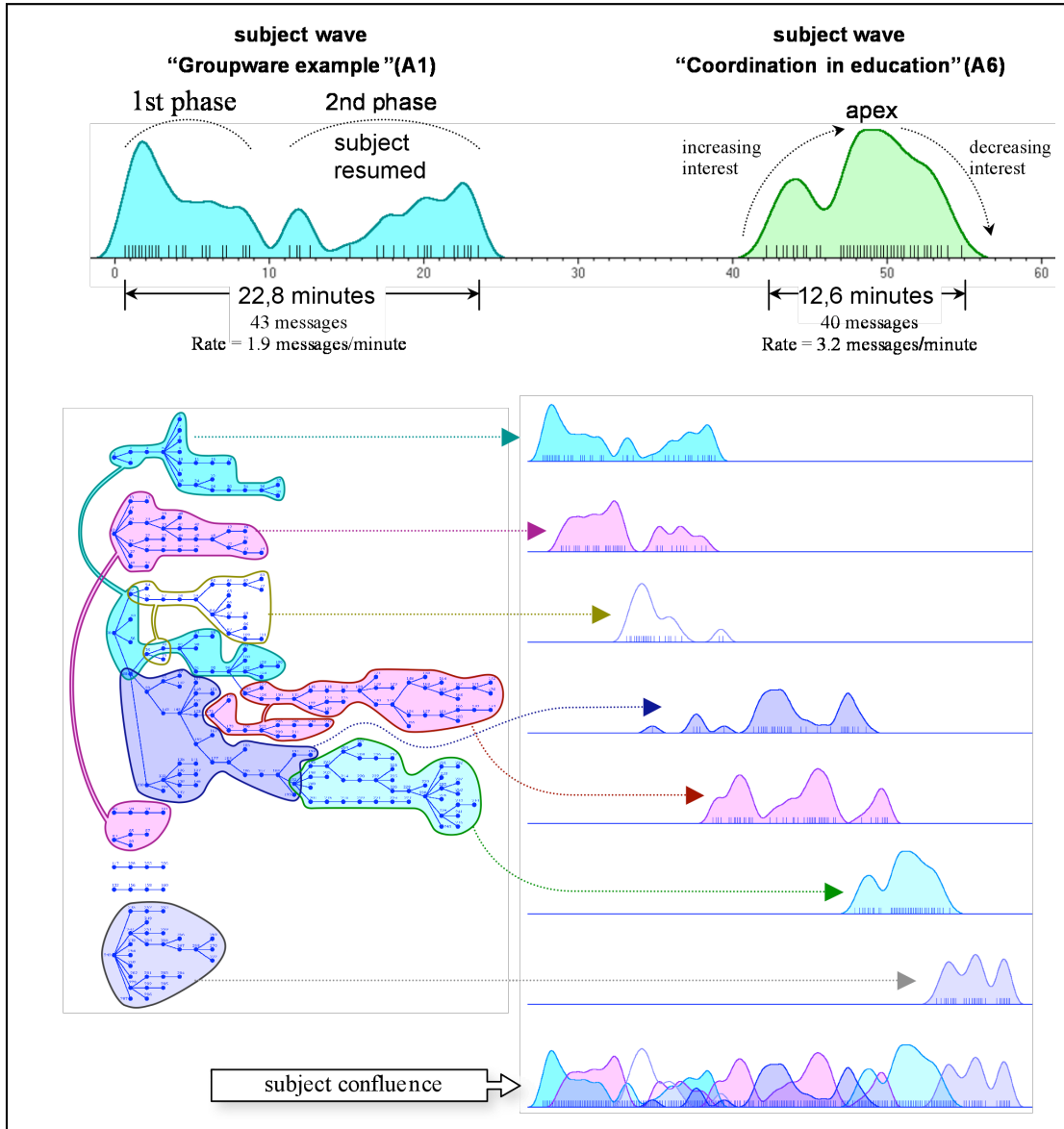The representation of subjects as waves helps to visualize the parallelism of a chat conversation. Although on one hand subjects are being discussed in parallel, on the other hand it can be observed that a subject prevails for a while, as illustrated in Figure 21-6.
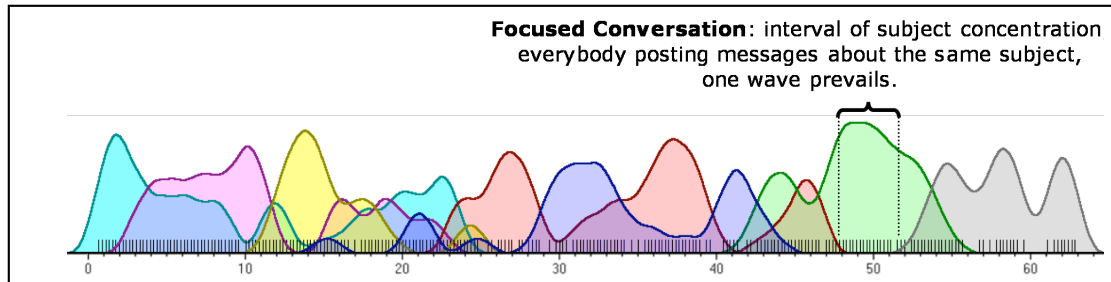


*Figure 21-6. Concentration and confluence.*

Despite our focus here, we do not claim that non-linearity is the only cause of confusion in chat conversation. There are other known problems: lack of links among people and what they say; lack of visibility of turns-in-progress; flooding, overloading and gusting (sudden pouring) of messages; lack of useful recordings and social context; anonymity and flaming; and various other problems (Fuks et al., 2006; Oikarinen & Reed, 1993; Smith, Cadiz & Burkhalter, 2000; Viegas & Donath, 1999).

**Manifestation**

Response-structure confusion is the difficulty in identifying to which previous message each chat message is responding. Eventually, a participant may manifest her confusion in the conversation by posting a message where she states her discomfort in following the conversation, or asks for the sender to confirm or disambiguate her inference. Another way to identify the manifestation of confusion is when the chatter wrongly infers a chaining and another chatter clarifies the misunderstanding. Messages 31 and 167 from Log 21-2 are manifestations of confusion.

*Log 21-2.*

| Line | Nick | Message |
|---|---|---|
| 30 | Liane | I believe that it is just the contrary, that groupware can help in the authoring process since it can facilitate the communication process among members of a team |
| 31 | Homero | Contrary to what, Liane, I'm lost |
| ... | | ... |
| 166 | Liane | I agree... |
| 167 | Marcelo | with what, Liane? |

Counting the incidents that could be identified as manifestations of response-structure confusion is a very rough way of measuring the problem. The manifestations seem to indicate only the tip of the iceberg—not every doubt or confusion is textually acknowledged by the participants.

**Chat Tool Mechanisms**

Chat threading mechanisms have the potential for reducing confusion. Most chat tools do not have a mechanism for establishing references among messages. A few tools such as ThreadedChat (Smith et al., 2000), HiperDialog (Pimentel, 2002) and MuViChat (Holmer, Lukosch & Kunz, 2008) structure the discourse in a tree, forcing chatters to indicate always to which previous messages their current message is an answer as in forums (Gerosa et al., 2003).

ConcertChat (see Chapter 15)—which was adopted and adapted in VMT—offers a mechanism for referencing messages that is optional. It is a hybrid solution between the chat systems without referencing and the chat systems where all messages are chained. The aim of this chapter is to investigate confusion given the VMT environment's graphical referencing mechanism.

# Response-Structure Analysis Method

In this section, the strategies developed to analyze chat sessions are introduced. In order to exemplify the response-structure analysis method, first the corpus of analysis of this work is presented.

**Corpus of Analysis**

The chat sessions analyzed in this section took place through the VMT chat environment. The purpose of the sessions was to discuss papers prepared for the Chat Analysis Workshop at CSCL 2007. These papers comprise early drafts for this volume. Table 21-1 presents a synthesis of the sessions' data.

*Table 21-1. Data from the VMT chat-analysis workshop.*

| Session | Day/ Month | Number of messages in the log | Number of discussion messages | Number of participants | Chapter in book | Elapsed time of discussion |
|---------|-----------|-------------------------------|-------------------------------|------------------------|-----------------|----------------------------|
| Nan Paper | 21/05 | 510 | 199 | 11 | 8 | 1h 14min |
| Ramon Paper | 23/05 | 388 | 261 | 11 | 9 | 1h 11min |
| Murat Paper | 25/05 | 311 | 111 | 7 | 7 | 0h 42min |
| Johann Paper | 29/05 | 478 | 249 | 9 | 6 | 1h 24min |
| Stefan Paper | 30/05 | 424 | 311 | 11 | 24 | 1h 19min |
| Chee-Kit Paper | 01/06 | 349 | 203 | 10 | 25 | 1h 36min |
| Liz Paper | 04/06 | 341 | 265 | 8 | 11 | 1h 17min |
| Carolyn Paper | 06/06 | 435 | 284 | 11 | 19 | 1h 09min |
| Alan Paper | 08/06 | 416 | 314 | 10 | 14 | 1h 19min |

| | | | | | |
|---|---|---|---|---|---|
| Terry Paper | 11/06 | 304 | 180 | 7 | 27 | 1h 19min |
| Dan Paper | 18/06 | 287 | 208 | 6 | 10 | 1h 22min |
| Arthur Paper | 20/06 | 141 | 69 | 4 | 13 | 0h 27min |
| **Average** | **-** | **365** | **221** | **8.8** | | **1h 11min** |

These chat sessions took place in the two months preceding the CSCL 2007 workshop. They comprised a total of 12 sessions. On average, in each session 365 messages were exchanged, 221 of them being identified as discussion messages. The discussion part of the chat sessions took an average of 1 hour and 11 minutes. Including the papers' authors and co-authors, an average of 9 people associated with the VMT Project joined in the discussion session. Their objective was to discuss ways to enhance their papers.

**Discussion Messages**

The first step of the response-structure analysis method is to isolate the messages that are relevant for the analysis, classifying log messages in types, namely: system messages, pre-discussion messages, discussion messages and post-discussion messages. This typology is shown in Log 21-3, using the data from the session on Nan's paper. System messages announce the participants who are joining or leaving the chat session. Pre-discussion messages are exchanged before the "real thing" starts and include all sorts of greetings; the same is true for post-discussion messages at the end of the session, where participants say good-bye. Discussion messages deal with the subject being discussed, including coordination messages and jokes. The data analyzed in the next sections only considers the discussion messages.

*Log 21-3.*

| Type | Line | Time-stamp | Nickname | Message |
|---|---|---|---|---|
| | 1 | 9:48:33 | stefan | joins the room |
| | 2 | 9:50:08 | stefan | leaves the room |
| system messages | | | | ... |
| | 19 | 14:39:41 | dennysj | joins the room |
| | 20 | 14:51:29 | Gerry | joins the room |
| | 21 | 14:55:12 | Jsarmi | joins the room |
| | 22 | 14:55:42 | Jsarmi | Hi, there |
| | 23 | 14:55:59 | dennysj | Hi! |
| pre-discussion messages, including hellos | 24 | 14:56:04 | Gerry | Hi Johann and Ramon! |
| | 25 | 14:56:35 | dennysj | Are you all off-campus? |
| | 26 | 14:56:49 | Jsarmi | This should be a great session |
| | | | | ... |
| | 80 | 15:04:05 | Nan | how should we start? |
| | 81 | 15:04:11 | Jsarmi | guess |
| | | | | ... |
| | 86 | 15:04:43 | terry | joins the room |
| | | | | ... |
| | 91 | 15:06:27 | terry | Hi there |
| | 92 | 15:06:35 | Nan | hi |
| | 93 | 15:06:44 | Nan | thanks everyone for coming |
| | 94 | 15:07:06 | Jsarmi | quite a crowd! :-) |
| | 95 | 15:07:45 | Jim_Waters | So, Nan, what is the punchline ? |
| | | | | ... |
| discussion messages | 98 | 15:09:50 | Nan | i wanted to argue when small groups collaborate on math problem solving, information is constructed and made sense of by the participants through their interactions |
| system message | 99 | 15:10:12 | stefan | joins the room |
| | 100 | 15:10:38 | stefan | hi all |
| pre-discussion messages | | | | ... |
| | 112 | 15:13:10 | stefan | it's great to meet you all here |
| | 113 | 15:13:18 | Nan | this paper is part of my dissertation research studying information behavior of small groups in the networked environment |
| | ... | | | ... |

As exemplified by Log 21-3, even after trying to start the discussion by posting messages 80 and 81, participants might continue sending pre-discussion posts like messages 91 to 94. There is also a late chatter who automatically generates a system message (99) and then greets the group (100). In Nan's session, the discussion started on message 80, falling back to a pre-discussion phase that lasted until message 113. From then on all participants engaged in the discussion.

## Referencing Messages: Explicit and Inferred

After isolating the discussion messages, the next step is to get the response structure. For each message, we identified which previous message it takes up. This establishes a chain (not necessarily sequential) of messages. VMT chat offers a referencing mechanism that allows chatters to explicitly reference a previous message. However, given that the use of this mechanism is optional, there are non-referenced messages in the log, leaving the job of inferring references to the reader or analyst. The strategies described below help the reader to infer these references. The mapping of all the response structure of a chat session is necessary in order to carry on with the confusion investigation.

In Log 21-4 from the chat on Stefan's paper, solid arrows represent the explicit references established by the chatters, while the dotted arrows represent the references inferred by the reader. For example, in message 65 Stefan uses the referencing mechanism to link his message to message 58 in response to Nan's questioning. On the other hand, message 59 posted by Wes also refers to Nan's message 58, but given that Wes made no use of the referencing mechanism, the relation had to be inferred by the reader from the content of Wes' message, which began by explicitly addressing Nan.

*Log 21-4.*

| Type | Line | Time-stamp | Nick | Message |
|---|---|---|---|---|
| | 33 | 15:03:30 | gerry | Stefan, do you want to make an opening statement about your paper? |
| | | | | ... |
| | 44 | 15:04:34 | stefan | thank you Gerry! after entering I read the text on the whiteboard |
| | | | | ... |
| | 54 | 15:05:39 | stefan | and I think that you pointed excelently maybe the most important idea of the paper |
| | | | | ... |
| | 56 | 15:06:37 | cprose | i have to say, I agree with Alan's comments |
| | 57 | 15:07:21 | stefan | I have read also what Alan wrote |
| | 58 | 15:07:41 | Nan | i have some trouble understanding the idea of voices, that what they really mean to capture |
| | 59 | 15:08:37 | wes | Not sure I understand your question nan |
| | 60 | 15:08:38 | cprose | i would think if anything, dissonance should be related to the idea of socio-cognitive conflict, which would be a good thing rather thn a negtive thing |
| | 61 | 15:08:46 | Nan | i couldn't find where this concept is explained in the paper and i had to wonder by myself |
| | 62 | 15:08:57 | wes | ah |
| | 63 | 15:09:06 | azemel | good point |
| | 64 | 15:09:14 | wes | i will leave that to Stefan |
| | 65 | 15:09:22 | stefan | the idea of considering voices and polyphony is offering a model that can be used for analysing how is meaning made |
| | 66 | 15:09:22 | cprose | i am also wondering - what does this analogy really buy us? does it allow us to see some important pattern we didn't already know about? |

**Legend:**

⟶ explicit reference

- - -▶ inferred reference

The reader should consider the following strategies in order to infer references among messages: recency analysis, cohesion analysis, turns and conversational sequences analysis, subject analysis, context analysis and coherence analysis (Pimentel & Sampaio, 2001).

*Recency Analysis*

Usually chatters tend to answer more recent messages. Normally, most messages are related to messages posted not longer than 2 minutes earlier; they rarely answer messages 5 minutes old (Pimentel, 2002). On the other hand, a regular chatter needs some time to read a message and type a response: it might take 30 seconds to enter a turn (Vronay, Smith & Drucker, 1999). Therefore, it is quite improbable that a paragraph-long message is related to a previous message that is just 10 seconds old. These recency patterns guide the reader in trying to infer the referencing of a message to messages posted in the previous time interval ranging from 10 seconds to 5 minutes. For example, the reader should not consider message 59 when trying to infer message 60's referencing, for it was posted only 1 second before. He should also refrain from considering messages before message 33, itself older than 5 minutes. It is probably the case that message 60 is related to messages within the 54 to 58 scope given their recency.

*Cohesion Analysis*

Looking for grammatical and lexical links between messages is another strategy that should be pursued by the reader. Cohesive devices are employed by chatters when preparing messages. In Log 21-5, the expression "**the idea of voices**" that appears in message 58 is repeated in message 65, constituting a lexical cohesion (Halliday & Hasan, 1976) that helps the reader to infer a referencing between them.

*Log 21-5.*

| | | | |
|---|---|---|---|
| 58 | 15:07:41 | Nan | i have some trouble understanding the idea of voices, that what they really mean to capture ... |
| 65 | 15:09:22 | stefan | the idea of considering voices and polyphony is offering a model that can be used for analysing how is meaning made |

*Turns and Conversational Sequences Analysis*

In the basic dialog model, interlocutors wait for their turn to speak (Sacks et al., 1974). In a face-to-face conversation going on between more than two persons, a common conversation coordination mechanism is to look to the person to whom the answer is addressed. When many persons are chatting, it is common to write in the responding message the addressee's name (handle or nickname), as exemplified in Log 21-6.

*Log 21-6.*

---

33   15:03:30   gerry   Stefan, do you want to make an opening
                          statement about your paper?
                          ...
44   15:04:34   stefan   thank you Gerry! after entering I read the text
                          on the whiteboard

---

Another way to infer the reference between messages is to identify conversational sequences (adjacency pairs) where one turn or message leads to another, like: question → answer; invitation → acceptance or refusal; greeting → greeting; challenge → justification etc. In the example presented in Log 21-6, it is expected that after Gerry offers the floor to Stefan to open the discussion, Stefan will react to it by posting a message.

It is likely in a chat conversation that the sequence of messages exchanged between two chatters will be separated by unrelated messages. The more active participants there are the more likely this is to occur. The reader should look for a previous sequence of messages from the same pair of chatters, as exemplified in Log 21-7, which shows an example of a two-person dialog embedded within a many-persons chat.

*Log 21-7.*

---

58   15:07:41   Nan   i have some trouble understanding the idea of
                       voices, that what they really mean to capture
59   15:08:37   wes   Not sure I understand your question nan
                       ...
61   15:08:46   Nan   i couldn't find where this concept is explained
                       in the paper and i had to wonder by myself
62   15:08:57   wes   ah

---

Monologs are also quite common in chats: the same chatter sends message after message fostering a "long turn" like the one in Log 21-8. This is a consequence of message recency, for it might be better to post 2 or 3 short messages than take the time to write a long elaborate message and risk that the chat context will change substantially in the meantime. Therefore, the reader should also look to the same chatter's previous messages in order to infer references.

| 56 | 15:06:37 | cprose | i have to say, I agree with Alan's comments |
| | | | ... |
| 60 | 15:08:38 | cprose | i would think if anything, dissonance should be related to the idea of socio-cognitive conflict, which would be a good thing rather thn a negtive thing |
| | | | ... |
| 66 | 15:09:22 | cprose | i am also wondering - what does this analogy really buy us? does it allow us to see some important pattern we didn't already know about? |

*Subject Analysis*

Normally, when answering a message, chatters stick to the same subject or write something related to it. During a conversation, a subject unfolds until it is finished, abandoned or drifts off into a different subject. In Log 21-9 it is possible to identify groups of messages related to the same subject. The reader should consider messages dealing with the same subject when looking for references.

*Log 21-9.*



| Topics | Line | Time-stamp | Nick | Message |
|---|---|---|---|---|
| | 33 | 15:03:30 | gerry | Stefan, do you want to make an opening statement about your paper? |
| | | ... | | |
| | 44 | 15:04:34 | stefan | thank you Gerry! after entering I read the text on the whiteboard |
| Stephan`s paper discussion opening | | ... | | |
| | 54 | 15:05:39 | stefan | and I think that you pointed excelently maybe the most important idea of the paper |
| | | ... | | |
| | 56 | 15:06:37 | cprose | i have to say, I agree with Alan's comments |
| | 57 | 15:07:21 | stefan | I have read also what Alan wrote |
| | 58 | 15:07:41 | Nan | i have some trouble understanding the idea of voices, that what they really mean to capture |
| | 59 | 15:08:37 | wes | Not sure I understand your question nan |
| The relevance of the analogy | 60 | 15:08:38 | cprose | i would think if anything, dissonance should be related to the idea of socio-cognitive conflict, which would be a good thing rather thn a negtive thing |
| | 61 | 15:08:46 | Nan | i couldn't find where this concept is explained in the paper and i had to wonder by myself |
| The concept of multiple voices | 62 | 15:08:57 | wes | ah |
| | 63 | 15:09:06 | azemel | good point |
| | 64 | 15:09:14 | wes | i will leave that to Stefan |
| | 65 | 15:09:22 | stefan | the idea of considering voices and polyphony is offering a model that can be used for analysing how is meaning made |
| | 66 | 15:09:22 | cprose | i am also wondering - what does this analogy really buy us? does it allow us to see some important pattern we didn't already know about? |

*Context Analysis*

In order to infer references, sometimes the reader has to make use of information that is not within the log. VMT offers a whiteboard where chatters can pose and share information related to the session, but which does not appear typed in the chat. Eventually, this information makes its way into the chat conversation—as is the case of messages 44, 54, 56 and 57 in Log 21-9, where chatters discuss Gerry's and Alan's whiteboard comments. This contextual information helps the reader in inferring references.

*Coherence Analysis*

In order to infer references among messages, coherence has to be investigated: the reader should question whether a message makes sense as being a response to another one. The conversation is expected to make sense, unfolding in a sound way. Consistency, relevance, linguistic elements, etc., should be considered when looking for coherence.

All these strategies help the reader to infer references among messages. Nevertheless, sometimes this inference is blurred by ambiguity causing the occurrence of response-structure confusion.


# Data Analysis

In this section, the data are analyzed in order to investigate response-structure confusion, and particularly to check whether the use of the referencing mechanism implemented in VMT reduces confusion. The first step is to characterize how the mechanism was used based on its frequency of use. Next, a study of the profiles of different users regarding their use of the referencing mechanism is presented: some chatters establish references systematically in all the messages they write, while others almost never make use of the mechanism. Finally, a study of the occurrence of response-structure confusion is presented, indicating that there was confusion even with the use of the referencing mechanism in the VMT environment.

**The Frequency of Use of the Referencing Mechanism**

Table 21-2 synthesizes the data obtained from the chat sessions of the corpus under investigation regarding the use of the graphical referencing mechanism implemented in VMT.

*Table 21-2. Referencing data.*

| Discussion Session | Number of Discussion Messages | Number of messages with explicit reference | Number of explicit references to text fragment | Number of messages with explicit reference to workspace | Number of messages with several explicit references |
|---|---|---|---|---|---|
| Nan Paper | 199 | 115 (58%) | 3 | 2 | 4 |
| Ramon Paper | 261 | 128 (49%) | 6 | 1 | 2 |
| Murat Paper | 111 | 41 (37%) | 2 | 2 | 3 |
| Johann Paper | 249 | 131 (53%) | 19 | 1 | 2 |
| Stefan Paper | 311 | 166 (53%) | 10 | 0 | 1 |
| CheeKit Paper | 203 | 136 (67%) | 11 | 0 | 2 |
| Liz Paper | 265 | 136 (51%) | 5 | 0 | 0 |
| Carolyn Paper | 284 | 56 (41%) | 0 | 1 | 3 |
| Alan Paper | 314 | 151 (48%) | 13 | 1 | 2 |
| Terry Paper | 180 | 104 (58%) | 4 | 1 | 1 |
| Dan Paper | 208 | 111 (53%) | 9 | 0 | 0 |
| Arthur Paper | 69 | 42 (61%) | 4 | 0 | 1 |
| Average | 221 | 110 (50%) | 7.2 | 0.75 | 1.75 |

The *referencing mechanism was used in half of the messages* (see column "Number of messages with explicit reference" of Table 21-2—this is the type of reference represented graphically by solid lines in Log 21-4). This 50% average indicates that the referencing mechanism was widely used. From the logs' analysis, it can be verified that the references between messages were established almost error-free, as in Logs 21-1 to 21-9 presented thus far. Log 21-10 from Nan's paper's session shows a counter-example: in message 340 the chatter established the reference erroneously and alerted peers about that error in the subsequent message.

*Log 21-10.*

| | Type | Line | Time-stamp | Nick | Message |
|---|---|---|---|---|---|
| wrongly established reference → | | 334 | 17:23:26 | murat | sorry being a math geek again, but I think these were the things this group was missing |
| | | | | | ... |
| | | 336 | 17:23:43 | Jsarmi | :-) the member's account |
| | | | | | ... |
| | | 340 | 17:24:08 | murat | hey I was moderating that session, so I am a quasi member at least:-) |
| | | 341 | 17:24:23 | murat | sorry, wrong reference |

The referencing mechanism is so useful for chatters that in many cases the reference established among the messages becomes an inalienable part of the discourse, i.e., the reference is used as a means of expression. For example, message 63 of Log 21-11 is better understood taking into consideration the reference established by Azemel to message 60. Had the reference not been established the message would have to be elaborated in a different way, something like: "**cprose: good point**" citing the name of the sender of the message being replied to; or "**good point about dissonance**" introducing cohesion devices.

*Log 21-11.*

| | 60 | 15:08:38 | cprose | i would think if anything, dissonance should be related to the idea of socio-cognitive conflict, which would be a good thing rather thn a negtive thing |
|---|---|---|---|---|
| | ... | | | ... |
| | 63 | 15:09:06 | azemel | good point |

From these data, one concludes that the referencing mechanism is implemented in such a way that it leads to correct usage, and that it is a desirable one because it was incorporated as a means of expression. The non-establishment of references in the other half of the messages seems to be a consequence of the chatters' expression

styles rather than of some problem with using the mechanism (see next section on chatter profiles).

In the VMT system, it is possible to *reference a specific selection of text* within a previous posting by highlighting that section when pointing to it. Regarding the use of the referencing mechanism for citing a text fragment in the body of another message, it was used on average in 7% of the established references—see column "Number of explicit references to text fragment" of Table 21-2. Log 21-12 and Log 21-13 illustrate this way of referencing. In Log 21-12 from the session on Johann's paper, the following posting fragment is highlighted: "**making time reference is not particularly interesting.**" In Log 21-13 from Ramon's paper, the single words "**requires**" and "**Negotiation**" are referenced.

*Log 21-12.*

| | | | |
|---|---|---|---|
| 371 | 17:38:31 | azemel | making time reference is not particularly interesting. how time reference is done sequentially in this kind of interaction space, vmt chat, with the persistence of text and wb objects, and the imposition of sequential order by servers, etc., is really interesting |
| ... | | | ... |
| 375 | 17:38:48 | Jsarmi | agree... completely |

*Log 21-13.*

| | | | |
|---|---|---|---|
| 189 | 15:41:23 | dennysj | Argumentation, I think requires opposing viewpoints. Negotiation may result in merging or even grafting together non-opposing but different positions. |
| ... | | | ... |
| 193 | 16:41:57 | Jsarmi | but this two things are different |

An average of 7% is considerable: it characterizes neither intensive nor low use. However, when analyzing the citation-references, one can conclude that some were established as a result of errors in using the referencing mechanism: the objective was to establish the reference for the whole message, but in the referencing mechanics by mistake some random part of the message was selected. These malformed citations are exemplified in Log 21-14 (Johann's paper) and Log 21-15 (Nan's paper).

*Log 21-14.*

| | | | |
|---|---|---|---|
| 150 | 16:33:50 | murat | I know how hard it is to incorporate graphical stuff to analysis, but it is really a vital resource |
| 151 | 15:34:02 | azemel | indeed |

*Log 21-15.*

| | | | |
|---|---|---|---|
| 248 | 15:57:39 | dennysj | You want to make the case that this is GROUP information behavior in contrast to INDIVIDUAL infomration behavior? |
| ... | | | ... |
| 252 | 15:58:43 | Jsarmi | right, so one thing that I think that will take your paper further (besides the ideas about theory already presented) is to actually name some methods, show more instances and then see if you can ask more questions about them |

From these data and its analyses, one concludes that the citation referencing is desirable and useful for chatters, as it was used properly and frequently. However, the mechanics of citation referencing occasionally leads chatters to committing mistakes.

Regarding *referencing to the workspace*—see column "Number of messages with explicit reference to the workspace" of Table 21-2—this mechanism was used no more than twice per session. This apparent low use of the mechanism is not an indication of its uselessness. It was observed that the mechanism was correctly and continuously used throughout the sessions—it enables the integration between the chat conversation and the workspace objects. The sessions analyzed here were not math problem-solving sessions, as is typically the case for which the VMT system with whiteboard was designed. These were discussions of papers that were not displayed in the system, and the whiteboard was only minimally used.

The possibility of establishing *multiple references originating from a single message,* such as in message 341 of Log 21-10 and as in message 193 of Log 21-13, was used in less than 1% of the messages—see column "Number of messages with several explicit references" of Table 21-2. The very low use of this mechanism and the decrease in its application throughout the chat sessions indicate that referencing multiple messages is not normally useful (or well understood, or easy to accomplish). Establishing a single reference per message seems to be enough in a chat conversation. It is not clear whether the very low use justifies the increase in the complexity of the user interface and of the conversation structure.

## Chatters' Profiles Regarding Referencing

Given that the use of VMT's referencing mechanism is optional, it is possible to identify different profiles regarding referencing. It is striking that some participants use it with full intensity while others practically do not use it at all.

In Table 21-3, the percentage of messages with explicit references is presented. Three types of chatters were identified:

- *Intensive*: establish references in most of their messages;
- *Occasional*: establish references in some of their messages;
- *Low*: rarely establish references in their messages.

*Table 21-3. Chatter profiles.*

| Discussion Session | Chatter Profile on Referencing Mechanism (explicit references/total postings) | | | | | | | | | | | | Non-Counted Participants: those who only participated in 1 or 2 sessions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | intensive user | | | | | occasional user | | | | low user | | | |
| | Dennysj | Stefan | Jim | Jsarmi | Murat | Nan | Gerry | Weigin | Wes | Azemel | Terry | Cprose | |
| Nan Paper | 94% (17/18) | 78% (7/9) | 35% (6/17) | 86% (18/21) | 93% (13/14) | 52% (43/82) | 50% (10/20) | - | - | - | 0% (0/7) | - | Frank: 9% (0/5) Liz: 33% (1/3) Powel: 0% (0/3) |
| Ramon Paper | 91% (40/44) | 86% (12/14) | 79% (15/19) | 77% (20/26) | 70% (7/10) | 57% (13/23) | 32% (7/22) | | 38% (3/8) | 19% (10/54) | 6% (1/16) | 0% (0/25) | - |
| Murat Paper | 50% (3/ 6) | - | 63% (5/8) | - | 57% (13/23) | 29% (6/21) | 25% (5/20) | - | - | 26% (6/23) | 30% (3/10) | | - |
| Johann Paper | 100% (11/11) | 100% (1/1) | 64% (9/14) | 73% (62/85) | 78% (14/18) | 31% (4/13) | 47% (7/15) | - | - | 26% (22/85) | 14% (1/7) | - | - |
| Stefan Paper | 100% (15/15) | 81% (42/52) | 93% (14/15) | 80% (12/15) | 64% (9/14) | 50% (5/10) | 61% (22/36) | | 41% (13/32) | 43% (26/61) | 33% (4/12) | 8% (4/49) | - |
| CheeKit Paper | 89% (8/9) | 100% (4/4) | 79% (23/29) | 87% (20/23) | 82% (9/11) | - | 54% (14/26) | | 90% (9/10) | - | 14% (1/7) | - | Chee: 43%(10/23) Wee: 62%(38/61) |
| Liz Paper | 60% (3/5) | - | 100% (9/9) | 73% (27/37) | 78% (18/23) | 46% (6/13) | 45% (25/56) | | 38% (37/97) | - | - | - | Liz: 44% (11/25) |
| Carolyn Paper | 83% (10/12) | 100% (1/1) | 100% (13/13) | - | 77% (10/13) | 41% (7/17) | 17% (2/12) | 45% (9/20) | 17% (1/6) | 0% (0/9) | - | 1% (2/180) | Mjkhoo: 100% (1/1) |
| Alan Paper | 86% (6/7) | 40% (2/5) | 85% (17/20) | 68% (26/38) | 63% (17/27) | 44% (15/34) | 83% (5/6) | 35% (4/11) | 35% (8/23) | 36% (51/143) | - | - | - |
| Terry Paper | 83% (5/6) | 80% (4/5) | 95% (20/21) | - | 85% (29/34) | 43% (3/7) | 40% (18/45) | - | - | - | 40% (25/62) | - | - |
| Dan Paper | - | 89% (17/19) | - | - | - | - | 48% (22/46) | 33% (2/6) | - | 46% (23/50) | 57% (4/7) | - | Suthers: 54% (43/80) |
| Arthur Paper | 58% (7/12) | 64% (9/14) | - | - | 84% (16/19) | 42% (10/24) | - | - | - | - | - | - | - |
| Average | 86% | 80% | 79% | 76% | 75% | 46% | 45% | 41% | 40% | 32% | 30% | 2% | - |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(11/13)** | **(10/12)** | **(13/17)** | **(26/35)** | **(14/19)** | **(11/24)** | **(12/27)** | **(5/12)** | **(12/29)** | **(20/61)** | **(5/16)** | **(0/85)** | |

It is not a matter of learning how to use the mechanism—if that were the case, then the infrequent initial use of the mechanism by a few chatters would be understood as a consequence of their lack of experience with the tool and would be expected to increase over time. However, chatters tend to keep the same pattern of referencing usage throughout several chat sessions, indicating that this is an individual expression style.

Establishing references is a question of profile. Occasional and low users choose to reference in specific situations, like when they anticipate ambiguity, want to discuss an old message or need to be explicit about some previous message. In Log 21-16 (from Stephan's paper session) there is a fragment where chatters were discussing these referencing situations.

*Log 21-16.*

| Line | Time-stamp | Nick | Message |
|---|---|---|---|
| 219 | 16:42:24 | stefan | what I observed was that the explicit links (the ConcertChat refences) are different from the implicit ones |
| ...<br>221 | 16:42:59 | stefan | that means mayve that the participants felt to make explicit something that was not obviously related |
| ...<br>223 | 16:43:10 | Jsarmi | and they serve many purposes as we discovered, not just say: posting X is about posting Y |
| ...<br>225 | 16:44:31 | Jim_Waters | Having read a loy of threaded discussions I would be cautious about such a conclusion |
| ...<br>229 | 16:45:11 | Nan | i thought participants usually thought of the need before they actually made the reference |
| ...<br>231 | 16:45:38 | Jim_Waters | i.e this is soemtimes justa matter of personal style, some prefer to make their responses more concrete and others assume that peers will know what they are referring to |
| ...<br>236 | 16:47:16 | Jim_Waters | Yes, but how they choose to express is a matter of style |
| ...<br>238 | 16:47:29 | dennysj | If there is a sign of misunderstanding later, then it wil be clear that the assumption had not been correct. |
| 239 | 16:47:47 | Nan | it may be |
| 240 | 16:48:11 | Jim_Waters | yes but by then its too late :-) |
| ...<br>243 | 16:48:39 | dennysj | But not too late to be clarified or repaired in a subsequent posting. |
| 244 | 16:48:42 | cprose | i agree about the style comment |

A distinguished feature of VMT's referencing mechanism is that it suits different types of chatters. Some prefer not to use it at all and are probably happy enough to have messages showing just in chronological order with no other apparent structure. Others rather need to establish references in order to clearly express themselves and

find comfort in tree-like structures forced by threading tools. VMT's referencing mechanism does not force any single expression style, suiting everybody.

**The Manifestation of Response-Structure Confusion**

Unlike previous research (Pimentel et al., 2003; Smith et al., 2000), in this chapter there is no comparison of conditions with and without a referencing mechanism. Here, the aim is not to prove that such a mechanism reduces confusion, but to check whether confusion takes place even when VMT's referencing mechanism is being used.

It is reasonable to believe that there is less chance of having confusion when using VMT's referencing mechanism compared to when using other chat tools that do not let chatters establish references between messages because a reader does not have to infer the main reference of messages whose authors establish the link.

However, it is unreasonable to believe that just by using the VMT tool no confusion will take place—particularly given that the use of the referencing mechanism is optional. When the reference is not established by the author, the reader has to infer what previous message is being answered. Moreover, when the reader does not pay attention to the established reference or when it is wrongly established, it may give way to confusion.

As a matter of fact, some evidences of confusion were found in the VMT corpus. For example, in Log 21-17 (on Stephan's paper), after CPRose declared in message 267 "**i don't understand denny's question above**," Dennysj could not identify which of his messages above was being cited and manifested confusion in message 270: "**Which question?**" Faced with Dennysj's manifestation, CPRose used the referencing mechanism in messages 274 and 276 in order to point to Dennysj's cited message. Then, Dennysj's confusion is gone, and in message 283 he posts an explanation regarding the message that CPRose had not understood.

Had no confusion been manifested in Log 21-17, four messages—270, 274, 276 and 283—would not have been posted. These messages were needed to restore understanding in spite of disturbing the conversation flow and not developing the subject. This is probably what moved Gerry to post message 277: "**Let's get back to Stefan's paper**."

*Log 21-17.*

| Refs | Line | Time-stamp | Nick | Message |
|---|---|---|---|---|
| | 248 | 3:49:06 PM | cprose | but i think transactivity is not something that needs to be recognized as such ina dialogue in order to serve its purpose |
| | ... | | | ... |
| | 250 | 3:49:52 PM | gerry | some times it does, sometimes not |
| | 251 | 3:50:10 PM | gerry | like now, most people feel they need to use the arrows |
| | 252 | 3:50:19 PM | terry | i don't |
| | 253 | 3:50:26 PM | cprose | for example, let's say we are agruing and you state a position and I argue against it |
| | 254 | 3:50:28 PM | Jsarmi | do |
| | 255 | 3:50:33 PM | murat | how would you characterize the implicit in the transactivity context? just curious |
| | 256 | 3:50:48 PM | cprose | you may not recognize that my counter argument relates directly to your argument, but you do know that you dissagree with what I said |
| | 257 | 3:50:52 PM | cprose | so then you rgue against me |
| | 258 | 3:51:14 PM | cprose | from the form of the discussion, it is not clear whether you recognized the relationship between your argument and my counter argument or not |
| | 259 | 3:51:21 PM | cprose | the form of the discussion is the same in both cases |
| | 260 | 3:51:26 PM | dennysj | You might use them if you think that the other participants may miss the link you want to make to another posting. |
| | 261 | 3:51:39 PM | cprose | and an analyst may see transactivity there even if you didn't get the connection while the discussion was happening |
| | 262 | 3:52:18 PM | cprose | deeny, true, but making sure someone sees the link or not may not be part of my goal |
| | ... | | | ... |
| | 265 | 3:52:42 PM | gerry | When we analyze these chats, the question of what connections the participants "got" is not even a legitimate question |
| | 266 | 3:53:21 PM | Jim | Why not ? |
| | 267 | 3:53:29 PM | cprose | if that's true, then i don't understand denny's question above |
| | 268 | 3:54:28 PM | gerry | Because, if we accept what Carolyn said, then there is no visible difference that can be observed |
| | 269 | 3:54:46 PM | dennysj | Due to the nature of the chat environment, short of using several ways to point to my posting, there is no guarantee that my link is being paid attention to by other participants. |
| **Confusion Manifestation** | 270 | 3:55:22 PM | dennysj | Which question? |
| | 271 | 3:55:25 PM | cprose | (I couldn't make the explicit pointer work for some reason...) |
| | 272 | 3:55:59 PM | murat | double click on the target message |
| | ... | | | ... |
| | 274 | 3:56:07 PM | cprose | look at 3:51:26pm |
| | 275 | 3:56:08 PM | dennysj | Double click on the posting that you want to link to. |
| | 276 | 3:56:36 PM | cprose | i guess it was not really a question so much as a comment |
| | 277 | 3:56:59 PM | gerry | Let's get back to Stefan's paper |
| | ... | | | ... |
| | 283 | 3:57:55 PM | dennysj | It was a reaction to Terry's comment and a way of emphasizing that participants use referencing to make explicit some linking that they want to clearly establish in some way. |

The confusion shown in Log 21-17 might have taken place because CPRose wrongly thought that Dennysj's message 260 was associated to one of her messages. However, Dennysj's message was referencing Terry's message 252, and in spite of it, CPRose answers Dennysj in message 262 as if he was talking to her. A few moments later the coin finally drops and in message 267 she says, "**then i don't understand denny's question above**."

The process of identifying an occurrence of confusion is not an exact one, and being subject to interpretation makes it difficult to state how many of them took

place. For example, as is illustrated in Log 21-18 (on Ramon's paper), message 240—"**which term? 'common ground'?**"—is not a confusion manifestation, but really an expression of amazement caused by the "**dump the term**" proposal in message 239. Although messages 240 in Log 21-18 and message 270 in Log 21-17 are similar, the latter is a manifestation of confusion while the former is not.

*Log 21-18.*

| Line | Time-stamp | Nick | Message |
|------|------------|------|---------|
| 237 | 16:52:02 | dennysj | I referred to the term 'common ground' because it is used in the literature but I have not been able to see an actual specification of it. |
| ... | | | |
| 239 | 16:52:16 | azemel | then dump the term |
| 240 | 16:53:08 | dennysj | which term? 'common ground'? |

Only a few cases of response-structure confusion manifestation were identified in this corpus of analysis, probably due to the use of VMT's referencing mechanism. Nevertheless, one has to consider that these chatters are researchers in chat analysis and for that reason were more experienced than most people in following a chat conversation. Most were also quite experienced in using the referencing mechanism. Perhaps, having other people as chatters, more confusion manifestations might take place given that VMT cannot prevent them from occurring by offering a mechanism for its reduction.


## Conclusion

In this chapter the response-structure confusion problem was presented. This problem derives from the difficulty in identifying which previous message is being taken up by a message in a chat conversation. When participants are unable to infer the unfolding of a conversation, have doubts regarding which previous message is being answered, or wrongly infer a referencing between messages, then co-text loss takes place. This problem is quite relevant when the chat session is for learning, for working or for supporting the enactment of some group dynamics that requires precise understanding of the chat conversation.

Response-structure confusion stems from the high non-linearity of chat conversation: most messages do not refer to the preceding one and the subjects that are being discussed are not chained linearly. In a chat session, different subjects are discussed at the same time, in parallel and alternately, fostering a confluence of subject waves. These chat characteristics bring confusion to the conversation, making it especially difficult to follow by novice chatters.

In order to properly follow the conversation, the reader has to infer the response structure. In this chapter the main strategies to help inferring this structure were

presented. However, even for advanced chatters it is sometimes ambiguous and difficult to find out which previous message is currently being answered. For that reason, some chat tools offer mechanisms to let a chatter indicate the message to which they are responding.

VMT's referencing mechanism was investigated in this chapter. Based on evidence from the VMT workshop corpus it is clear that the referencing mechanism was used considerably and was quite useful, especially for chatters who systematically used it in almost all or in many of their messages (intensive and occasional user profile). Even chatters who rarely used the mechanism (low-user profile), sometimes felt like using it for returning to a subject originated in a far-away message, or for avoiding ambiguity and its potential for co-text loss. For example, CPRose, although being a typical non-user, felt the need of referencing after the confusion manifested in Log 21-19.

The possibility in VMT of establishing references to multiple messages did not appear to be very useful to indicate conversation structure. Establishing a single reference per message seems to be enough for the unfolding of a chat conversation. However, chatters sometimes feel like citing messages and pointing to objects on the workspace making the multiple-referencing capability a desirable one. It might be interesting to have a way to differentiate the unfolding ("**that's**") and citing ("**above**") references as illustrated in Log 21-19.

*Log 21-19.*
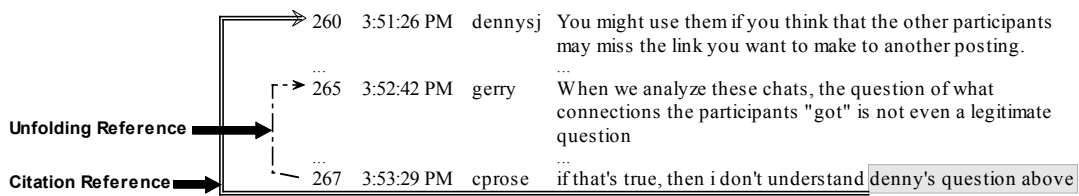


When a participant explicitly indicates a reference, it lessens the chance of causing a co-text loss related to that reference. On the other hand, establishing the graphical reference is time consuming, makes the conversation somehow more formal, introduces undesirable hand movements, and is not prized by all chatters. Unlike threaded chat tools where all messages have to be in a thread, or chat tools that do not support graphical referencing, VMT's referencing mechanism is optional. Being optional, the mechanism suits a variety of chatters' profiles, even the typical non-user that scarcely deems it necessary. This way, it has the potential to reduce confusion without imposing itself by forcing chatters to always explicitly indicate their references.

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