An Investigation of Interactional Coherence in Asynchronous Learning Environments

By

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Numerous studies have affirmed the value of asynchronous online communication as a learning resource. Several investigations, however, have indicated that discussions in asynchronous environments are often neither interactive nor coherent. This research sought to develop an enhanced understanding of interactional coherence in asynchronous learning environments. The study used Rhetorical Structure Theory (RST) to analyze and assess the coherence of a several asynchronous discussions.

The analysis revealed that the discussions were structurally dynamic. While RST structures resulting from static documents are acyclic tree-shaped structures, the rhetorical networks representing asynchronous threads are frequently cyclic. Thus, the analysis required a modified form of RST based on reduced constraints and restricted schemas. By this means, it was possible to create structural models of the discussions. These models were used to investigate asynchronous argumentation and topic drift and to perform a comparative analysis of multiple discussions.

The investigation found argumentation was more prevalent in some groups than others. In one group the analysis indicated the dominant mode of interaction was disagreement; in another group, argumentation was generally constructive; and in a third group, argumentation tended to be supportive and concessive. The investigation found that topic drift does not occur as a matter of chance. Participants use topic drift in order to adapt discussion to a topic of preference. As such, topics do not drift so much as they are pushed and pulled. A consequence of this process is that threads often begin with a strong research-based opening message, but descend to anecdotes and personal commentary. The conferencing systems used for the discussions were similar in their features, but the discussions differed, particularly in their use of threading. In one group, less than half of the messages were threaded, with the remainder posted as singletons. In other groups most of the messages were in threads.

This research provides a framework and a terminology for fine-grained analysis of interactional coherence. By showing the applicability of RST to asynchronous discussion, the study has offered evidence that assessment technology could be developed for online discussions. In addition, the development of rhetorical networks as a directed graph theory for representing the semantics of asynchronous interaction could lead to new knowledge representation technologies for multi-agent collaboration systems.

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Introduction

Problem Statement and Goal

Background

Numerous studies have affirmed the value of asynchronous online communication as a learning resource. Prominent among these, Harasim (1990) found that the attributes of asynchronous computer conferencing could be used to amplify the learning process. This would be accomplished through a combination of active learning and knowledge building. The interactive and asynchronous aspects of the environment foster active learning, according to Harasim; knowledge building occurs through online idea generation, linking, and structuring. Hiltz and Wellman (1997) found that asynchronous environments are sufficiently rich to support the development of communities of learning, where students may establish both the cognitive and emotional ties necessary for effective learning. Blanchette (2001) studied student interaction in asynchronous discussions and found that the students engaged in higher levels of cognition than those in face-to-face environments, and their use of language tended to be more interactive than that of students in face-to-face environments.

Rovai (2002) investigated whether students developed a sense of community in online learning environments and found that, not only was this possible, but that a sense of community in an online environment correlated positively with students' perceived level of learning. Meyer (2003) found that students working online devote more time to achieving learning objectives than students in the face-to-face classroom. Online students benefit from the time permitted for higher-order reflection afforded by asynchronous online discussion, and since their contributions usually remain accessible throughout the duration of the course, any conversational thread can be revisited or resumed at any time. Characteristics such as these distinguish online from face-to-face discussion, where conversations endure only as long as the time spent to enact them (Meyer, 2003). Reasons, Valadares, and Slavkin (2005) compared student outcomes in asynchronous environments with face-to-face and with combinations of face-to-face and asynchronous learning and found evidence that a purely asynchronous approach could be significantly superior to the other formats.

More generally, the advantages of the anytime-anywhere features of asynchronous online environments has been mentioned extensively in the literature of online education (e.g. Arbaugh, 2004; Chute, 2003; Dalziel, 2003; Doherty, 1998; Dringus & Terrell, 1999; Engelbrecht, 2005; Garrison & Kanuka, 2004; Harasim, 1990; Harasim, Hiltz, Teles, & Turoff, 1995; Kramer, 2001; Phillips & Santoro, 1989; Rovai, 2003; Weller, 2002; Westfall, 2003). In short, the preponderance of evidence suggests that, not only are asynchronous environments conducive to learning, they may be superior to traditional pedagogy.

By no means, however, should this be taken to imply that asynchronous learning has reached its full potential. Open issues remain, which, if better understood, could lead to more effective communication in the virtual classroom, improved technology utilization, and new directions for future technology development. Among these issues are known problems in sustaining coherence in asynchronous discussions. It is this area, called *interactional coherence*, which was the focus of this research.

Problem Statement

The term *interactional coherence* has been used to denote matters of coherence and incoherence as they pertain to asynchronous discussion (Farrell, 2002; Herring, 1999b, 2001; Jones, 2000; Jones, Ravid, & Rafaeli, 2001; van der Meij, de Vries, Boersma, Pieters, & Wegerif, 2005; Van der Pol, Admiraal, & Simons, 2006). The investigations of Henri (1992), Herring, and others suggest that asynchronous discussions are too often neither interactive nor coherent. The accustomed orderliness of turn-by-turn conversation disappears when participants in asynchronous discussions make overlapping exchanges, reply to multiple previous messages within a single message, or simply fail to respond at all (Herring, 1999b; van der Meij et al., 2005). Discussions seem to drift aimlessly from one topic to another, without returning to key points or questions raised earlier (Herring, 1999b; Hewitt, 2001; Severinson Eklundh & Rodriguez, 2004). Threads may diverge into numerous sub-threads, with no prospect for eventual convergence (Hewitt, 2001). Participants routinely ignore the contributions of others, so that the resulting transcript reads more like a collection of monologues than a discussion (Henri, 1995; Hew & Cheung, 2003a; Pena-Shaff & Nicholls, 2004).

Clearly, maintaining coherence is problematic for asynchronous discussions. Yet, despite a wealth of research relating to matters of coherence in asynchronous discussion, no clear understanding of what is meant by coherence in this context has been articulated. Tools for conceptualizing, analyzing, and describing interactional coherence remain largely undeveloped. Herring (1999b) proposed response schemas as a method for describing cross-turn incoherence. Other message mapping techniques have been used by other researchers (Hara, Bonk, & Angeli, 2000; Henri, 1992; Howell-Richardson &

Mellar, 1996; Kear, 2001; Levin, Kim, & Riel, 1990; Schrire, 2006). These tools are useful for illustrating holistic flow of interaction (Schrire, 2002, 2006) and offer insight into the structural dynamics of coherence (Condon & Cech, 2001).

Jeong (2003, 2004) developed a set of rhetorical categories for encoding message-response sequences. These yielded identifiers used for mapping transitional probabilities among message pairs, but there is no indication that they may apply to the more general question of interactional coherence. Kneser, Pilkington, and Treasure-Jones (2001) developed a method of asynchronous dialogue description called Exchange Structure Analysis (ESA). ESA provides a relatively easy to use tool for analysis of turn taking; however, the focus of this tool is limited to clarifying the roles of the participants, in particular to determining which participants assume a dominant role in the dialogue (Kneser et al., 2001). These efforts have made significant and interesting contributions, but none offers a general conceptualization for considering coherence in asynchronous discussion.

The need for further research is apparent. Given the prominent role of interaction in the constructivist theories that underlie much of the thinking and practice in online education (Erkens, Kanselaar, Prangsma, & Jaspers, 2003; Harasim, 1990, 1993; Hiltz, 1986; Lapadat, 2002; Rovai, 2004), it is highly relevant to the integrity of these theories that interactional coherence be understood. After all, insofar as incoherence would by definition signal an attenuation of communication, interactional coherence is fundamental to any theory that claims interaction among its enabling assumptions. On a more practical level, it is important that practitioners understand the constraints and features of interactional coherence, as this will help instructors and learners to make better use of language in asynchronous environments (Lapadat, 2002; Potter, 2004). Furthermore, the investigation reported here contributes to current research in distributed knowledge systems. Providing a formalized method for describing interactional coherence also lays the groundwork for advancing knowledge representation technologies for use in implementing interactive agent support in asynchronous learning environments and other computer supported collaborative applications (Potter & Streeter, 2002; Streeter & Potter, 2004).

The problematic character of interactional coherence might seem odd, considering the advances in the study of coherence that have occurred in other venues in recent decades. The seminal work of researchers such as Grimes (1975), Hobbs (1979), Longacre (1983), Grosz and Sidner (1986), Mann and Thompson (1988), Sanders, Spooren, and Noordman (1992), den Ouden (2004) and Taboada (2004a) opened new doors in understanding the mechanisms of coherence. In particular, Rhetorical Structure Theory (RST), developed by Mann and Thompson (1988), provides a tool for modeling the coherence of texts, such that it is possible to identify the specific patterns used to achieve coherence, as well as lapses in coherence. RST has been predominant among theories of coherence to emerge in recent research (Hoey, 2001; Moore & Wiemer-Hastings, 2003). It has been applied to many types of discourse, including expository prose, news articles, letters, and dialogue (Mann & Taboada, 2005). Its use for the analysis of asynchronous discussion, however, has been severely limited (Taboada, 2004b; Van der Pol et al., 2006). Consequently, further study was needed to provide insight into the problems of interactional coherence in asynchronous learning environments. This research addressed this need by applying the resources of rhetorical structure theory to asynchronous discussion, resulting in significant implications for learning theory, natural language processing, and knowledge representation.

Statement of Goal

The goal of the research was to develop a theoretical explanation of the nature, extent, and limitations of interactional coherence in asynchronous learning environments. Using RST as its principal tool, the research identified and described the rhetorical structures that serve to unify and integrate discourse elements, identified patterns of coherence and incoherence, and developed an exploratory discussion of the implications of interactional coherence for asynchronous learning environments. The following four sub-goals formed the basis of the research:

1. *Identification of rhetorical structures*—Identify and describe the rhetorical structures that serve to unify and integrate discourse elements in asynchronous discussions.
2. *Identification of patterns of coherence*—Identify the patterns of coherence and incoherence as they may occur within the discussions.
3. *Description of the nature of interactional coherence*—Use the information provided through this analysis to develop evidence regarding the nature of interactional coherence in asynchronous learning environments.
4. *Identification of the implications of interactional coherence*—Explore the implications of interactional coherence for technology and technology utilization.

Research Questions

The research questions undertaken were defined to address these four sub-goals. They were used to motivate a series of studies, consisting of 1) an application of RST to asynchronous discussions, 2) an investigation of collaborative reasoning in these discussions, 3) a study of asynchronous topic drift, and 4) a comparative study of interactional coherence in computer conferencing systems. Table 1 identifies the research questions and their associated goals. The following sections provide a detailed discussion of each.

Table 1. Research Questions and their Associated Sub-Goals

	Research Question		**Sub-Goal**
RQ1	What RST modifications are required for the analysis of asynchronous discussion?	SG1	Identification of rhetorical structures
RQ2	What are the role and extent of argumentative structures in asynchronous discussion?	SG1	Identification of rhetorical structures
		SG2	Identification of patterns of coherence
RQ3	What are the rhetorical relations or structures of topic drift, and what relations are used to manage it?	SG1	Identification of rhetorical structures
		SG2	Identification of patterns of coherence

	Research Question		Sub-Goal
		SG3	Description of the nature of interactional coherence
RQ4	Do the characteristics of the computer conferencing software used to support asynchronous discussions affect the characteristics of interactional coherence in asynchronous discussions?	SG3	Description of the nature of interactional coherence
		SG4	Identification of the implications of interactional coherence

Application of RST to Asynchronous Discussion

RQ1: What RST modifications, if any, are required for the analysis of asynchronous discussion? *(Sub-goal 1—Identification of rhetorical structures)*

The RQ1 investigation laid the foundation for the subsequent research questions addressed in this study. Although rhetorical structure theory has proven useful in a wide range of analyses, it had not previously, to this researcher's knowledge, been applied to asynchronous discussion in only two studies. Taboada (2004b) used RST in an analysis of messages in online financial investment discussion groups. The use of RST in this study was limited to an examination of argumentative relations within a single message, without regard for interactional aspects of discussion. Shaw (2005) used RST to compare the use of attribution, elaboration, and explanation relations between tutors and students in asynchronous discussions. Here again, the study was limited to an examination of relations within individual messages. As such, the use of RST for the study of interactional coherence in asynchronous learning environments was both promising and novel. RQ1 addressed the following issues:

a. Can asynchronous discussions be plausibly analyzed using RST?
b. Are additional relations required?
c. Are structural modifications required?

RST is a descriptive theory of text coherence (Mann & Thompson, 1988). It is based on the notion that the coherence of a text can be described in terms of the way the parts of a text relate to one another. Without such relationships, there would be no means for distinguishing an arbitrary series of statements from a coherent text. A coherent text forms a *tree structure.*

Figure 1 shows an example of such a tree structure. The nodes of the tree structure are called *text spans*. Text spans that are leaf nodes are also called *units*, and they usually consist of independent clauses. The links between the nodes are *relations*. Mann and Thompson (1988) defined a set of 24 relations they believed would be sufficient to analyze most texts. Relations between text spans may be *binary* or *multi-nuclear*. In a binary relation, there are two spans; one text span is the *nucleus*, and the other is the *satellite.* The nucleus is more central to the intended effect than the satellite.

Coherence is defined in terms of four constraints: *completeness*, *connectedness*, *uniqueness*, and *adjacency* (Mann & Thompson, 1988). The completeness constraint requires that all units in the text be included in the structure. Connectedness requires that all units be related, either directly or by means of nested spans. Uniqueness stipulates that each text span will be engaged in no more than one relation. Adjacency requires that for any relation, the nucleus and satellite text spans must be adjacent to one another, or that if not adjacent, any intervening text spans must be satellites of the same nucleus. Thus, a judgment as to the coherency of a text is based on whether it meets the constraints of completeness, connectedness, uniqueness, and adjacency.

Several investigators have suggested that changes must be made to accommodate RST to spoken dialogue. Daradoumis (1996) argued that a variety of structural modifications would be required for application of the theory to tutorial dialogues. Stent (2000) proposed several new relations to accommodate RST to task-oriented dialogues. In a study of scheduling dialogues Taboada (2004a) found it necessary to relax the adjacency constraint. RQ1 examined the extent to which modifications are required for the analysis of asynchronous discussion.

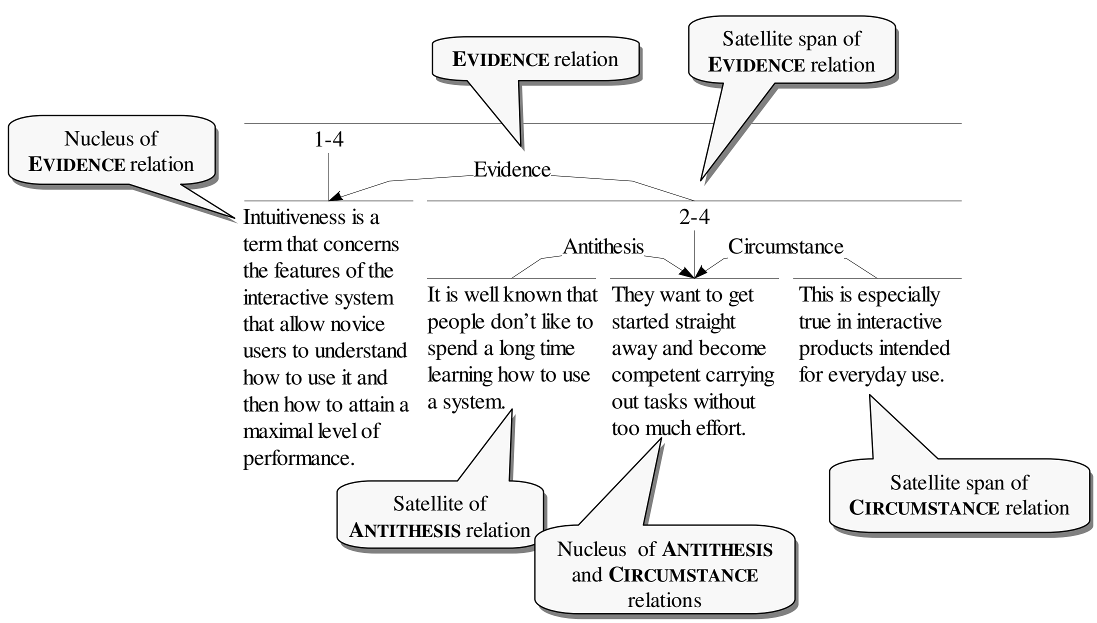


Figure 1. An example RST Diagram (A-Intuit-M15-P14)

Argumentative Collaboration in Asynchronous Discussions

RQ2: What are the nature and extent of argumentative structures in asynchronous discussion? *(Sub-goal 1—Identification of rhetorical structures; Sub-goal 2—Identification of patterns of coherence)*

An *argument* consists of one or more premises and a conclusion, such that the premises give support as to the truth or acceptability of the conclusion (Juthe, 2005). By extension then, *argumentation* is the process of engaging in argumentative reasoning; that is, participants support their claims by means of evidence (Kuhn, 1991). Numerous researchers have noted the importance of argumentation to the learning process (e.g. Andriessen, Baker, & Suthers, 2003; Buckingham Shum, 2003; Carr, 2003; Erkens et al., 2003; Garrison & Anderson, 2003; Kanselaar et al., 2003; Morgan, 1996; Petraglia, 1998; Selvin, 2003; Shauf, 2001; Uren, Shum, Li, Domingue, & Motta, 2003). To the extent that argumentation plays a significant role in learning, the manner and extent to which it occurs in asynchronous learning environments are of interest.

However, it was not germane to the investigation to distill from asynchronous discussions the underlying argumentative structures defined by traditional logic, Toulmin models (1958) or derivative theories (e.g. Selvin, 2003; van Gelder, 2003). That is, the objective was not to assess the validity of reasoning, but rather to investigate the rhetorical dynamics of asynchronous argumentative interaction. This involved going beyond inferential structures and examining evolving argumentative structures as found in asynchronous discussion. For if, in fact, argument plays a significant role in asynchronous learning, arguments should evolve and interact over the course of the discussion. That being the case, it would be useful to reach some understanding of the argumentative dynamic. RQ2 investigated the following issues:

a. Are the asynchronous discussions argumentative?
b. What are the structures of argumentation?
c. What are the dynamics of argumentation?
d. What are the characteristics of non-argumentative discussions?

The theoretical basis for the RQ2 investigation was derived from Azar (1999) and Taboada (2004b). Azar showed how rhetorical structure theory could be used to examine argumentative texts and to distinguish between argumentative and other types of texts. This investigation applied Azar's work to discussions in asynchronous learning environments. Azar argued that only a few RST relations should be regarded as argumentative. Among these, he included EVIDENCE, MOTIVATION, JUSTIFY, ANTITHESIS, and CONCESSION. What distinguishes these relations as argumentative is that their loci of effect are in the nucleus, and further, that the intended effect is to persuade, move, or otherwise influence the reader to accept the content of the nucleus. In other words, the satellite provides some impetus for accepting the nucleus.

Taboada (2004b) proposed a generic form that argumentative asynchronous messages tend to follow. According to Taboada, messages consistent with argumentative forms typically open with a link to previous discussion, followed by an optional statement of the author's viewpoint, objections to previous argument, statement or restatement of the author's viewpoint, optional examples, and an optional disclaimer. Although some variation would be anticipated in the specific RST relations employed in this structure, it might be expected to resemble diagram given below in Figure 2. Distinguishing these relations and structures as argumentative provides a tool for describing, analyzing, and comparing argumentative texts. If, as indicated by the literature, argumentation has an essential role in asynchronous discussions, and if, as argued by Azar (1999), the argumentative relations of rhetorical structure theory can be used for analyzing argumentative texts, it seems likely that argumentative structures would predominate in asynchronous discussions. Such was the basis of thinking going in to RQ2.

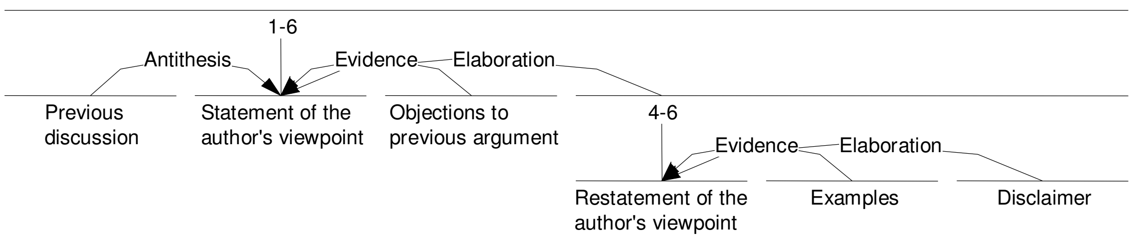


Figure 2. General Argumentative Structure of Asynchronous Messages

Asynchronous Topic Drift

RQ3: What are the rhetorical relations or structures of topic drift, and what relations are used to manage it? *(Sub-goal 1—Identification of rhetorical structures; Sub-goal 2—Identification of patterns of coherence; Sub-goal 3—Description of the nature of interactional coherence)*

Topic drift refers to the tendency of computer-mediated discussions to stray from their announced topic, commonly dissolving into interminable rounds of mutual recrimination or endless bickering over the proper handling of the topic in question (Fahy, 2002; Harasim et al., 1995; Herring, 1999b; Herring & Nix, 1997; Kayany, 1998; Osborne, 1998; Powazek, 2002). Described by Powazek as the "bane of every email list" (p. 202), topic drift has often been associated specifically with computer-mediated communications (Raymond, 2003), but the concept has its roots in general linguistic research and has been studied as a characteristic of conversation (Hobbs, 1990; Maynard, 1980).

According to Hobbs (1990), topic drift occurs incrementally, through a series of minor modifications to the topic. Taken individually these modifications are not necessarily problematic for coherence, and in fact they rely on the same structures used in fully coherent texts to maintain coherence and enrich communication (Hobbs, 1990; Lenk, 1998; O'Donnell, 2000). What distinguishes topic drift, however, is that these relations are engaged without return to the previous topic of discourse (Hobbs, 1990). As the name suggests, the topic drifts with no prospect for recovery. Hobbs identified three devices that account for topic drift. These are *parallel association, metatalk*, and *chained explanation*.

Parallel association occurs between two text spans when the spans are related tangentially to one another. Parallel association is achieved using a mechanism Hobbs (1990) called *discourse pivot*. A discourse pivot forms a link between two otherwise unrelated topics. Discourse pivot incorporates some associations in the preceding text with those of the emergent topic, thus smoothing the transition from one topic to another. In conversations, parallel association may be used as a pretext for making gradual shifts from one speaker's interests to those of another (Hobbs, 1990). Parallel association is similar to the RST LIST multi-nuclear relation, which consists of two or more comparable text spans. Other possible manifestations are the CONTRAST and ANTITHESIS relations, in which there is some basis for comparison, but, in other respects, the differences override the similarities.

The *metatalk* relation occurs when one text span comments on another regarding the objectives of the conversation (Hobbs, 1990). When this happens, the topic may shift to become a conversation about the conversation. The main RST counterpart of metatalk is the EVALUATION relation, in which the satellite text span assesses the situation presented in nucleus text span. However, metatalk is distinctive in that it assesses not the content, but the form or process of the evaluated text span.

Chained explanation is a complex mechanism involving a series of interlinked explanations, with each new explanation displacing the topic of its predecessor (Hobbs, 1990). Chained explanations may occur using a variety of relations in RST, such as ELABORATION, and EVIDENCE, INTERPRETATION. It may also incorporate elements of the other strategies for topic drift, parallel association, and metatalk. Through a sequence of text spans linked recursively by these relations, the topic may rapidly shift to where it has no relevance to its original subject.

Hobbs (1990) claimed that parallel association, metatalk, and chained explanation account for most topic drift in conversation. These strategies permit speakers to alter the topic of conversation without resorting to overt breaks in continuity. The RQ3 investigation used this framework for studying topic drift in asynchronous discussion. This investigation addressed the following issues:

a. Can topic drift in asynchronous discussion be explained in terms of parallel association, metatalk, and chained explanation?

b. Are there distinctive rhetorical structures associated with these topic drift mechanisms?

c. What rhetorical relations are used to maintain or restore topic continuity?

An expectation for this investigation was that the devices of topic drift in asynchronous discussions would be similar to those of spoken conversation as identified by Hobbs (1990). That is, drift in asynchronous discussion would be describable in terms of parallel association, metatalk, and chained explanation. To the extent that this is the case, it could be asked whether the phenomenon is problematic: topic drift is common in conversation, with little if any harmful effect. However, in an asynchronous learning environment, students rely on asynchronous discussions to achieve their learning objectives. The delayed turnaround and reduced social presence in message exchange makes recovery from topic drift difficult and sometimes unachievable (Harasim, 1990; Whittaker, Bellotti, & Gwizdka, 2006).

The second expectation was that this investigation would suggest that recurrent rhetorical structures and relations might be associated with topic drift. That is, as participants seek to control the topic, they resort to discernible maneuvers for doing so, and these would be discoverable through RST analysis. Identification of these maneuvers would be useful is managing and participating in online discussions.

A final expectation was that, as users attempt to restore a discussion to its original topic, the means adopted for doing so will similarly be reflected in recurrent rhetorical structures and relations. Once topic drift occurs, the discussion would seldom return to the original topic. As observed by Osborne (1998), asynchronous discussions occur over extended periods of time, topic evolution can be gradual, and participants in the discussion change over time, as some drop out and others join in. Under these circumstances, individual participants may have few resources for ensuring continuity. It was hoped that the insights afforded by the RQ3 investigation would yield insights into how topic continuity could be achieved.

A Comparative Study of Interactional Coherence in Computer Conferencing Systems

RQ4: Do the characteristics of the computer conferencing software used to support asynchronous discussions affect the characteristics of interactional coherence in asynchronous discussions? *(Sub-Goal 3—Description of the nature of interactional coherence; Sub-Goal 4— Identification of the implications of interactional coherence)*

Whittaker (2003) and others have observed that the features of a computer conferencing environment will influence the nature of the interaction. Features of thread management, for example, differ from one conferencing system to another, and in systems lacking thread support, participants resort to various forms of reference in order to maintain the integrity of the discussion (Kear, 2001; Pincas, 1999; Preece, 2000; Reed, 2001). They may, for example, resort to *ad hoc* typographical conventions in order to distinguish material quoted from a previous message from new information (Pincas, 1999). Sometimes, as participants await a response to their messages, they may post further messages, resulting in overlapping exchanges, resulting in interleaved threads, interruptions, and loss of integrity (Herring, 1999b). The RQ4 investigation examined the rhetorical structures used by participants in two different environments in an effort to discover how the features lead to differences in interactional coherence. This investigation addressed the following issues:

a. In terms of argumentation and topic drift, what are the salient differences in interactional coherence between discussions enacted in three different computer conferencing systems?
b. Are there apparent differences in the rhetorical structures employed?

The RQ4 investigation built on research performed for the first three research questions. The earlier analyses were re-examined in terms of differences in the features of computer conferencing environments.

Barriers and Limitations

The theoretical nature of the study imposed numerous barriers and limitations on the study. There were several issues associated with the use of rhetorical structure theory. These include the partial nature of RST as a theory of coherence, the role of subjectivity in structural analysis, and the possibility of multiple analyses for a given text. While these issues do not invalidate RST as a theoretical tool, they impose limitations on the certitude of any conclusion reached. More significant to this dissertation research is the applicability of RST to asynchronous discussion: RST was designed for use with monologue, not dialogue or discussion. The following sections discuss these issues in detail.

RST as a Partial Theory of Coherence

RST formulates coherence as the ability to account for the presence of the elements of a discourse by providing a plausible description of the relational structure of these elements (Mann & Taboada, 2005). While this yields a comprehensive model of a rhetorical structure, there are other aspects of coherence that RST does not address. It does not, for example, address the syntactic characteristics of coherence, developmental order, or holistic coherence (Mann, Matthiessen, & Thompson, 1992).

Subjective Judgment

Subjective judgment is a necessary part of RST methodology (Mann et al., 1992). For a text to be judged coherent, judgments about the functions of the parts of a text and their relations are a necessary part of the analysis. To this extent, RST relies on the analyst's understanding of the language, culture, and subject matter of the text (Mann & Thompson, 1987). It is the claim of RST that such judgments are plausible rather than certain. The judgments comprising an analysis achieve credibility by means of their internal cohesion—that is, the structure arising from an analysis is essentially a localized theory of the text under analysis (Mann et al., 1992; Mann & Thompson, 1987, 1988; Moore & Wiemer-Hastings, 2003). As such, RST is a methodology for generating theory.

Differences in Analysis

Differences in analysis in RST are attributable to a number of sources, including boundary judgments, structural ambiguities, simultaneous analyses, differences between analysts, and analytical error (Mann & Thompson, 1987). Boundary judgments are an inevitable consequence of having to choose from among categories; borderline cases must be resolved in order for the analysis to proceed. Similarly, structural ambiguities are an inevitable and normal part of RST because the language itself contains ambiguities. To insist otherwise would be to demand of the text greater precision than it contains (Mann & Thompson, 1987). Simultaneous analyses occur when multiple relations are applicable to a single pair of text units. Unlike ambiguity, where the intended meaning may not be discernible, simultaneous analyses occur when the rhetorical intent seems clear, but the intent seems to involve two dissimilar relations (Mann & Thompson, 1987).

Given the susceptibility of RST to differences in boundary judgments, structural ambiguities, and simultaneous analyses, analytical discrepancies may occur. Even so, Mann and Thompson claim that discrepancies occur infrequently (Mann et al., 1992; Mann & Taboada, 2005; Mann & Thompson, 1987), and this claim is supported by the literature. Den Ouden, van Wijk, Terken, and Noordman (1998) studied the reliability of segmentation and structuring of relations and found a high degree of consistency among the analysts studied. Marcu, Amorrortu, and Romera (1999) developed a statistical method for measuring agreement in rhetorical structures and found that analysts achieved high levels of agreement in defining structures. Their investigation also suggested that divergence was more likely to occur when the analysts were unfamiliar with the subject matter of the text. Similarly, den Ouden (2004) found high levels of reliability relative to other structural analysis methods and suggested that this may be best accounted for by the explicitness of the definitions used and the labor intensive nature of the analysis.

Finally, there is the issue of analytical error. While the possibility of error can never be ruled out, the occurrence of analytical error decreases with experience (O'Brien, 1995), and the rigorous definitional basis defined for RST makes errors less likely, so long as the methodology is strictly observed (Mann & Taboada, 2005; Mann & Thompson, 1988; O'Brien, 1995; Taboada, 2004a). The definition of each relation includes a set of constraints, and these constraints define not only the relationship between the nucleus and its satellite, they also place constraints on the nucleus itself (Mann, 1984). These constraints served as signposts to the analyst, reducing, but not eliminating, the likelihood of analytical error.

Delimitations

The study was based on the analysis of transcripts of two selected asynchronous discussions that occurred in masters courses offered at Nova Southeastern University Graduate School of Computer and Information Science between 2003 and 2005. Additional publicly available transcripts were used to support the study. Delimitations include the following:

1. The asynchronous discussions studied were from courses that were taught entirely online using a combination of online conferencing, email, and Web-based resources. The generality of the results of the study is limited to comparable courses offered in an online format.
2. The conferencing software used in the study included Allaire Forums and WebCT. It was anticipated as part of this study that the features of these products would affect the characteristics of interactional coherence in asynchronous

discussions. To the extent that this was the case, it also follows that discussions taking place using other products may have unique characteristics. Therefore, the generality of the results may be limited to discussions using the Allaire Forums and WebCT products.

3. The analytical approach used was fundamentally theoretical, and therefore the conclusions reached are of a plausible, not definitive nature. As described in the section on Barriers and Limitations, an RST analysis is a plausible explanation for the relational structure of a set of discourse elements (Mann & Taboada, 2005). RST is a methodology for generating theory. Any inferences drawn from an RST analysis are thereby qualified.

4. The reliability of the results reached in this study was limited to what could be provided by tools used. As described in the section on Barriers and Limitations, several studies found high levels of reliability with the RST methodology (den Ouden, 2004; den Ouden et al., 1998; Marcu et al., 1999). However, no direct measure of reliability was incorporated in this study. Again, the level of certitude applicable to the results of this study is of a theoretical nature.

5. The study relied on RST for its validity. Although RST continues to be used by many investigators (den Ouden, 2004; Taboada, 2004a; Taboada & Mann, 2006a, 2006b; Wolf & Gibson, 2005), not all researchers embrace the theory. For example, Knott and Dale (1994) and Kehler (2002) have criticized RST for failing to provide a definitive set of relations.

Definition of terms

This section defines specialized terms used in this dissertation. This includes terminology relevant to the study of interactional coherence in asynchronous learning environments as well as terms necessary for the application of rhetorical structure theory to asynchronous discussions. Other terminology, such as terms specific to argumentation, topic drift, or computer conferencing, is also defined. In addition to these definitions, a complete set of formal definitions for RST relations is provided in Appendix A.

Adjacency: One of four RST constraints used to define coherence. The adjacency constraint requires that for any relation, the nucleus and satellite text spans must be adjacent to one another, or if not adjacent, any intervening text spans must be satellites of the same nucleus (Mann & Thompson, 1988). The other constraints are completeness, connectedness, and uniqueness.

Anchored Discussion: A discussion is centralized around a document that serves as the anchor or focal point of the discussion (Guzdial & Turns, 2000).

Argument: A text, or part of a text, containing one or more premises and a conclusion, such that the premises give support as to the truth or acceptability of the conclusion (Juthe, 2005).

Argumentation: The process of engaging in argumentative reasoning, that is, the participants in argumentation support their claims by means of evidence (Kuhn, 1991).

Asynchronous discussion: Any discussion that occurs in an asynchronous learning environment.

Asynchronous learning environment: A learning environment supported by text-based asynchronous computer-mediated communication (Hiltz & Wellman, 1997).

Binary relation: A relation between two text-spans, one of which is designated as the nucleus and the other as the satellite (Mann & Thompson, 1988). The nucleus is the more salient and least dispensable of the two.

Chained explanation: A form of topic drift involving a series of interlinked explanations, with each new explanation displacing the topic of its predecessor (Hobbs, 1990).

Coherence: The structural features of the text that enable it to make sense as a whole, and that give it an integral organization, such that all parts contribute in an understandable way (Mann et al., 1992). In RST, coherence is defined in terms of four constraints: completeness, connectedness, uniqueness, and adjacency (Mann & Thompson, 1988).

Completeness: One of four RST constraints used to define coherence. The completeness constraint requires that all units in the document must be included in the structure (Mann & Thompson, 1988). The other constraints are connectedness, uniqueness, and adjacency.

Connectedness: One of four RST constraints used to define coherence. The connectedness constraint requires that all units be related, either directly or by means of nested text spans (Mann & Thompson, 1988). The other constraints are completeness, uniqueness, and adjacency.

Convergence: Occurs when elements of a thread are brought together into a single comprehensive perspective (Hewitt, 2001; Moran, 1991). Convergences fall into two categories: direct and general.

Depth of Reference: The extent of reference from a message to its predecessors in an online discussion (Reed, 2001).

Direct Convergence: A type of convergence that specifically identifies its linkage to its predecessors using rhetorical relations to produce a comprehensive topical perspective.

ExtMT: An extended set of RST relations defined by Mann (Mann & Taboada, 2006).

General Convergence: A type of convergence that provides a comprehensive perspective, but without specifically identifying the predecessors converged.

Interaction: An exchange of messages in an asynchronous learning environment. One message interacts with another to the extent that there is a rhetorical relation between the two.

Interactional: In the term interactional coherence, indicates that emphasis is on the coherence of interaction within the group, not merely on the coherence of individual messages.

Interactional coherence: An asynchronous discussion that is structurally and rhetorically integrated. Similar to a rational conversation, as defined by Jacobs and Jackson (1983), an interactionally coherent discussion is goal-directed, such that each message in some way contributes to the goal. The goal need not be stated explicitly, it may not be clearly understood by all participants, and there may be differing views among participants as to what the goal is; factors such as these may contribute to the level of coherence manifest in the discussion.

Learning environment: A virtual facility used for interactively sharing and constructing knowledge, be it under the auspices of formal education programs or otherwise (Vermunt, 2003).

Message: A text contribution to an asynchronous discussion. The terms message, posting, and article are used interchangeably (Crystal, 2001).

Metatalk: A topic drift device in which the respondent to a message refers not to the content of the message but instead comments on it with regard to the objectives of the conversation.

Multi-nuclear relation: an RST relation that may contain more than two text spans, all of which are of equal importance (Mann & Thompson, 1988).

Nucleus: A text span which, in an RST relation, is dominant relative to the satellite text span (Mann & Thompson, 1988).

Parallel association: When two or more adjacent text spans are associated with one another by virtue of their similarity to one another. In topic drift, parallel association may be used as a means for making gradual shifts from one speaker's interests to those of another (Hobbs, 1990).

Participant: any person who participates in an asynchronous discussion.

Relation: The functional relationship between the spans (Mann & Thompson, 1988). Relations may be binary or multi-nuclear.

Rhetorical Network: A directed graph representation of a thread. The thread's messages are represented as nodes and RST relations are represented as vertices.

Rhetorical Structure Theory: A descriptive theory of text coherence, based on the assumption that the coherence of a text can be accounted for in terms of the way the text spans comprising the text relate to one another to form an integral structure (Mann & Thompson, 1988). Rhetorical structure theory defines a set of schema that identify the abstract structures, as well as a set of relations used in applying these schemas.

Satellite: A text span which, in an RST relation, is subordinate or adjunct to the nucleus text span (Mann & Thompson, 1988).

Schema: An abstract structural pattern showing one of several possible arrangements of text-spans and relations (Mann & Thompson, 1988).

Schema application: An instantiation of a schema, wherein the abstract elements are instantiated with actual text spans and relations (Mann & Thompson, 1988).

Segment: The elementary unit of an RST analysis, usually consisting of an independent clause, taken together with its clausal dependencies (Mann & Thompson, 1988).

Segmentation: The process of defining the segment boundaries in a text (Mann & Thompson, 1988) or asynchronous discussion.

Sequential integrity: the ordering of messages in a thread, such that each successive message is a coherent reply to its predecessor (Reed, 2001). When a breakdown in sequential integrity occurs, the thread unravels.

Singleton: A message that is linked to no other message within a discussion, not part of a thread

Structure: A schema application, or more generally, the results of an analysis performed using rhetorical structure theory.

Text span: Either an individual segment or it may be a structure consisting of several segments interrelated by one or more relations.

Thread: A linked series of messages in an asynchronous learning environment that constitute a discussion (Carlson, 1997). All messages in a thread either serve to initiate the thread or are posted in response to some other message in the thread (Preece, 2000). Some computer conferencing software provides formal support for threading; others do not (Kear, 2001; Preece, 2000; Reed, 2001).

Topic Convergence: When the various elements of a diverged asynchronous discussion are brought back by its participants into a single comprehensive topic (Hewitt, 2001; Moran, 1991).

Topic Divergence: When an asynchronous discussion continuously branches into ever finer threads, with little prospect for topic convergence (Hewitt, 2001; Moran, 1991).

Topic drift: The tendency of discussions to drift incrementally away from their announced topic (Hobbs, 1990); in computer-mediated discussions, the tendency of discussions to stray irrecoverably from the topic, commonly dissolving into interminable rounds of mutual recrimination or endless bickering over the proper handling of the topic in question (Fahy, 2002; Harasim et al., 1995; Herring, 1999b; Herring & Nix, 1997; Kayany, 1998; Powazek, 2002).

Turn: In conversation analysis, a turn is a basic unit of conversation (Sacks, Schegloff, & Jefferson, 1974). A conversation proceeds as a series of turns taken by the participants, wherein a turn is the occasion during which a participant is the speaker.

Turn adjacency: An indicator of coherence in which each turn is respondent to its immediate predecessor (Herring, 1999b).

Uniqueness: One of four RST constraints used to define coherence. The uniqueness constraint requires that each text span will be engaged in no more than one relation. The other constraints are completeness, connectedness, and adjacency.

Summary

The issues associated with interactional coherence raise significant problems for asynchronous learning environments. Discussions occurring in these environments may lack sequential integrity, and they are prone to topic drift, topic divergence, and poor interaction. Although these issues are widely acknowledged, few tools have emerged that would provide the means for investigating interactional coherence. This study used rhetorical structure theory as a tool for conducting such an investigation. The goal of the study was to use RST to describe the nature, extent, and limitations of interactional coherence in asynchronous discussions. As will be detailed in subsequent chapters of this study, this includes identification of the rhetorical structures used, identification the patterns of coherence and incoherence prevalent in the discussions, and implications of interactional coherence for technology and technology utilization.

Chapter 2

Review of the Literature

Introduction

The following review proceeds in stages and is intended to reflect the context of the research. The review begins with a discussion of the nature of coherence and the research foundations of interactional coherence. This is followed by an examination of research relevant to the theme of argumentation as it relates to interactional coherence. Next, the literature on topic drift is discussed, here again noting the influence of conversation analysis on research in asynchronous learning environments. The review of topic drift is followed by a discussion of research touching on the ways technological features influence the coherence of asynchronous discussion. This last section revisits a number of the studies cited earlier in the review, but is revelatory in its suggestion that while research that would shed light on the problems of interactional coherence is lagging, technologies that purport to solve them either are already in use or wait only for their acceptance.

Coherence in Asynchronous Discussion

The claim that coherence in asynchronous discussion is problematic is easily established. Reaching consensus as to precisely what constitutes coherence remains difficult. In studies of online communication, two lines of research have predominated. The first of these derives from Grice's philosophical work in logic and conversation, which led to his famous cooperative principle (Grice, 1975). The other is from conversation analysis, as defined by Sacks, Schegloff, & Jefferson (1974). A third strand of research, that of coherence relations, also deserves attention, as is attested by the current research.

Grice‘s (1975) cooperative principle and its associated maxims have been used as a standard for spoken conversational coherence. The maxims include admonitions to be as informative as necessary, but no more so; to be sincere; to be relevant; and to avoid obscurity, ambiguity, unnecessary wordiness, or disorderliness (Grice, 1975). Grice's influence can be found in a variety of works in linguistics (Lindblom, 2001; Simner & Pickering, 2005), philosophy (Baccarini, 1991; Neale, 2004), artificial intelligence (Hoadley & Enyedy, 1999; Hulstijn, Dignum, & Dastani, 2004; Kelleher, Costello, & van Genabith, 2005; Walker, 1996), and psychology (Brisch, 2002; Kempler, 2004).

Therefore, there should be no surprise that the cooperative principle should play a foundational role in defining coherence in online communication. In her study of interactional coherence in computer-mediated communication, Herring (1999b) uses Grice's maxims, especially the maxim of relevance, to establish her claims. Pincas (1999) used Grice's maxims as her model for coherence in her study of sequential integrity of asynchronous discussions. Brennan and Ohaeri (1999) used the cooperative principle as the basis of their conceptual framework in their study of rudeness in online discussions. Greenfield and Subrahmanyam (2003), in their study of discourse in chatrooms, base their definition of coherence on Grice's principle. Cech & Condon (2004) invoke Grice's maxim of relevance in their study of turn-taking in synchronous computer-mediated communication. Schallert et al. (1996) investigated what they see as a duality in coherence, one being a social activity defined consistently with Grice's maxim and the other being a sense-making activity, through which individuals respond to discourse interpretively, as theorized by Van Dijk (1977) and others.

The other seminal source used in defining asynchronous coherence is conversation analysis, as defined by Sacks, Schegloff, & Jefferson (1974). A point of primary focus in this area of research is the concept of turn-taking. Turn-taking is viewed as fundamental to human social interaction. Not only is it used in playing games, but in allocating political office, controlling traffic flows, waiting on customers, and regulating speech exchange systems, such as debates, interviews, meetings, and—importantly—conversations. Because conversation occupies a prominent position among speech exchange systems, understanding turn-taking in conversations is essential to understanding the dynamics of speech exchange systems.

Sacks et al. (1974) began their study by identifying a number of observations resulting from their studies of conversation. These observations they refer to as "grossly apparent facts" (pp. 700-701):

1. Speaker change recurs, or at least occurs
2. Only one speaker speaks at a time
3. More than one speaker may talk at a time, but only briefly
4. Transitions usually involve no gap or overlap
5. Turn order varies
6. Turn size varies
7. The length of conversation is not specified in advance
8. What is said is not specified in advance
9. Relative distribution of turns is not specified in advance

10. The number of participants can vary
11. Talk can be continuous or discontinuous
12. Turn allocation techniques are used, including current speaker selection of the next speaker and self-selection
13. Turns consist of various turn construction units (e.g. sentences, phrases, clauses)
14. Repair mechanisms are used to correct turn taking errors and violations

Turns are treated as a resource, such that conversational participants make seek turns, try to avoid them, or allocate their turn to some other speaker. Therefore, the turn-taking system may have an economic dimension. If that is so, the organization and distribution of turn-taking will have effects on the outcome of the conversation. Since conversation is a central instrument in political, scientific, business, and educational discourse, it is important that conversation *qua* instrument be understood.

In their study of coherence in text-based electronic conferencing, McCarthy, Wright, and Monk (1992) used conversation analysis to study problems in establishing coherence in synchronous online conversation. Their primary point of interest is on what they call *parallel topic development*. Several topics are introduced and developed in an intertwined manner over the course of several exchanges in this phenomenon. While in face-to-face conversation parallel topic development is less prevalent, it is common, according to McCarthy et al., in online discussion, occurring in most of the conversations studied. They propose that to the extent online participants are able to sustain such conversations, they do so by relying on access to the online transcript to reduce cognitive load. Further, McCarthy et al. suggest that although parallel development may seem unnecessary, the latency between messages, even in synchronous environments, may be sufficient to render it inevitable. They argued that participants in online discussions must develop strategies specific to the environment in order to maintain coherence. They propose three strategies: *addressing*, *sequential organization*, and *message compression*. In the addressing strategy, participants mark messages by naming the recipient or referencing or quoting some previous text. Sequential organization is used to develop a point-by-point response to prior discussion, such that the response and prior discussion are structurally parallel. The message compression technique is specific to synchronous discussion and involves breaking down messages into short but rapidly delivered spurts, which have the effect of enabling the writer to keep the floor through a series of comments.

Moran (1991) cited the research of Sacks, Schegloff, and Jefferson (1974), not to identify similarities between conversation and asynchronous discussion, but to highlight the differences. According to Sacks et al., in conversation, only seldom does more than one person speak at a time. When two people do find themselves speaking at the same time, one of them stops abruptly to repair the situation. There is no analog for this in asynchronous discussion. Further, in face-to-face conversation, in order to get an opportunity to speak, one must also listen, at least attentively enough to segue from one topic to another. However, in asynchronous discussion, there is nothing about the technology or conventions that govern its use that obliges the participants to read the contributions of others. A consequence of this is online discussions tend to be divergent rather than convergent.

In a study of turn-taking in synchronous online conversations, Phillips (2000) hypothesized that the classic notion of alternating and orderly turns between dialogue participants attributed to Sacks et al. (1974) is inapplicable for the analysis of collaborative conversations and an ineffective means for achieving collaborative objectives. Phillips proposed that restricting dialogue participants to a strict regimen of alternating turn-taking would result in lower quality collaboration. To test this hypothesis, Phillips defined three synchronous dialogue interface conditions and tested the performance of a small group of pairs of participants under each condition. The first condition, called the *WYSIWIS (what you see is what I see) open condition* permitted the participants to monitor one another's activity on a keystroke-by-keystroke basis and each participant could enter keystrokes, immediately visible to the other participant at any time. The second condition, called the *WYSIWIS turn-marker* condition, was similar to the first, except that by convention each participant signaled with a special keystroke when ready to yield the floor to the other participant. Thus each participant could observe what the counterpart was entering stroke by stroke, but could not begin responding until granted the termination keystroke was entered. Finally, the third condition, called the *chunked* condition prevented the participants from seeing what their counterparts were entering until the counterpart explicitly sent the message. The participants were given two tasks to perform under their designated condition. The results of this experiment suggest that participants using the moment to moment interaction modality (the WYSIWIS open condition) were collaboratively superior to those operating under the other two conditions. There were fewer disruptions in question-answer pairings and statement-response pairings, and the open condition participants fared better with regard to idea development and level of detail. In addition, the open condition participants were able to invoke these details using significantly fewer words than were required to by the other two groups.

While Phillips' (2000) results do not settle any outstanding issues with regard to turn taking in online discussions, they indicate some observations relevant to interactional coherence. First, Phillips' work suggests that even subtle changes in the interactional parameters can lead to significant changes in the effectiveness of communication. Second, if changes as minor as those used here lead to measurable differences in synchronous interaction, little may be inferred from face-to-face or synchronous interaction as to what may be reasonably be expected in asynchronous learning environments. Finally, an imposition of social (turn-marker) or technological (chunked) constraints on interaction, although perhaps well intended, do not necessarily lead to a richer interactional experience.

The salience of the concept of conversational adjacency pairs has been particularly attractive to researchers in interactional coherence. Adjacency pairs, according to Sacks, et al. (1974) consisted of well understood conversational patterns, such as question-answer, greeting-greeting, and request-grant. Herring (1999b) points to the prevalence of disrupted adjacency as form of incoherence in computer-mediated communication. In the same vein, Schallert et al. (1996) found that students compensated for the lack of turn adjacency through the use of referential markers, giving an indication to what previous messages they were responding.

Although the principle of cooperative conversation and conversation analysis have been predominate in defining the coherence as used in studies of asynchronous discussion, conversational metaphors are not the only resource available to researchers in this area. Crystal (2001) observed that while online communication borrows some characteristics from conversation, it also has properties from written texts. Therefore, theories of text coherence might provide useful tools for analysis of asynchronous discussion. Theories of text coherence are used to describe how the parts of a text are interrelated to produce a whole greater than the parts. Within this realm, a wide variety of theories, models, and relation sets have been postulated (Hovy & Maier, 1993). Several of these have proven particularly durable, including theories of coherence relations, cognitive coherence relations, and rhetorical structure theory. These theories share a common bond. The coherence of a text is based on the way the parts of the text relate to one another. Furthermore, these relations are specifiable.

As defined by Hobbs (1979), coherence relations are relations that may be inferred from the successive parts of a text. Thus, for example, if there are two statements, *S0* and *S1*, such that *S1* elaborates on *S0*, then the relation between the two is ELABORATION. In Hobbs argued the number of relations required (at least in English) is small, and identifies ELABORATION, PARALLEL, and CONTRAST as sufficient. Sanders, Spooren, and Noordman (1992; 1993) developed a taxonomy of relations, such that composite relations could be built from primitive relations. More recent research has suggested a few additional relations, including RESEMBLANCE and CAUSE-EFFECT (Hendriks, 2004; Kehler, 2002).

Among theories of coherence relations, rhetorical structure theory (Mann & Thompson, 1988) is distinctive in several respects. It provides a well-defined methodology for constructing comprehensive structures representing an entire text, and it specifies a rigorous protocol for defining relations, but without making any theoretic commitment as to what the specific relations should be.

Taking a neutral stance on relation set has kept RST free from some of the problems that have beset other research. Once the question is asked, a number of questions with metaphysical dimensions arise. Are the relations cognitive relations, in the sense that they are defined, as needed, by the reader to make sense of the text? Alternatively, are they analysts' tools, and serve no purpose beyond the investigation? Or, is it the case that every instantiation of a relation is unique, such that the relations that bind text segments are as unlimited as the possible number of utterances? Difficulties such as these have been troublesome for researchers who sought to resolve on a fixed set of relations (Grosz & Sidner, 1986; Hobbs, 1979, 1985; Hovy & Maier, 1993; Kehler, 1994; Sanders, 1997; Sanders et al., 1992, 1993)

Theories of coherence relations have been little used for conversation, although Hobbs (1979; 1985; 1990) made no distinction as to the applicability of his theory to both text and conversation. Rhetorical structure theory has been used to analyze dialogue in only a few studies (Stent, 2000; Stent & Allen, 2000; Taboada, 2004a). To the extent that asynchronous communication may be viewed as a hybrid mode of expression, exhibiting properties of both written text and conversation, theories of coherence relations should prove useful in the study of interactional coherence.

Argumentation

An *argument* consists of one or more premises and a conclusion, such that the premises give support as to the truth or acceptability of the conclusion (Juthe, 2005). By extension them, *argumentation* is the process of engaging in argumentative reasoning, that is, the participants in argumentation support their claims by means of evidence (Kuhn, 1991). Numerous researchers have noted the importance of argumentation to the learning process (Andriessen et al., 2003; Buckingham Shum, 2003; Carr, 2003; Erkens et al., 2003; Garrison & Anderson, 2003; Kanselaar et al., 2003; Morgan, 1996; Petraglia, 1998; Selvin, 2003; Shauf, 2001; Uren et al., 2003). To the extent that argumentation apparently plays a significant role in learning, the manner and extent to which it occurs in asynchronous learning environments are of interest.

Some evidence has suggested that levels of argumentation in asynchronous learning environments may be low. Morgan (1996) studied online activity of undergraduate writing students and found that although the students could be disputatious, their ability to engage in a process of argumentative reasoning was very low. For conducting his study, Morgan employed three tools for rhetorical analysis. These he identified as *argument-as-experiment*, *dialogical stance*, and *rhetorical conversation*. The argument-as-experiment model is derived from Willard (1983), who emphasized argumentation as a means for social construction of knowledge. Hypotheses and arguments could be presented for the purpose of consideration and joint inquiry. Morgan found that students often introduced topics for discussion, but in doing so, framed them in such a way as to set an absolute answer as the objective of the discussion, and then recognizing that such absolutes were not immediately forthcoming, fell back on truism, dispute, or simple restatement of the problem, with the result that discussions typically died prematurely, without in-depth exploration.

Similarly, Marttunen (1998) studied interaction and argumentation in an asynchronous learning environment and found that even when explicitly directed to engage in grounded discussions the students were unable to do so. Students were divided into two groups, a tutor-led group and a student-led group. Both groups were given the same the same course content, including two books and a course lectures, and both groups were assigned the same pedagogical task. Their assigned task was to practice argumentation using the books and lectures as the basis for their discussions. Students were asked to provide grounded opinions of their views, to respond to the arguments of others, and to defend their views when criticized.

Marttunen (1998) measured the interaction and argumentation that occurred in the email exchanges. The analysis of interaction was based on Henri's categories *genuine interactivity, quasi-interactivity,* and *monologue* (Henri, 1995), although Marttunen changed the terminology to *real interaction*, *interaction*, and *non-interaction*. Analysis of argumentation considered four categories: agreement, grounded agreement, non-grounded disagreement, and irrelevant. Agreement and grounded agreement included expressions of shared opinion, disagreement and grounded disagreement included expressions of opposite opinion, and irrelevant referred to non-argumentative text.

In his analysis of the email messages, Marttunen (1998) found an interaction rate of less than half, and real interaction was only 6%. Further, of those that were interactive, only 10% expressed grounded agreement and 4% expressed grounded disagreement. As such, despite the nature of the assignment and ongoing tutoring in the nature of argumentation, the students were unable to carry out argumentative discussions.

Mabry (1997) studied the use of *framing tactics* in argumentative messages from various bulletin boards, newsgroups, and email lists. Framing is a commonly used message-structuring device useful for establishing inter-message coherence in argumentative discourse. Framing is used to insert segments from a previous message into a new message containing claims against it. The arguer is thus able to using framing in presenting counter-claims. This provides the arguer with useful resource for a variety of rhetorical moves, such as turning the opponent's argument against itself, argument deconstruction, or shifting emphasis. Mabry hypothesized that there is a curvilinear relationship between the use of framing strategies and the emotional tenor of posted messages and that there is a linear relationship between message connotation (appeasement, conciliation, aggressiveness) and emotional tone (level of argumentativeness).

Reliance on framing tactics was defined in terms of two variables: referencing of previous message and length of quotations of previous messages. The analysis revealed a curvilinear relationship between references to previous messages, but not to the length of quotations. That is, the dependence on reference to previous messages increased as the emotional tone became increasingly negative until emotional tone reached the level of disagreement and antagonism, at which point the dependence flattened out. As the emotional tone reached the level of hostility, dependence on reference to previous messages began to diminish. No such relationship between length of quoted material and emotional tone could be established. Mabry (1997) was also unable to confirm the second hypothesis, that there would be a linear relationship between message connotation and emotional tone. However, the results did indicate that conciliatory and apologetic message connotation increased as an emotional affect increased.

As such, Mabry's (1997) hypotheses were only partially supported. Mabry claimed that the results indicate that conversational and argumentative structuring is common in computer mediated conversation (CMC)—and to the extent that this means that users make use of framing, that much is made clear. Mabry also argued that online conversations, like face-to-face dialogues, often transition from platforms for agreement to platforms for contention. Finally, Mabry claims that his research demonstrates the efficacy of applying face-to-face research models to the study of online interaction. In other words, people do use the framing conventions Mabry set out to study, they often engage in argumentation, and related information can be useful to future research.

Erkens et al. (2003) studied collaborative and deliberative processes among secondary students in writing an argumentative text. The study was predicated on the notion that argumentation is an essential function of constructivist learning. That is, as participants engage one another online, they enact a mechanism for testing, enriching, and sharing their insights. As such, students build argumentation structures consisting of claims, counter-claims, qualifications, and rebuttals in the process of collaborative problem-solving. From this perspective, echoing Petraglia (1998), Erkens et al. view education as an essentially argumentative process. They were interested in confirming the utility of the T3C learning environment as a tool for collaborative argumentative writing. The environment supports both collaborative task performance and deliberative interaction. While their findings generally confirmed their hypothesis, there were some caveats. For example, the availability of planning tools did not, in themselves, suffice to render a more positive outcome, as some students were ineffective in their use of them. However, students who used the tools properly also created higher quality argumentative texts. Considerations such as these led Erkins et al. to conclude that, while some useful statements may be deduced from this research, little is known of the use of educational technology in the collaborative development of argumentation skills.

Taboada (2004b) proposed a generic form that argumentative asynchronous messages tend to follow. Messages consistent with argumentative forms typically open with a link to previous discussion, followed by an optional statement of the author's viewpoint, objections to previous argument, statement or restatement of the author's viewpoint, optional examples, and an optional disclaimer. If, as indicated by the literature, argumentation has an essential role in asynchronous discussions, and if, as argued by Azar (1999), the argumentative relations of rhetorical structure theory can be used for analyzing argumentative texts, it would seem likely that argumentative structures would predominate in asynchronous discussions.

Topic Drift

Topic drift refers to the tendency of computer-mediated discussions to stray from their announced topic, commonly dissolving into interminable rounds of mutual recrimination or endless bickering over the proper handling of the topic in question (Fahy, 2002; Harasim et al., 1995; Herring, 1999b; Herring & Nix, 1997; Kayany, 1998; Powazek, 2002). Described by Powazek as the "bane of every email list" (p. 202), topic drift has often been associated specifically with computer-mediated communications (Raymond, 2003), but the concept has its roots in general linguistic research. It has been discussed in detail as a characteristic of conversation Maynard (1980), Hobbs (1990), Watson Todd (1998), Watson Todd, Thienpermpool, & Keyuravong (2004) and others.

Background in Spoken Conversation

Maynard's (1980) investigation of topic drift (or *shift* as he prefers to call it) falls within the tradition of conversation analysis as defined by Sacks, Schegloff, and Jefferson (1974). Maynard found that in spoken conversation shifts do not occur randomly. In a well-behaved conversation, one turn moves to the next, with each successive utterance reflecting an understanding of the content of previous turns (Sacks et al., 1974). Each successive speaker seeks to provide a smooth transition from the previous remarks. Conversations are marked by transition places, at which the current speaker selects the next speaker, the next speaker self-selects, or the current speaker simply continues. However, there are circumstances under which a transition does not occur. A perceptible lull occurs. At these junctures a topic shift may occur. Maynard argued that topic changes occur as a solution to the problem of unsuccessful speaker transition. Typically, transition failures such as this are marked by several brief silences during which speakers produce on-topic utterances, in an apparent effort to revive the stalled conversation and resume continuous talk. When this is unsuccessful, the new topic may be introduced, thus affecting the topic shift. In other cases, a speaker may use some aspect of the current topic in order to cause a shift. For example, speaker could change the topic from cigars to cigarettes by virtue of both topics being related to smoking and tobacco.

Statements used to produce a topic change often rely on features of the setting in which the conversation takes place. Maynard (1980) found that speakers often revived their conversations by making remarks about the experiment they were participating in, such as a reference to the two-way mirror used by the researcher. Other procedures for restoring conversation include making announcements and invitations. Announcements constitute information that would be expected to be regarded as news to the recipient and ensure at least one response from the recipient, e.g. an acknowledgement, a question, or an assessment. Invitations are produced as questions, hence inviting an answer, and therefore continued talk. Thus, an examination of topic shift must include study not just of the topical content, but also of the tactics used by the participants to manage the shift. Although topic shifts are a regular feature of continuous conversation, the procedures used to perform them are complex, and require, in Maynard's words, a "finely-tuned interactional sensitivity" (p. 285).

Maynard's (1980) analysis is instructive for its apparent inapplicability to asynchronous discussion. The role of timing and silence in prompting turn transitions and indicating failed transitions is essential to conversational topic management. Nevertheless it is impossible to modulate control in this way in an asynchronous discussion. While broadly parameterized studies, such as Yates' investigation of oral and written linguistic aspects of computer conferencing, indicate linguistic similarities between asynchronous and spoken discourse (Yates, 1996), Maynard's analysis shows that important characteristics of a conversation are heavily influenced by the immediate circumstances in which the conversation takes place. These circumstances seem to be absent from the asynchronous environment.

As defined by Hobbs (1990), topic drift occurs as a series of incremental changes in a discussion, where each turn is coherent with its immediate predecessor, but where there is no overall topic continuity. Hobbs described conversational topic drift in terms of three coherence relations: *parallel association, chained explanation,* and *meta-talk*. Parallel association relies on common semantic entailments shared by adjacent discourse segments. That is to say, the segments must share some relevant semantic property. Owing to the complexity of language, any non-trivial segment presents multiple opportunities for parallelism. Thus, a segment may be parallel with its predecessor by virtue of one property and with its successor by means of some other property. In such a case, the segment functions as what Hobbs calls a pivot point for topic drift. By this means, parallel association relation accounts for many conversational tangents (Hobbs, 1990).

The *chained explanation* relation occurs when the topic of one turn is used as opportunity for introducing a new topic in the successor. In a well-formed discourse, the conversation returns to the primary topic when the explanation is complete. But when multiple explanations are chained, without return to the original topic, topic drift is said to occur (Hobbs, 1990).

The *meta-talk* relation holds between two segments when one segment evaluates another in terms of its support for the goals of the conversation. In other words, meta-talk shifts the topic to talking about talk. With topic drift, talk about talk can seamlessly become talk about talk about talk. This may be used to call attention to a perceived defect in the conversation or simply to divert attention from a difficult topic. Hobbs argued that most instances of topic drift can be accounted for with the parallelism, explanation, and meta-talk relations (Hobbs, 1990).

Watson Todd (1998) used topic-based analysis to study coherence in classroom discussions. Topic-based analysis combines bottom-up methods, such as theme-rheme and lexical analysis and with topic-down development of a semantic network. This permits categorization of topic in terms of drift, maintenance, renewal, and insertion. Watson Todd found that confusion and topic drift tended to occur when the instructor neglected to use explicit indicators of topic change when managing classroom discussion.

While an understanding of topic drift in spoken conversation is useful to the study of asynchronous discussion, Osborne's (1998) study of topic development in USENET groups found important differences between asynchronous and spoken formats. In spoken conversation, the number of participants is limited, and only one topic is discussed at a time. In one online discussion Osborne studied, there were over 300 participants, and participants took part in multiple discussions at the same time. Online topics frequently splinter into sub-topics, which are carried out concurrently with one another. It is rare that these topics reconstitute once divergence has taken place. Whereas a conversational turn may typically consist of only a few sentences, asynchronous messages can be lengthy, extending to hundreds of words. According to Osborne this contributes to the coherence and makes for more reasoned discourse.

The asynchronous nature of online discussion works against orderly turn-taking typical of spoken conversation. This, Osborne noted (1998), is particularly evident in USERNET discussions because the distribution of the network is global and messages arrive at nodes in unpredictable fashion. It is not unusual for a reader to see a reply to a message when the original message has yet to arrive. In addition, because messages may be cross-posted to multiple newsgroups, it is not unusual for the same or overlapping discussions to appear in multiple groups. Thus, while asynchronous communication lends itself to greater coherence in the composition of individual messages, the ability to maintain coherence across turns seems reduced, as compared to spoken conversation.

Topic Drift in Asynchronous Discussion

Herring (1999b) notes that in computer-mediated communication topic drift is both prevalent and problematic in online discussions. Topic drift is problematic because of the difficulty in repairing a discussion once drift occurs. In a spoken conversation, the mechanisms for returning a discussion to a previous topic are relatively effortless (Crow, 1983). However, online discussions are distinctive in terms of the costs imposed on the participants. That is, the effort to produce and read online messages being significant, a discussion once gone astray may be irrecoverable (Herring, 1999b). Herring based this argument on research by Clark and Brennan (1991), who found that participants in any communication tend to minimize the effort expended on collaboration. An important factor in determining the constraints imposed on collaboration is the medium in use. For example, the constraints on asynchronous discussion facilitate the ability to review previous contributions and to revise contributions privately before transmitting them, but they place severe limitations on the ability to maintain sequential or temporal integrity of communication. And although CMC participants may have the opportunity to review previous messages before posting, the evidence suggests that the seldom do (Herring, 1999b).

Constraints such as these impose various costs on achieving successful collaboration (H. H. Clark & Brennan, 1991). Costs associated with asynchronous discussion include formulation and production costs, reception and understanding costs, delay and asynchrony costs, speaker change costs, and fault and repair costs. Formulation and production costs are the costs associated with creating and transmitting messages. Reception and understanding costs are the costs associated with accessing and assimilating the messages of others. Delays levy costs in interpreting or misinterpreting the delays that occur between a message and its subsequent response. Asynchrony costs result from the inability to employ communication techniques that involve precise timing. Speaker change costs result from the lack of cues for selecting the next contributor in an exchange. Fault and repair costs have to do with the effort required to restore coherence once a breakdown occurs. For asynchronous discussion, the picture that emerges is one where there are plenty of opportunities for misinterpretation, these misinterpretations are conducive to the sort of incremental changes that lead to topic drift, and topic drift, once it occurs, is difficult to repair (H. H. Clark & Brennan, 1991).

Brennan and Ohaeri (1999) used the concept of communication cost to explain the lack of politeness in online communication. In this context, politeness was not defined in terms of common courtesy, e.g. the use of “please” and “thank you,” but rather in the use of hedging as a means of softening the strength of claims made in online exchanges. For example, participants may soften their claims using questions instead of assertions of disagreement, or by using expressions of tentativeness or uncertainty. Brennan and Ohaeri found participants in online discussion used significantly fewer hedges than those in face-to-face discussions, and they attribute this to the formulation and production costs involved in participating in the discussion. This tendency to be less polite, when combined with topic drift, helps explain why online discussions not only stray from their announced topic but also commonly dissolve into rounds of recrimination and bickering (Fahy, 2002; Herring, 1999b; Kayany, 1998).

In his study of the use of quoting in asynchronous conversation, Reed (2001) found that participants tend to limit the depth of reference of the discussion as revealed in the quoted text. Reed found this depth usually extended to no more than two or three messages, and never exceeded five, regardless of the number of predecessor turns in the thread. Reed noted that this practice contributes to the conversational feel of the discussion, gives message writers considerable control over the apparent context into which they insert their responses. However, by so limiting their view of the discussion, participants may render their participation more prone to drift, despite the availability of the complete discussion transcript.

Several researchers have attempted to address the problem of topic drift using *anchored discussion*. In an anchored discussion, the discussion is centralized around a document that serves as the anchor or focal point of the discussion. Guzdial and Turns (2000) compared anchored discussions to non-anchored discussions and found that discussions in the anchored environment discussions were significantly longer in terms of the number of messages posted. However, in both groups, off-topic messages were rare; hence, it was unclear that anchoring reduced topic drift.

Lid and Suthers (2003) developed an anchored online learning environment to support what they called “artifact-centered discourse” through which participants could establish links between their messages and the documents being discussed. In addition, they provided a cross-threading feature that enabled messages to appear in multiple forums within the environment. The intent of these features was to reduce topic drift and divergence. Although Lid and Suthers performed no formal assessment of the results of instituting this technology, they feel the quality of online classroom discussions has significantly improved.

Severinson Eklundh and Rodriguez (2004) studied anchored online discussions of students using a groupware system for collaboratively annotating and discussing shared sets of Web documents. The system supported non-threaded asynchronous discussion. The lack of threading and the document-centric collaboration model required participants to improvise methods for achieving interactional coherence. Participants used a variety of explicit, implicit, and external mechanisms for establishing references. Explicit references included were message identification numbers, author names, and subject matter references. Implicit references included deixis (e.g. second person and demonstrative pronouns), conversational sequences, and topic relatedness. External references consisted of cross-references to other documents within the domain and to group experiences outside the system, such as classroom events. Severinson Eklundh and Rodriguez found that references to the document under discussion (being the most prominent part of the discussion) were often implicit. To the extent that deictic reference was used, it often resulted in ambiguity. For explicit references from one message to another, the preferred means was to reference the author of the anchor message by name. Although the participants were willing to expend significant effort in establishing references, there nevertheless were instances of interactional incoherence.

Van der Pol, Admiraal, and Simons (2006) discussed interactional coherence in terms of co-intentionality, co-reference, and common ground. Co-intentionality concerns shared objectives for the discussion, co-reference has to do with whether the participants are talking about the same thing, and common ground refers to the shared values and goals of the participants, as defined earlier by Clark and Brennan (1991). The loss of any of these would result in loss of interactional coherence. Van der Pol , et al. claimed that by increasing the topical context, that is by structuring the environment to make the nature and scope of the topic under discussion more explicit, maintenance of co-intentionality could be improved. This could be achieved through anchoring the discussion around objects representing topics for discussion. Better co-reference and common ground could be achieved through software features that would enable users to respond to messages by defining links to the specific points to which they are responding. These expectations led to the development of an annotation conference system, such that discussion would be visually anchored around a designated document.

Van der Pol et al. (2006) then compared use of this system with use of Blackboard. They found that users of the annotation scheme produced shorter, more direct messages than the Blackboard users. Blackboard messages tended to resemble email, containing openings and closings, various metacognitive statements, and the core message followed by more metacognitive or social statements. Messages in the annotation system tended to contain only the core statements. They often contained pronouns that referred by to previous messages, suggesting that co-reference was not problematic. They also note that the number of messages was much higher, resulting higher levels of turn-taking, which afforded the students greater opportunity to make repairs when misunderstands arose. In short, overall interactional coherence was increased through these changes in features.

Low levels of interaction

If phenomena such as topic drift indicate that people have trouble interacting coherently in asynchronous discussions, it should not be surprising some research indicates sometimes they interact little, if at all. Noting that asynchronous discussions often take the form of serial monologues rather than discussions, Moran (1991) argued that this is because participants rely on the conventions of face-to-face communication, but, as noted earlier, these conventions do not function well in the online environment.

In a study of participation in an asynchronous learning environment, Henri (1995) found that only one-third of the messages were interactive, and that taken as a whole the conferences consisted of independently constructed texts on related topics. Although high order thinking was common, there was little evidence of interactive learning. Henri proposed that in asynchronous discussions the process of interaction is internal to the learner rather than explicit. She further speculated that asynchronous forums provide the means for sharing the results of this internal learning process and give students the means for validating new knowledge and abilities. However, it is unclear how this validation could be said to take place, in the absence of interaction.

Marttunen (1998), discussed earlier, studied interaction and argumentation in an asynchronous learning environment and found that even when explicitly directed to engage in grounded discussions the students were unable to do so. Pena-Shaff and Nicholls (2004) analyzed the transcript of an asynchronous classroom discussion to determine whether the students used dialogic processes to construct knowledge. The categories used in this content analysis consisted of question, reply, clarification, interpretation, conflict, assertion, consensus building, and judgment. Using these definitions the researchers found little evidence that knowledge construction was dialogic. Rather the students tended to use the occasion of the discussion to engage in monologue.

In his study of email usage by undergraduate writing students, Morgan (1996) found that the students' writing habits were oriented toward the composition of monologues, and he argued that this might account for the lack of interaction in online environments. Morgan argued that writing for the online environment requires a rhetorical reorientation, away from essay composition and toward a dialogic, deliberative rhetoric. He claimed that participants need to adopt more open and enabling style of argumentation, one that invites further topic development. However, in his study Morgan found that to the extent that students engaged in dialogue, they did so in an eristic rather than dialectic style.

Hew and Cheung (2003a) investigated participation in an asynchronous learning environment to determine the types of messages posted, the frequency of postings, and the extent to which co-creation could be found in the students' interactions. They based their methodology on earlier work in content analysis by Henri (1992). The unit of analysis used in the study was "message ideas." This approach was adopted because the authors recognized that simply using complete messages as units of analysis would result in a loss of information, since messages frequently contain more than one idea. Thus participation could be gauged on the number of ideas generated by a student, rather than the number of messages posted.

For the message typology, Hew and Cheung (2003a) borrowed from McKenzie and Murphy (2000), designating four general types of messages: 1) course administration, 2) technical aspects of the learning environment, 3) social expressions, and 4) content of the case-based problem. Interaction was defined using Henri's (1995) distinction between explicit and implicit interaction, where explicit interaction entails a direct reference to a person, to the group, or to some other message, and implicit interaction makes indirect reference to a person, to the group, or to some other message. In addition, these categories were broken down further into response to a question and indirect commentary.

The objective of this approach was to provide a means for determining when participants are responding to and commenting on one another's ideas. Hew and Cheung (2003a) defined a framework for co-construction of knowledge based on earlier research by McKenzie and Murphy (2000) and Gunawardena, Lowe, and Anderson (1997). Major dimensions of the framework were quality of participation, type of participation, and types of interaction. Subcategories and indicators further distinguished each of these. This framework was used the basis of evaluating the transcripts from the online discussions. There were 17 messages posted containing 36 message ideas. Each participant produced an average of 2.25 message ideas. Of these 36 message ideas, 5 were social comments and the rest were task-oriented. Most (94.4%) message ideas were in the subcategory of sharing and comparing ideas. All messages were independent statements, referring for the most part to the case study, seldom referring to prior contributions to the discussion. Thus, interactively they would all fall into either Henri's designations of either monologue or quasi-interactive, i.e. dyadic interactions, consisting of a single message and a reply.

In attempting to account for low levels of participation and the absence of interaction, Hew and Cheung (2003a) offered several possibilities. The duration of the discussion was only one week, the students may have been uncomfortable with the asynchronous environment, the moderators failed to support interaction, the students may have procrastinated (most of the messages were posted on the last day of the discussion), and the students may have been interested in participating only to the extent that it was a requirement for the course. In any case, few conclusions can be drawn from this research. Hew and Cheung suggested that the findings indicate that for these students, i.e. pre-service teachers, their interests were primarily task-oriented rather than interactive.

Given the short duration of the discussion, it would seem there was hardly time for the participants to become interactively engaged. As discussed by Garrison and Anderson (2003), the development of social and cognitive presence involves a process of group dynamics to establish a climate for knowledge co-creation. In addition, Hew and Cheung point out the importance of effective facilitation in the online classroom.

In a second paper, Hew and Cheung (2003b) reported their findings from an investigation into the qualitative aspects of thinking as revealed in asynchronous discussions. The discussion transcripts studied were the same as those used earlier by Hew and Cheung (2003a). In their second paper, Hew and Cheung postulated three general categories of thinking: 1) clarification and understanding, 2) critical thinking, and 3) creative thinking. These categories are derived from a handbook for teaching of critical and creative thinking in elementary school classrooms (Swartz & Parks, 1994). The clarification and understanding category is characterized by classification, hypernymy and hyponymy, comparisons, rankings, logical analysis, definitions, summaries, and reformulations. Critical thinking skills include the ability to assess accuracy and reliability and the ability to make logical inferences. Creative thinking is the ability to generate new ideas, and is indicated by the multiplicity of ideas and the use of metaphor and analogy. These categories are viewed as progressive; that is, for thinking to be effective, clarification and understanding must precede creative and critical thinking.

The messages were analyzed into message ideas. These ideas were then classified using the three categories of thinking, with result that 5.5% of the ideas were classified as clarification and understanding, 77.8% were classified as creative thinking, and 16.7% were classified as critical thinking. The low level of clarification and understanding indicated that the students tended to plunge into critical and creative thinking without first establishing a clear understanding of the problems to be addressed. This result is consistent with Morgan (1996) who found the students he studied to be poorly prepared for effective thinking in an asynchronous learning environment. Here, as in Part I of their study, Hew and Cheung (2003b) recommended that teachers ensure that online discussions be carefully facilitated to assist students in developing and using effective thinking skills.

Siegel, Ellis, and Lewis (2004) studied two groups of users, one being a class of graduate students studying issues associated with hate crimes and freedom of expression, the other a corporate group discussing the value of teamwork. The participants were instructed to read each scenario, post a response, read the responses of other participants and comment on them. Siegel et al. tabulated message word counts and the number of replies to each message. They found that the messages posted in the academic discussion were longer than those in the corporate discussion. In neither discussion were there many replies to previous messages. The participants typically responded to the scenarios and the problems posed by the scenarios rather than to one another. Siegel et al. also examined the relevance of the postings, relevance being defined as “on-topic,” and found that most messages were relevant.

Siegel et al. (2004) found that the participants in both the academic and corporate forums interacted little with one another, seldom posted more than once or twice per scenario, and generally looked to the next scenario rather than developing a deep shared understanding of the topic. However, in contrast to Herring’s (1999) findings, they found little evidence of incoherence or topic drift. They suggest this may be due to the presence of a facilitator or to the features of the WisdomTools Scenarios product. WisdomTools Scenarios is an e-learning product that uses case-based narratives to structure discussions; it is possible that these narratives serve to focus the discussion in manner similar to anchor documents in anchored discussions. The lack of topic drift in these discussions may also be attributable to thinness of the discussion; i.e. if the participants do not interact with one another, there is little opportunity for topic development or drift. The participants were, as found earlier by Henri (1995) and others, simply enacting monologues.

In the second part of the paper, Siegel et al. (2004) argued that a deep conversation is one in which the participants interact with one another—that is participants engage one another in a series of messages and responses. The depth of the conversation is literally the depth of the thread. In support of this, Siegel et al. contended that messages of interest to readers are more likely to generate discussion. This claim is based on Barbabási’s (2002) theory of the fitness of network nodes in a competitive environment. The more fit the node, the more links it acquires, and the more rapidly it acquires them. Siegel et al. sought to transpose this argument onto the reply patterns of asynchronous discussions.

To apply this to asynchronous discussion, Siegel et al. (2004) proposed a graphic social proxy for the response behavior of the discussion participants. This consists of a ring, representing the discussion surrounded by circles, each of which represents a participant. The more responses a participant's messages receive, the larger the circle. Thus, the participants are effectively able to keep score as to whose messages contribute most to the depth of the conversation, as represented in response frequency, and they can use the graphic rendering to navigate to portions of the discussion reflecting high activity. Some potential disadvantages to this approach include potential lopsidedness in the representation of interesting messages resulting prolific versus succinct online behavior, group inattention to less active yet interesting contributions due to under representation in the graphical rendering, and overemphasis of success as represented graphically, to the detriment of actual conversational substance (Siegel et al., 2004).

Topic Divergence

Difficulty in using the asynchronous medium for achieving convergence has been a longstanding issue. Hiltz and Turoff (1985) noted that the prevalence of unresolved topic divergence is a key factor in what they called *information entropy*, a condition that manifests itself through dead-end threads, inaccurate responses, participant procrastination, and attrition. Moran (1991) argued that the lack of convergence is the result of poorly defined conventions. It was his view that the technology is essentially neutral, that over time conventions governing the use of the technology would evolve.

Citing examples from the history of photography and the telephone, he argued that people would adopt new ways of thinking about the medium and adjust their behavior accordingly.

A number of researchers have taken the position that these problems can best be addressed by enhancing the skills of the participants. Lapadat (2002) argued that while asynchronous environments are uniquely suited for collaborative learning, a style of writing which she calls “interactive writing” is an essential part of the environment. Greenfield and Subrahmanyam (2003) described how chat room participants adapted their behavior to meet the demands of the technology. Ragan and White (2001) described what they called the “golden triangles of online communication,” which consist of a number of recommendations for how instructors can make better use of online learning environments. Stroupe (2003) claimed that effective use of online environments could best be achieved through strengthening the aesthetic, linguistic, and performative processes of online writing. Similarly, Potter (2004) argued for a tool-oriented approach. According to this argument, the asynchrony of the learning environment provides learners with a situation uniquely suited to treating language as a tool and using the tools of rhetorical analysis to understand and employ online language more effectively.

Still others regard conferencing software as fundamentally flawed, in both their user interfaces and their underlying information architectures, and these flaws account for topic divergence and other aspects of interactional incoherence. Hewitt (2001) argued that current designs encourage branching, fragmentation, and what he identified as the *tunnel vision effect.* In perpetuating these practices, conferencing software has failed to support convergent discourse patterns. Branching is a natural consequence of using the reply command omnipresent in conferencing software products. The user is guided to reply to a particular message rather than the message within its surrounding context. Fragmentation is an inevitable consequence of repeated branching. This tunnel vision effect is the electronic counterpart to Hobbs' (1990) chained explanations. The tunnel vision effect occurs, as with chained explanations, when over a series of turns the participants respond to subtopics rather than topics in one another's contributions.

Hewitt (2001) studied convergence in three online discussions and surveyed student perceptions of summarization and synthesis activities in online discussions. To support the study, he developed a qualitative rating scheme for categorizing messages: standalone, add-on, multiple references without convergence, and convergent. Standalone messages introduce new information without reliance on any previous postings. Add-on messages comment on a previous posting. Multiple references without convergence occur when reference is made to two or more previous messages, but the reference entails no summarization or synthesis. Convergent messages not only refer to two or more previous messages, they include summarization or synthesis of the ideas presented in the previous messages.

Hewitt (2001) found that 94% of the student messages posted to the discussions were of either the standalone or add-on type. Only 2% were convergent. The survey of student perceptions of convergence revealed that although students felt they would benefit from higher levels of convergence, few of them (19%) make an effort to contribute convergent messages, for 75% the possibility of contributing a convergent message never occurred to them, and only half the students consider the overall discussion when responding to an individual message. Hewitt theorized that that the lack of convergence is in part due to the lack of software features supporting convergent activity. The interactive mechanisms provided for contributing to online discussion are limited to new messages and replies, and this fosters a tunnel vision mentality that results in poor convergence and high levels of topic drift.

Hewitt (2001) identified several practices that have been adopted in an effort to address the convergence problem. These include the use of a rotating moderator, task assignments that explicitly require synthesis, non-threaded conferencing technologies, and the use of periodic synchronous discussions. The use of a moderator and special task assignments can, if properly administered, result in increased convergence. Non-threaded conferencing technologies may also help, but at some cost to discourse coherence. As Hewitt pointed out, the problem is not in the branching of discussion, but in the failure to converge the branches. Periodic synchronous or face-to-face discussions can be used to summarize and synthesize earlier asynchronous discussion, but they present logistical problems for students and teachers operating at a distance.

Because currently available options for convergence are insufficient, Hewitt (2001) argued that the problem can be more fully addressed through a new generation of conferencing technology. This would include support for multiple message response mechanisms, discourse structure mapping and depiction, thread review features, and the ability to view multiple messages at the same time. While these proposals might lead to improved online conferencing software, there is still need for additional research in pedagogical methods and technology utilization to achieve the same ends. For example, promoting increased awareness of the possibilities for convergence and developing techniques for more effective message reading and composition could lead to better results.

A few researchers, upon examining the difficulties of achieving interactional coherence have reported that there is no problem, that coherence in online discussion compares favorably to face to face discussion, or that if there is a problem it is easily remedied. McDaniel, Olson, and Magee (1996) claim their research shows that problems in maintaining coherence in computer-mediated communication occur only infrequently. In their comparative examination of interactional coherence of face-to-face and synchronous conversations among a group of atmospheric physicists, they found that although there were occasional online miscommunications, these were infrequent and readily recognized, and readily corrected. However, the conversations used in their analysis were limited in several respects. On average the number of participants per CMC thread was less than three, the participants were already acquainted with one another, the number of words per thread was less than 160, and the duration of each was under 25 minutes. As such, there was little opportunity for incoherence.

Similarly, van der Meij et al. (2005) describe a situation in which the number of participants was limited, the opportunities for sending and receiving messages were regimented, the messages themselves were composed only after careful consideration by classmates of the two participants. Van der Meij et al. identified an interactional pattern, called a “zigzag” pattern which, when carefully adhered to, would assure turn adjacency. While maintaining such a protocol might be possible in online conversations involving only two participants, the literature describing the advantages of online learning lends no support for such stringent regimentation (Harasim et al., 1995; Hiltz & Wellman, 1997;

Lapadat, 2002; Weller, 2002). In particular, Phillips (2000) found that the imposition of technological constraints on turn-taking in online discussions do not necessarily lead to a richer interactional experience.

The Effects of Features

Whittaker (2003) and others have observed that the features of a computer conferencing environment have an influence the nature of interaction. For example, features of thread management differ from one conferencing system to another (Kear, 2001; Preece, 2000; Reed, 2001). In systems lacking thread support, participants resort to various forms of reference in an effort to maintain sequential integrity in their discussions. They may, for example, resort to *ad hoc* typographical conventions in order to distinguish material quoted from a previous message from new information (Pincas, 1999).

Some researchers have attempted to understand the effect of features on interactional coherence by adding new features that might reduce incoherence or improve learning outcomes. As mentioned earlier, research in anchored conferencing environments has received attention from several researchers (Guzdial & Turns, 2000; Lid & Suthers, 2003; Pincas, 1999; Severinson Eklundh & Rodriguez, 2004; Van der Pol et al., 2006). Other research in this area includes Abowd, Pimetel, Kerimbaev, Ishiguro, & Guzdial (1999), Brush, Bargeron, Grudin, Borning, and Gupta (Brush, Bargeron, Grudin, Borning, & Gupta, 2002), Severinson Eklundh and Rodriguez (2002), and Suthers and Xu (2002). Although experimentation of this nature seems to enjoy some success, it is worth noting that while a shift in features may improve interactional coherence, there may also be unintended consequences. Van der Pol , et al. noted that with their annotation system messages became shorter and more direct. What is sacrificed here is the use of asynchronous messaging as an occasion for reflection. Numerous researchers have affirmed the role of asynchronous learning in-depth analysis, critical thinking, and synthesis (Deziel-Evans, 2000; Garrison & Anderson, 2003; Garrison, Anderson, & Archer, 1999, 2001; Greenlaw & DeLoach, 2003; Jeong, 2003; Lapadat, 2002; Laurillard, 1993; Meyer, 2003; Ragan & White, 2001).

A change in feature is a change, subtle or otherwise, in the medium. This in turn results in changes in the way learners participate. While that, of course, is the objective, the environment is a complex and its role in cognition is not understood fully. As documented by Schrire (2006), the means for discovering the process of collaborative cognition is less than obvious. Although Dunning's catch phrase, "technology is too important to leave to the technologists" (Dunning et al., 2004) might seem facile, the interplay between technology and learning is a case in point. Without an adequate understanding of the interplay between discourse and cognition, identification of the features most suitable to promoting learning through interaction can be little more than trial and error.

Schrire (2002) analyzed asynchronous computer conferences from doctoral-level courses in computing technology in education. Her procedure consisted of mapping the interaction patterns of each discussion, measuring message lengths as an indicator of cognitive complexity, selecting relevant threads for analysis of latent cognitive content, categorizing them based on levels of cognition, performing a statistical analysis based on these categories and message lengths, in order to determine whether there was a relation between cognition level and complexity, and lastly performing a discourse analysis of the selected threads. The discourse analysis was used to further categorize messages in terms of their whether they initiated, responded, or followed-up a conversational move. Interaction patterns revealed through this procedure included instructor centered threads and synergistic threads. Instructor centered messages interacted directly or indirectly with a message from the instructor; synergistic messages interacted with messages from other students. Schrire found that synergistic patterns of interaction and cognition are positively related. While one obvious take-away from this research was its support for constructivist views of learning, more important is its lesson for the current state of research. For true progress, Schrire's study suggests, there need be no rush to produce solutions, not before the problems they would solve is understood—at least intuitively if not scientifically. Nor is there much value in hastening forward with convenient measures, if the questions they would answer are not the ones that should be asked.

Summary

The literature indicates an ongoing concern with issues associated with interactional coherence in asynchronous learning environments. Efforts to understand and address the problem have been heavily influenced by research in the philosophy of language and conversation analysis—two branches of inquiry, one highly introspective and the other occupied with detailed qualitative analysis. Grice's (1975) cooperative principle and its associated maxims provide a prescriptive ideal as to what one might hope to find in a fully coherent discussion. Conversation analysis, as defined by Sacks et al. (1974) offers a view of coherence as seen from the participant's view, one who strives to keep the conversation moving along without unseemly lapses or ungainly moves (Maynard, 1980; Sacks et al., 1974).

The literature suggests that what may be borrowed from the analysis of spoken conversation may be insufficient and sometimes misleading. Crystal (2001) and others have observed that asynchronous discussion is not simply a process of typing out conversational moves, but rather is a process of written composition as well (Lapadat, 2002; Ragan & White, 2001). The tools used to perform the analysis must be selected to accommodate this situation. Discourse analysis offers a variety of resources for analyzing textual coherence, including cognitive coherence relations (Hobbs, 1979; Sanders et al., 1992), rhetorical structure theory (Mann & Thompson, 1988), content analysis (Schrire, 2006) and other tools for textual analysis (Hoey, 2001). These tools and theories are each necessarily partial, but each contributes to a more complete understanding.

Chapter 3

Methodology

Introduction

This study investigated interactional coherence in discussions held in asynchronous learning environments. As understood in this context, a *coherent discussion* is a discussion that is structurally integrated. Similar to *rational conversation*, as defined by Jacobs and Jackson (1983), a coherent discussion is goal-directed, and each message contributes to the goal. This goal may not be stated explicitly, not all participants may understand it clearly, and there may be differing views among participants as to what the goal is. Upon examination, such a discussion would yield a discernible rhetorical structure that shows the way the parts of the discussion relate to one another. An incoherent discussion is one that does not lend itself to such an analysis.

Rhetorical structure theory was used to analyze discussions from two asynchronous computer conferencing systems and one email list. The study included an assessment of applicability of RST for analysis of asynchronous discussions, an examination of the use of argumentative rhetorical relations in asynchronous discussions, an analysis of topic drift, and a comparative study of interactional coherence in the two computer conferencing systems.

The following discussion provides a review of the research questions that were addressed, followed by a restatement of the research questions as hypotheses. For ease of reference, Table 2 summarizes the research questions and their associated goals. Also included are an RST overview, the transcript selection criteria, the conferencing systems, and the software tools that were used. The methodology is then described in terms of specific procedures followed in this investigation.

Table 2. Research Questions and their Associated Sub-Goals

	Research Question		**Sub-Goal**
RQ1	What RST modifications are required for the analysis of asynchronous discussion?	SG1	Identification of rhetorical structures
RQ2	What are the role and extent of argumentative structures in asynchronous discussion?	SG1	Identification of rhetorical structures
		SG2	Identification of patterns of coherence
RQ3	What are the rhetorical relations or structures of topic drift, and what relations are used to manage topic drift?	SG1	Identification of rhetorical structures
		SG2	Identification of patterns of coherence
		SG3	Description of the nature of interactional coherence
RQ4	Do the features of the computer conferencing software used to support asynchronous discussions affect the characteristics of interactional	SG3	Description of the nature of interactional coherence
		SG4	Identification of the implications of interactional

Research Question	Sub-Goal
coherence in asynchronous discussions?	coherence

Research Questions

The research questions addressed in this investigation pertain to selected attributes of interactional coherence, as identified in the literature. These questions were used to motivate investigations of the applicability of RST to asynchronous discussion, the role and extent of argumentative structures, the structure of topic drift, and the interplay between interactional coherence and the features of the computer conferencing environment.

RQ1: What rhetorical structure theory modifications, if any, are required for the analysis of asynchronous discussion?

The objective of this research question was to establish the applicability of RST for analysis of asynchronous discussions. The question left open the possibility that the theory might require modification in order to continue to the subsequent research questions. This was necessary because, while RST has been applied to a wide range of problems, it has not previously been used for in-depth study of asynchronous discussions, and there have been no studies, insofar as this researcher has been able to discover, using RST to study discussions in asynchronous learning environments. In RQ1, the study focused on the following issues:

a. Can asynchronous discussions be plausibly analyzed using RST?

b. Are additional relations required?

c. Are structural modifications required?

RQ2: What are the role and extent of argumentative structures in asynchronous discussion?

Azar (1999) showed that RST could be used to examine argumentative texts and to distinguish argumentative from non-argumentative texts. Azar (1999) found that only a few RST relations should be regarded as argumentative, including EVIDENCE, MOTIVATION, JUSTIFY, ANTITHESIS, and CONCESSION. What distinguishes these relations is that their loci of effect are in the nucleus, and further, that the intended effect is to persuade, move, or otherwise influence the reader to accept the content of the nucleus. In other words, the satellite provides some impetus for accepting the nucleus. RQ2 focused on the following issues:

a. Are asynchronous discussions argumentative?

b. What are the structures of argumentation?

c. What are the dynamics of argumentation?

d. What are the characteristics of non-argumentative discussions?

RQ3: What are the rhetorical relations or structures of topic drift, and what relations are used to manage it?

Hobbs (1990) identified three strategies that account for topic drift: parallel association, metatalk, and chained explanation. Parallel association occurs when adjacent text spans are associated with one another by virtue of their similarity to one another. Metatalk occurs when one text span comments on another with regard to the objectives of the conversation. Chained explanation is a complex mechanism involving a series of interlinked explanations, with each new explanation displacing the topic of its predecessor, without ever getting back to the original topic Hobbs (1990) claimed that these strategies could account for most topic drift in spoken conversation. The objective of RQ3 was to determine whether the same may be said of asynchronous discussion. The focus was on the following issues:

a. Can topic drift in asynchronous discussion be explained in terms of parallel association, metatalk, and chained explanation?
b. What rhetorical relations are used to maintain or restore topicality?

RQ4: Do the characteristics of the software used to support asynchronous discussions affect the characteristics of interactional coherence in asynchronous discussions?

Whittaker (2003) and others have observed that the features offered by a computer conferencing environment influence the nature of the interactions occurring in the environment. The RQ4 investigation examined the rhetorical structures used by participants in three different environments in an effort to discover how the features led to differences in interactional coherence. RQ4 addressed the following key issues:

a. In terms of argumentation and topic drift, what are the salient differences in interactional coherence between discussions enacted in three different computer conferencing systems?

b. Are there apparent differences in the rhetorical structures employed?

Hypotheses

The hypotheses presented here are intended as restatements of the research questions in terms amenable to procedural examination.

Hypothesis 1: Asynchronous discussions can be plausibly analyzed using RST.

1.1 The Extended Mann and Thompson (ExtMT) relation set is sufficient to define the RST relations used in asynchronous discussions

1.2 An RST analysis of asynchronous discussion provides a basis for describing discussions as jointly constructed integrated structures.

A detailed procedural description of RST is provided later in this chapter.

Hypothesis 2: Argumentative structures predominate in discussions in asynchronous learning environments.

2.1 The use of argumentative structures in asynchronous learning environments is comparable to that in an asynchronous scholarly debate.

2.2 Using Azar's (1999) identification of argumentative relations it is possible to make a plausible distinction between discussions that are argumentative and those that, although rhetorically persuasive, offer little actual support for their claims.

2.3 Argumentative messages loosely follow the form of Taboada's (2004b) general argumentative structure of asynchronous messages.

Hypothesis 3: Hobbs' (1990) theory of conversational topic drift provides a plausible account of topic drift in asynchronous discussion.

3.1 Devices used in topic drift include parallel association, chained explanation, and metatalk.

3.2 In parallel association, ANTITHESIS and CONCESSION are salient.

3.3 In chained explanation, ELABORATION, EVIDENCE, PURPOSE, SOLUTIONHOOD, VOLITIONAL-CAUSE, NONVOLITIONAL-CAUSE, VOLITIONAL-RESULT, and NONVOLITIONAL-RESULT are salient.

3.3 In metatalk, EVALUATION relation is salient.

3.5 Chained explanation will combine with metatalk and parallelism to push the topic progressively further from its origin.

3.6 Topic recovery uses the RST relations RESTATEMENT and SUMMARY.

Hypothesis 4: There is suggestive evidence that the features of the computer conferencing system used to support asynchronous discussions affect characteristics of interactional coherence.

4.1 There are discernible differences in the use of argumentative rhetorical relations in the discussions from the two computer conference systems.

4.2 There are discernible differences in patterns of topic drift in the discussions from the two computer conference systems.

4.3 There are discernible differences in patterns of recovery from topic drift in the discussions from the two computer conference systems.

Rhetorical Structure Theory

Gee (1999) has noted that, at least in discourse analysis, any theory implies a methodology, and any methodology implies a theory. To this extent, the methodological basis for this research is rhetorical structure theory. As such, it is appropriate at this point to provide a detailed discussion of RST from a methodological perspective. This provides a context for the procedures defined later in the chapter.

RST is a descriptive theory of text coherence (Mann & Thompson, 1988). It was originally developed for use in automated text generation (Mann, 1987), but has since been expanded into a broad range of applications and research in computational linguistics, cross-linguistic studies, dialogue, multimedia, discourse analysis, argumentation, and writing (Taboada & Mann, 2006a). According to RST, the coherence of a text can be described in terms of the way the parts of the text relate to one another. A coherent text is one whose parts can be accounted for in a fully connected hierarchical structure, in which the parts are the nodes and rhetorical relations define the links. Except as otherwise noted, the following discussion is based on Mann and Thompson's (1988) seminal paper on the subject.

The Elements of an RST Analysis

The principal elements of an RST analysis are *relations* and *spans*. A *relation* defines the functional association between multiple spans of adjacent, non-overlapping *spans* of text. There are two kinds of relations, *binary* and *multi-nuclear*. *Binary* relations are the most common and define an association between exactly two spans of text. *Multi-nuclear* relations define an association between two or more spans of text. In a binary relation, one text span is designated as the *nucleus* and the other as the *satellite*. The nucleus is more salient than the satellite. For example, when one text span explains another, the explanation is less salient than the situation being explained. In a multi-nuclear relation, all text spans are of the same stature, as in the case of a list of items or sequence of events.

A *span* of text may be a *unit* or a *structure*. A *unit* corresponds to a grammatical clause. It is the most elementary element of an RST analysis. A *structure* consists of multiple units and structures associated by means of one or more relations. The process of performing an RST analysis consists of defining the spans, relations, and structures in a text. In the following example is a message from the WebCT discussion on Web design. The message contains five units:

1. It's funny,
2. before I took this class
3. I only concentrated on how colorful, or interesting a website looked.
4. I never thought about the simple things that many users need like easy navigation, user-friendly, quick data access.
5. It's really important.

(W-Web-M5-P45)

Figure 3 shows the RST analysis of the message. The first unit, *It's funny*, is used to make the reader more interested in the units that follow. Thus, it is linked to its nucleus using the PREPARATION relation. The second unit, *before I took this class*, delimits the CIRCUMSTANCE of the third, which describes the writer's earlier approach to assessing a Web site (*I only concentrated…*). This view is then positioned in contrast to the fourth segment (*I never thought about the simple things that many users need*). However, the relation is not one of mere contrast, as the writer clearly favors the new perspective on Web site assessment. Hence, the relation is one of ANTITHESIS. Finally, in the last segment, the writer expresses approval of this newfound realization.

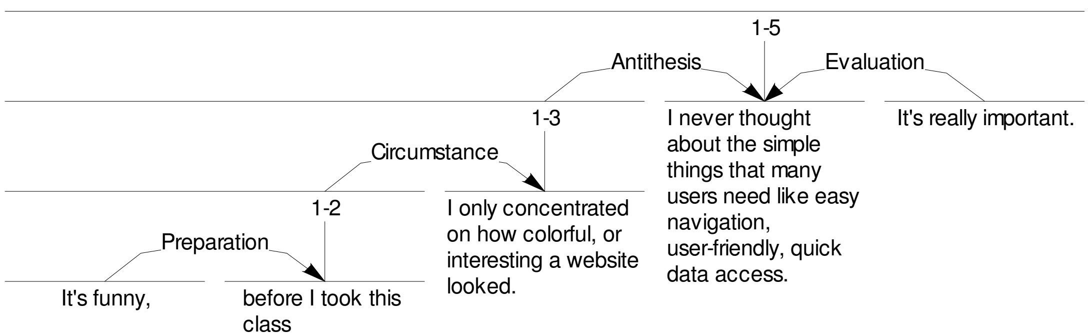


Figure 3. Example of RST Structure Consisting of Five Units

Coherence in RST is defined in terms of four structural constraints: *completeness*, *connectedness*, *uniqueness*, and *adjacency.* Completeness requires that all spans in the document must be included in the structure. Connectedness requires that all spans be related, either directly or by means of nested spans. Uniqueness constraint requires that each span be engaged in no more than one relation. Adjacency requires that for any relation, the nucleus and satellite spans must be adjacent, or that if not adjacent, any intervening text spans must be satellites of the same nucleus. The analyses applied these constraints in defining RST structures, and judgment as to the coherency of asynchronous discussions was based on the extent to which these constraints were met.

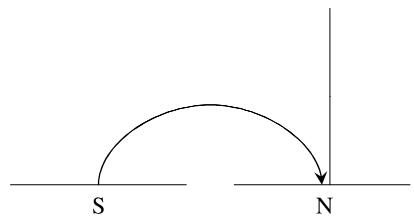
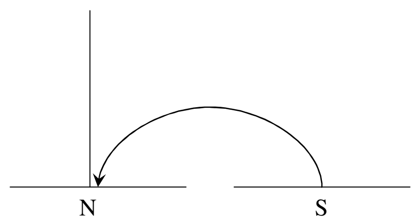
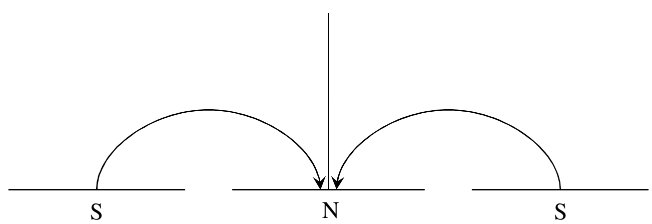
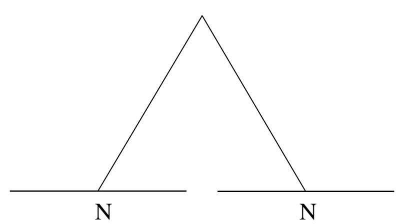
RST Schemas

RST uses *schemas* to define the structural patterns used to constrain the possible arrangements of text-spans and relations. Mann and Thompson (1988) define five schema types; O'Donnell (1997) has argued that three are sufficient to perform any analysis, but in his software tool for performing RST analyses, he supports four default schemas. In this dissertation research four schemas were used. In the literature, the schemas are not usually given names, but are typically identified by visual diagram. For clarity, they are named here as follows:

- Satellite-nucleus
- Nucleus-satellite
- Satellite-nucleus-satellite
- Multi-nuclear

As shown in Table 3, the satellite-nucleus schema describes a binary relation where the satellite precedes the nucleus. The nucleus-satellite schema describes a binary relation where the nucleus precedes the satellite. Satellite-nucleus-satellite describes a nucleus flanked both sides by satellites. In addition, the multi-nuclear schema describes any relation with multiple nuclei. The nucleus of a binary relation may participate in multiple binary schemas. That is to say, the nucleus may have multiple satellites. An application of a schema to a text is sometimes called a *schema application*. In the course of an analysis, schema applications are defined to produce structures of the kind shown earlier in Figure 3.

Table 3. RST Schemas

Name	**Diagram**
Satellite-nucleus	
Nucleus-satellite	
Satellite-nucleus-satellite	
Multi-nuclear	

Relations

Although no particular relation set is prescribed by RST, the seminal paper on the topic (Mann & Thompson, 1988) presented a set of relations that have been widely adopted (see e.g. Azar, 1999; Moore, 1995; Moore & Wiemer-Hastings, 2003; Taboada, 2004a). The relation set used in this research is based on this set, but has been extended to include a few refinements. This extended set is called *ExtMT.* As defined by Mann & Taboada (2006) the ExtMT relation set is presented in Table 4.

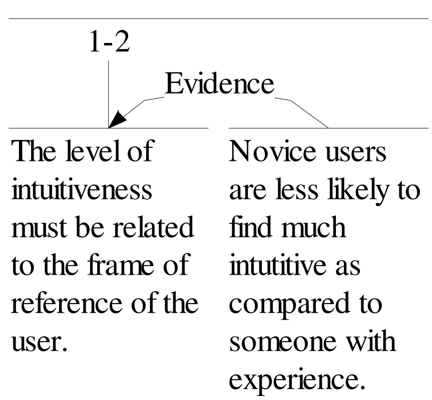
Table 4. ExtMT Relation Set

Binary Relations	**Multi-Nuclear Relations**
ANTITHESIS	CONJUNCTION
BACKGROUND	CONTRAST
CIRCUMSTANCE	DISJUNCTION
CONCESSION	JOINT
CONDITION	LIST
ELABORATION	RESTATEMENT-MN (Multi-Nuclear)
ENABLEMENT	SEQUENCE
EVALUATION	
EVIDENCE	
INTERPRETATION	
JUSTIFY	
MEANS	
MOTIVATION	
NONVOLITIONAL-CAUSE	
NONVOLITIONAL-RESULT	
OTHERWISE	

Binary Relations	Multi-Nuclear Relations
PREPARATION	
PURPOSE	
RESTATEMENT	
SOLUTIONHOOD	
SUMMARY	
UNCONDITIONAL	
UNLESS	
VOLITIONAL-CAUSE	
VOLITIONAL-RESULT	

The names of the relations derive from the function the satellite performs with respect to the nucleus. In the EVIDENCE relation, for example, the satellite presents evidence in support of the nucleus. However, it is insufficient to rely on the names of the relations. Each relation is defined in terms of specific constraints and effects. The constraints and effects are used in selecting the appropriate relation when performing an analysis. Constraints are on the nucleus, on the satellite, and on the combination of the nucleus and the satellite. The effect is a statement of the result the writer plausibly intended to produce. The effect may be located in the nucleus, or it may be located in both nucleus and satellite. Thus, as summarized in Table 5, in the EVIDENCE relation, the constraint on the nucleus is that, without the relation, the reader might not believe the nucleus. The constraint on the satellite is that the reader will find it credible. The constraint on the combination of the nucleus and satellite is that by comprehending the satellite, the reader’s belief in the nucleus is increased. The effect, located in the nucleus, is that the reader’s belief in the nucleus is thereby increased. When performing an RST analysis, the constraints and effects are used in determining which relation to apply in any given situation.

Table 5. The EVIDENCE Relation (Mann & Thompson, 1988, p. 251)

Relation Name	EVIDENCE
Constraints on Nucleus	Reader might not believe Nucleus to a degree satisfactory to Writer
Constraints on Satellite	Reader believes Satellite or will find it credible
Constraints on the Nucleus + Satellite Combination	Reader's comprehending of Satellite increases Reader's belief of the Nucleus
The Effect	Reader's belief of the Nucleus is increased
Locus of Effect	Nucleus
Example	

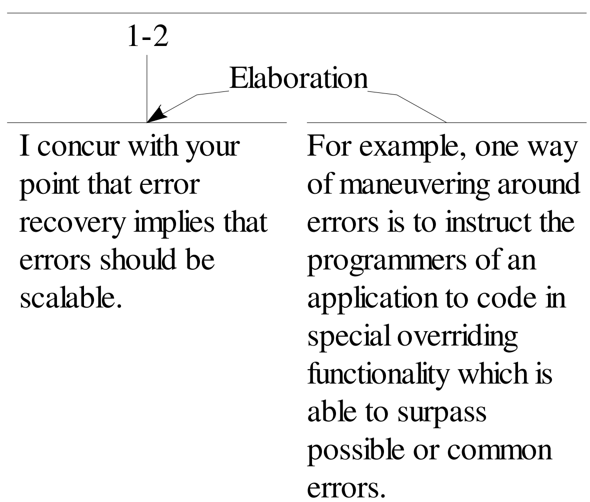
Some other commonly used relations are ELABORATION, ANTITHESIS, CIRCUMSTANCE, CONCESSION, and SOLUTIONHOOD. Definitions for these relations, with some discussion, are given here. A complete set of ExtMT definitions is provided in Appendix B.

The ELABORATION Relation

The ELABORATION relation, defined in Table 6, covers a variety of situations in which the satellite provides addition detail about the nucleus. For example, the satellite could identify members of a set presented in the nucleus, it could enumerate one or more steps in a process, or it could describe specific properties of an entity. As noted by Mann et al. (1992), ELABORATION occurs frequently, and in some texts it is the only relation used. Some researchers have found this relation overly general and have preferred to refine it into multiple relations corresponding to the various types of elaboration (Stent, 2000; Stent & Allen, 2000).

Table 6. The ELABORATION Relation (Mann & Thompson, 1988, p. 273)

Relation Name	ELABORATION
Constraints on Nucleus	None
Constraints on Satellite	None

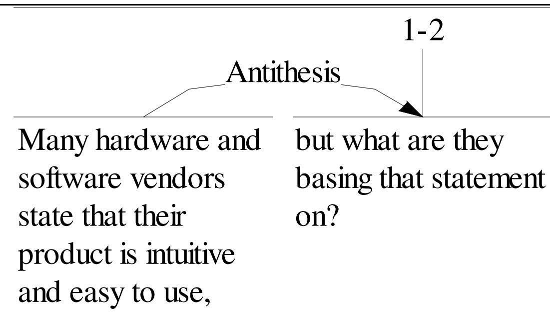
Constraints on the Nucleus + Satellite Combination	Satellite presents additional detail about the situation or some element of subject matter, which is presented in Nucleus or inferentially accessible in Nucleus in one or more of the ways listed below. In the list, if Nucleus presents the first member of any pair, the S includes the second: 1. set : member 2. abstract : instance 3. whole : part 4. process : step 5. object : attribute 6. generalization : specific
The Effect	Reader recognizes the situation presented in Satellite as providing additional detail for Nucleus. Reader identifies the element of subject matter for which detail is provided
Locus of Effect	Nucleus and Satellite
Example	

The ANTITHESIS Relation

In the ANTITHESIS relation (Table 7), the nucleus and satellite are mutually exclusive. In contrasting the two, the writer intends that one (the nucleus) is preferred over the other (the satellite). As with the EVIDENCE relation, the intent of ANTITHESIS is to persuade (Thompson & Mann, 1987).

Table 7. The ANTITHESIS Relation (Mann & Thompson, 1988, p. 253)

Relation Name	ANTITHESIS
Constraints on Nucleus	Writer has positive regard for the situation presented in Nucleus
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	The situations presented in Nucleus and Satellite are in contrast; because of an incompatibility that arises from the contrast, one cannot have positive regard for both the situations presented in Nucleus and Satellite; comprehending Satellite and the incompatibility between the situations increases Reader's positive regard for the situation presented in Nucleus
The Effect	Reader's positive regard for Nucleus is increased
Locus of Effect	Nucleus

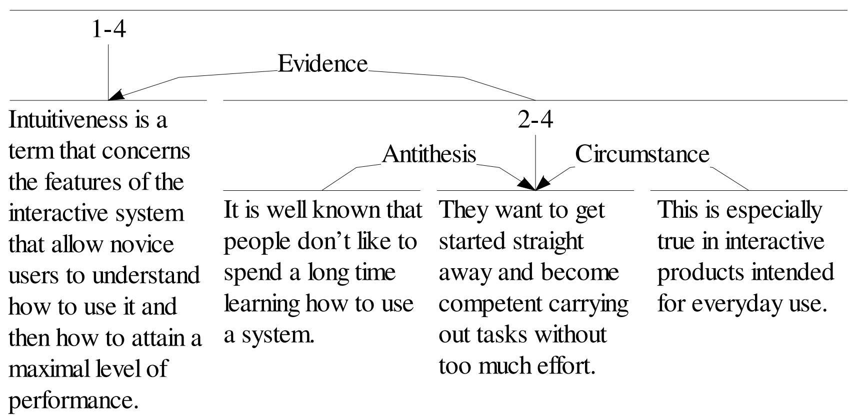
Example	

The C*IRCUMSTANCE Relation*

In the CIRCUMSTANCE relation (Table 8), the satellite presents a framework through which to interpret the nucleus. That is, the locus of effect is in both the nucleus and the satellite. Unlike relations of a persuasive or argumentative nature, such as EVIDENCE, MOTIVATION, JUSTIFY, ANTITHESIS, OR CONCESSION, where the satellite provides what is essentially a supportive goal, in the CIRCUMSTANCE relation the intent is that the nucleus be understood in view of the satellite.

Table 8. The CIRCUMSTANCE Relation (Mann & Thompson, 1988, p. 272)

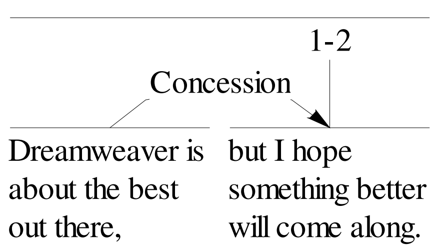
Relation Name	CIRCUMSTANCE
Constraints on Nucleus	Satellite presents a situation (not unrealized)
Constraints on Satellite	None

Constraints on the Nucleus + Satellite Combination	Satellite set a framework in the subject matter within which Reader is intended to interpret the situation presented in Nucleus
The Effect	Reader recognizes that the situation presented in Satellite provides the framework for interpreting Nucleus
Locus of Effect	Nucleus and Satellite
Example	

The C*ONCESSION* *Relation*

In the CONCESSION relation (Table 9), the writer concedes that the satellite may be true, and that it may be incompatible with the nucleus, but maintains the truth of the nucleus nevertheless. CONCESSION is similar to ANTITHESIS. In both cases, the satellite is intended to enhance the reader's positive regard for the nucleus, and in both cases, there is some question as to the compatibility between the satellite and the nucleus. However, in CONCESSION, the writer affirms that the two are, despite expectations to the contrary, compatible. No such affirmation is made in ANTITHESIS.

Table 9. The CONCESSION Relation (Mann & Thompson, 1988, p.254)

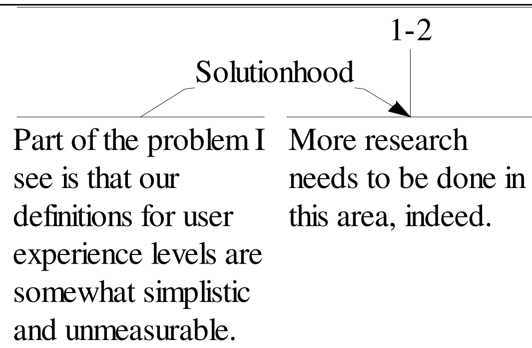
Relation Name	CONCESSION
Constraints on Nucleus	Writer has positive regard for the situation presented in Nucleus
Constraints on Satellite	Writer is not claiming that the situation presented in Satellite does not hold
Constraints on the Nucleus + Satellite Combination	Writer acknowledges a potential or apparent incompatibility between the situations presented in Nucleus and Satellite; Writer regards the situations presented in Nucleus and Satellite as compatible; recognizing that the compatibility between the situations in Nucleus and Satellite increases reader's positive regard for the situation presented in Nucleus
The Effect	Reader's positive regard for the situation presented in Nucleus is increased
Locus of Effect	Nucleus and Satellite
Example	

The SOLUTIONHOOD Relation

In the SOLUTIONHOOD relation (Table 10), the satellite presents a problem, and the nucleus presents a solution. The problem is understood to be a question, request, problem, or other need. As noted by Stent and Allen (2000), the problem can be any problematic situation to which the nucleus offers a remedy.

Table 10. The SOLUTIONHOOD Relation (Mann & Thompson, 1988, pp. 272-273)

Relation Name	Solutionhood
Constraints on Nucleus	None
Constraints on Satellite	Satellite presents a problem. The problem may be a question, request, problem, or other expressed need.
Constraints on the Nucleus + Satellite Combination	The situation presented in Nucleus is a solution to the problem stated in Satellite
The Effect	Reader recognizes the situation presented in Nucleus as a solution to the problem presented in Satellite
Locus of Effect	Nucleus and Satellite

Example	

Canonical ordering of spans

The formal definitions of rhetorical relations say nothing about the order of spans, as to whether the satellite might precede the nucleus or the nucleus the satellite; the definitions prescribe no particular schema. However, some relations seem more conducive to the satellite-nucleus schema while others are more likely to use a nucleus-satellite schema. While imposing no formal constraints, these tendencies are useful in determining appropriate relations. As such, the ordering of spans is canonical rather than definitive (Mann & Thompson, 1988, p. 256). Canonical orderings using the satellite-nucleus schema include

- ANTITHESIS
- BACKGROUND
- CONCESSION
- CONDITIONAL
- JUSTIFY
- PREPARATION
- SOLUTIONHOOD

In these relations, the satellite is used to prepare for the nucleus. For example, in the CONCESSION relation, the satellite forestalls counter-argument, and in SOLUTIONHOOD relation, the satellite poses the problem to which the nucleus is the solution.

Canonical orderings based on the nucleus-satellite schema include

- ELABORATION
- ENABLEMENT
- EVIDENCE
- PURPOSE
- RESTATEMENT

In these relations, the satellite serves to explain the nucleus. For example, in the ELABORATION relation, the satellite provides additional detail about the situation presented in the nucleus, in the EVIDENCE relation the satellite provides reason for believing the situation presented in the nucleus, and in RESTATEMENT, the satellite rephrases the nucleus. These orderings were used in relation identification.

Software Tools

The principal tools used in this investigation were Mick O'Donnell's RSTTool, version 3.45 (June 2004)[1] and Protégé 3.0 (Build 141)[2]. RSTTool is a markup program for RST analyses. Protégé is an ontology editor and framework for the creation of customized knowledge-based applications.

RSTTool, shown in Figure 4 supports text segmentation and structuring, relation set maintenance, and a limited facility for descriptive statistics. The segmentation editor allows the user to segment the text into units. The structuring editor is used for specifying the relations among text spans. The relation editor enables the user to specify the relation set to be used for the analysis and to add and delete relations from the set. Several

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[1] http://www.wagsoft.com/RSTTool/index.html

[2] http://protege.stanford.edu/

relation sets are provided with the tool, including the ExtMT set to be used for this investigation. The statistics feature provides the total number of each relation type and the percentage of each relation to the total analysis.

For complex diagrams, RSTTool also has a collapse and expand feature, which provides some control over the display. Any branch of a structure tree may be collapsed in order to reduce the space requirements needed to display the diagram. A collapsed branch is indicated using a triangle symbol, as shown in Figure 5.

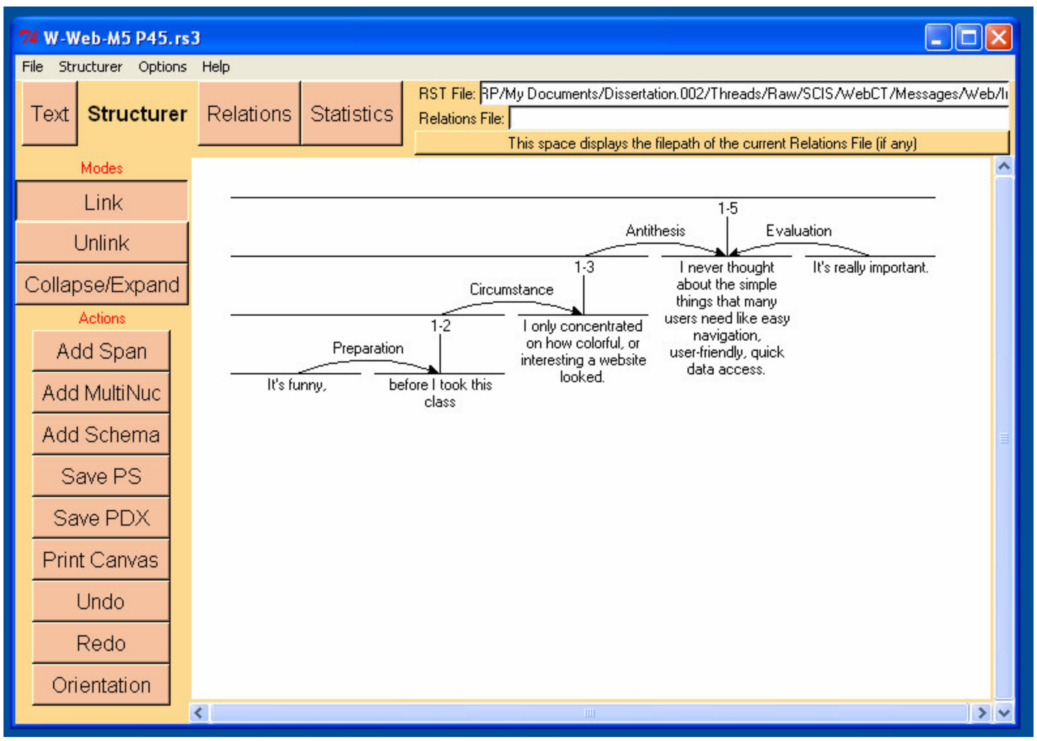

Figure 4. RSTTool Structure Editor

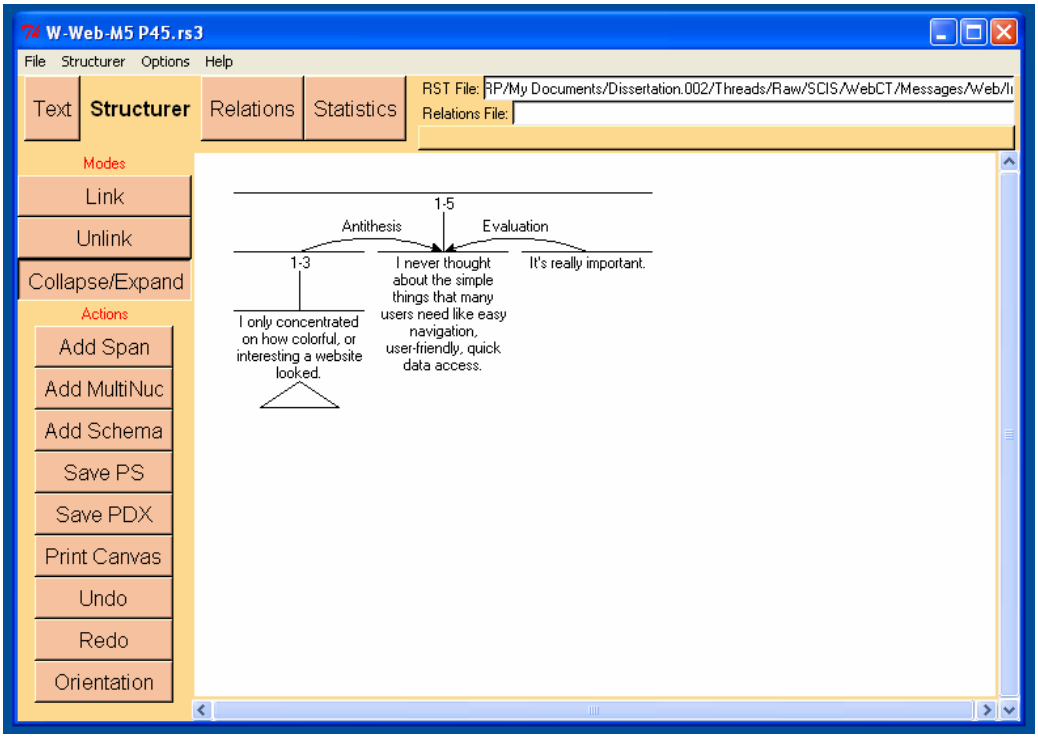

Figure 5. RSTTool Collapse-Expand Feature

RSTTool was used to create RST models for all of the messages included in the study. It was also used, to a limited extent, to create models of interactions within the discussions. While it was possible to model the rhetorical relations of message pairs, it became clear over the course of the analysis that the RST constraint of uniqueness could not be enforced when modeling entire threads. The uniqueness constraint stipulates that each text span may be engaged in no more than one relation. As will be discussed in Chapter 4, any message that receives multiple responses or that responds to multiple messages, may participate in satellite relations to each these other messages. Since RSTTool enforces the uniqueness constraint, these situations could not be modeled using it. This not only brought home Gee’s (1999) observation regarding the equivalence between theory and methodology; it also required adoption of an alternative tool, as well as adjustments to the theory.

The theoretical implications gave rise to the emergence of the concept of *rhetorical networks*, in which threads may be modeled as directed graphs. In a rhetorical network, messages are represented as nodes and rhetorical relations are represented as vertices. This concept will be presented in detail in Chapter 4.

Protégé was used for modeling and visualizing rhetorical networks. The Protégé is a set of tools for creating knowledge-based applications and other conceptual models. The principal tool of Protégé is the ontology editor, which allows the user to define various classes and instantiations of entities and to specify the interrelationships among them. Figure 6 shows an example of a thread modeled in this fashion. Protégé was used to model each of the threads in the study.

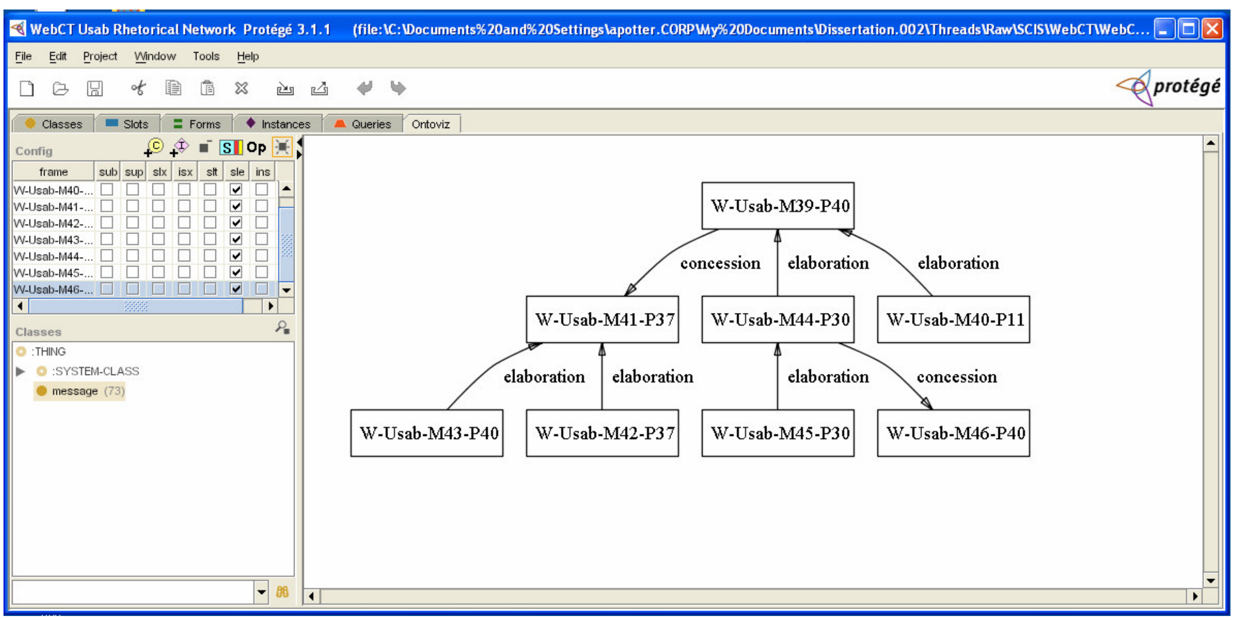

Figure 6. A Rhetorical Network created using Protégé

Transcripts

Three criteria were used in making the transcript selection. These were general, research-specific, and related-research criteria. The general criteria were based on the overall context of the research, the research-specific criteria arose in response to the four research questions identified for this investigation, and the related-research criteria were derived from an informal assessment of research publications similar to this investigation. The following sections explain these in detail and are followed by a summary of the overall criteria.

General Criteria for Transcript Selection

Asynchronous learning environments are central to the focus of this investigation, and therefore it is appropriate that the transcripts studied be from discussions held in these environments. Hiltz and Wellman (1997) define an asynchronous learning environment as a learning environment supported by text-based asynchronous computer-mediated communication, and a learning environment, as defined by Vermunt (2003), is a virtual facility used for interactively sharing and constructing knowledge, be it under the auspices of formal education programs or otherwise. These definitions might at first glance seem overly broad: an asynchronous learning environment typically entails an educational organization, either at the university (Laurillard, 1993) or K-12 levels (Clair, 2002; van der Meij et al., 2005). However, asynchronous learning environments are also used in professional training (Anderson & Kanuka, 1997; Segrave & Holt, 2003), lifelong learning (Alexander, 1998; Bourne, 1998a; Engelbrecht, 2005) and a variety informal learning communities, all beyond the purview of formal educational establishments

(Cook & Smith, 2004). Although the range of possible sources for transcripts seems therefore open-ended, it is necessary, if only as a practical consideration, to limit the investigation to a manageable scope. The emphasis for this study was on asynchronous learning environments in formal educational programs at the university level.

Having narrowed the transcript selection somewhat, it became possible to examine the selection criteria in terms of the specific research objectives. This was necessary in order to address several key parameters, including the number of discussions to be studied, the number of participants in each discussion, and the number of messages contributed to each discussion.

Research-Specific Transcript Selection Criteria

The criteria for selection of transcripts were defined to support an investigation of the research questions of this study. To this extent, it was necessary that the transcripts be sufficient to support investigations of 1) RST analyzability of asynchronous discussions, 2) argumentative structures, 3) topic drift, and 4) comparison of discussion characteristics in different computer conferencing systems. For these questions to be satisfied, the transcripts needed to be sufficient to address the issues they raised.

RQ1 investigated the fundamental issue of coherence. Coherence, as defined in rhetorical structure theory, is defined in terms of the way the parts of a text can be understood as a rhetorical organization (Mann & Thompson, 1988). In applying that metric to asynchronous discussion, this research examined the extent to which an asynchronous discussion might be regarded as an integral whole. For this reason, it is desirable that the transcripts examined comprise complete discussions—or at least that no part be arbitrarily excluded. Although RST has not been previously used for the analysis of discussions of this kind, in those studies most closely resembling this one, the approach has been to include discussions in their entirety (Shaw, 2005; Stent, 2000; Stent & Allen, 2000; Taboada, 2004a, 2004b). As such, because RST analysis was used to assess the structural integrity of the discussions, it was necessary that the transcript consist of complete discussions. This is consistent with applications of RST in other areas, including narratives (den Ouden, 2004), scripture (Terry, 1993), fund-raising letters (Abelen, Redeker, & Thompson, 1993), essay assessment (Burstein, Marcu, & Knight, 2003), argumentation (Liang, 2003), news articles (Marcu, 2000; Ramsay, 2001; Wolf & Gibson, 2005), expository texts (Owens, 2003), instructional texts (Keith Vander Linden, 1993; Keith Vander Linden & Martin, 1995), and a variety of other texts (Mann, 1984; Mann et al., 1992; Mann & Thompson, 1986, 1988; Taboada & Mann, 2006b; Thompson & Mann, 1987).

The transcript requirements for RQ2 and RQ3 were similar. RQ2 investigated argumentative structures in asynchronous discussion. To ascertain whether argumentative structures predominate in asynchronous discussions required that the discussions be sufficiently extensive to enable comparison among multiple argumentative and non-argumentative examples (Azar, 1999). The study of topic drift (RQ3) imposed similar requirements. Topic drift occurs over a series of messages (Hobbs, 1990). Although it was not possible to state in advance the number of messages necessary for these analyses, the study used multiple complete transcripts of representative discussions, such that an absence of topic drift and argumentation would be in itself revelatory.

RQ4 investigated the influence of conferencing system features on interaction. This required that transcripts be drawn from differing conferencing systems. To the extent that differing conferencing systems have different features, the way in which the systems are used may differ. RQ4 considered whether these differences might have an effect on interactional coherence. With respect to transcript selection, this has a clear implication: it was necessary to study transcripts from differing conferencing systems. For this research, the transcripts used were from the WebCT and Allaire Forums.

The transcript selection criteria as derived from the research questions offered useful qualitative parameters. These criteria were that the transcripts should consist of complete threads (RQ1), they should be extensive enough to enable comparison among multiple argumentative and non-argumentative examples (RQ2), they should consist of multiple series of messages (RQ3), and they should include discussions from multiple conferencing systems (RQ4). However, these criteria offered no indication as to the precise number of transcripts required, the number messages per transcripts, the duration of the discussions, or the number of participants. For this, it was necessary to look at transcript selection as it appears in related research.

Related-Research Transcript Selection Criteria

To obtain guidance in determining further transcript selection parameters for the investigation, the researcher performed an informal review of the selection criteria of several similar studies, identified in Table 11. Each was examined to determine the number of discussions, participants, and contributions included in the transcripts under study. The results are summarized in Figure 7.

Not all the studies examined provided information for all the parameters. However, for those provided, the number of discussions studied ranges between 6 and 32; the number of participants is between 10 and 50, and the number of messages included ranges between 17 and 2000. These ranges can be treated as general indicators of transcript parameters for the study. Thus, by this index, the number of discussions to be studied should be no fewer than six, the number of participants should be between 10 and 50, and the total messages should be greater 220 but less than 2000. For this study, seven discussions were be analyzed, with contributions from 120 participants and 521 messages.

Table 11. Transcript Selection in Asynchronous Learning Environment Research

ID	**Reference**
1	Brush, A. J. B., Bargeron, D., Grudin, J., Borning, A., & Gupta, A. (2002). Supporting interaction outside of class: Anchored discussion vs. discussion boards. In *Proceedings of Computer-Supported Collaborative Learning (CSCL'2002).* (pp. 425-434). Boulder, CO: University of Colorado.
2	Fahy, P. J. (2002). Epistolary and expository interaction patterns in a computer conference transcript. *Journal of Distance Education, 17*(1), 20-35.
3	Greenlaw, S. A., & DeLoach, S. B. (2003). Teaching critical thinking with electronic discussion. *The Journal of Economic Education, 34*(1), 36-52.
4	Henri, F. (1995). Distance learning and computer-mediated communication: Interactive, quasi-interactive, or monologue? In C. O'Malley (Ed.),

ID	Reference
	Computer Supported Collaborative Learning (pp. 145-161). Berlin: Springer-Verlag.
5	Hew, K. F., & Cheung, W. S. (2003). Evaluating the participation and quality of thinking of pre-service teachers in an asynchronous online discussion environment: Part I. *International Journal of Instructional Media*, 30(3), 247-262.
6	Lid, V., & Suthers, D. D. (2003). *Supporting online learning with an artifact-centered cross-threaded discussion tool.* Paper presented at the International Conference on Computers in Education, Hong Kong.
7	Marttunen, M. (1998). Electronic mail as a forum for argumentative interaction in higher education studies. *Journal of Educational Computing Research, 18*(4), 387-405.
8	Meyer, K. A. (2003). Face-to-face versus threaded discussions: The role of time and higher-order thinking. *Journal of Asynchronous Learning Networks*, *7*, 3. Retrieved June 6, 2004, from http://www.aln.org/publications/jaln/v7n3/index.asp
9	Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education, 42*(3), 243-265.
10	Pincas, A. (1999, July). Reference in online discourse. *TESL-EJ*, *4*, 1. Retrieved September 24, 2004, from http://www-writing.berkeley.edu/TESL-

ID	Reference
	EJ/ej13/a1.html
11	van der Meij, H., de Vries, B., Boersma, K., Pieters, J., & Wegerif, R. (2005). An examination of interactional coherence in email use in elementary school. *Computers in Human Behavior, 21*(3), 417-439.

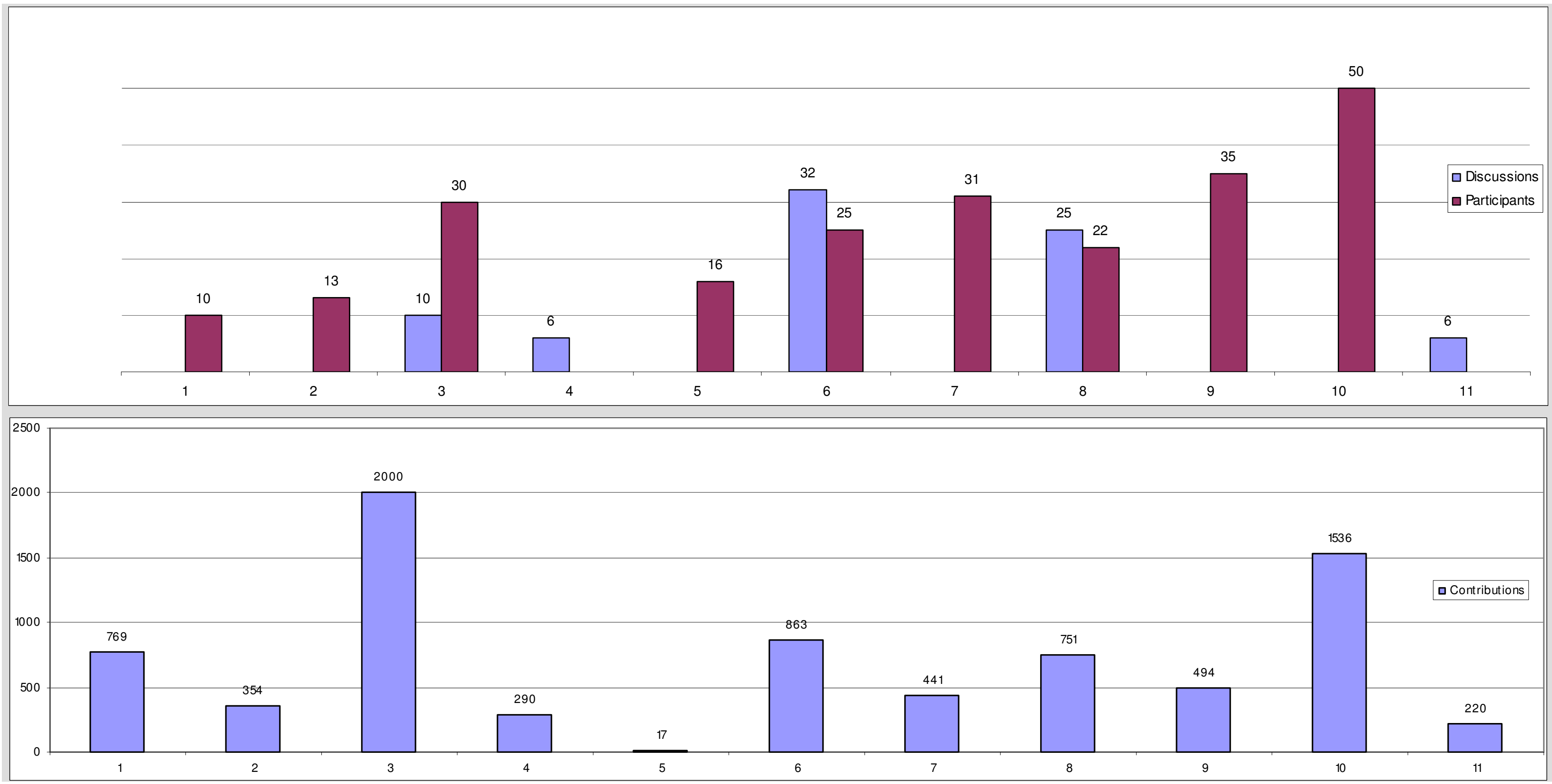

Figure 7. Transcript Parameters in Related Literature

Transcript Selection

The criteria for transcript selection include general, research-specific, and related-research criteria. General criteria specify that the transcripts be of discussions held in an asynchronous learning environment, and that for the purposes of this study, these should be limited to discussions held under the auspices of a formal educational program at the university level. The research-specific criteria indicate that each transcript should consist of a complete thread (RQ1), that each thread is extensive enough to enable comparison among multiple argumentative and non-argumentative examples (RQ2), that each thread is extensive enough to enable identification and analysis of topic drift (RQ3), and that the transcripts are drawn from multiple conferencing systems (RQ4). Finally, the related-research criteria offer a quantitative indication as to how the research-specific criteria might be implemented. For the purposes of this study, these parameters fall within the range indicated by the related-research criteria.

The principal transcripts used in this analysis were from a course in Human-Computer Interaction (HCI). This course (MMIS 680) was part of the core curriculum in the Master of Science in Management Information Systems program at Nova Southeastern University. Salient parameters regarding each of the transcripts are summarized in Table 12. The program was offered entirely online; participation in discussions is a required part of the coursework. The MMIS 680 transcripts derive from two separate offerings of the course. The first offering took place in 2004 and the discussions were held using the Allaire Forums conferencing system, and the second offering took place in 2005 with discussions held using the WebCT conferencing system.

To facilitate comparison, the topics discussed in the WebCT transcript were the same as those of the Allaire transcripts, and the same instructor moderated all.

In addition to the MMIS 680 transcripts, the investigation was amplified by a study of an additional transcript, one that occurred outside a formal educational program. This transcript was from a well-documented asynchronous scholarly debate (Dusek, 1998; Hert, 1997). The debate took place in 1994 on an email list devoted to the topic of science, technology, and society (STS). It attracted the attention and participation of numerous noted scholars in the field, such as Steve Fuller, Patrick W. Hamlett, Paul R. Gross, Harry Marks, Harry M. Collins, Sharon Traweek, and Warren Schmaus. Steve Fuller was one of the more active participants in the debate. At the time of the discussion, he was Professor of Sociology at the University of Warwick. He is now Professor of Sociology & Social Policy, University of Durham, England. Fuller is author of numerous articles in the sociology of science. Patrick W. Hamlett was then (and is presently) on the Faculty with the Division of Multidisciplinary Studies at the North Carolina State University. His research includes many publications in the politics of science. Paul R. Gross is Professor of Life Sciences at the University of Virginia. He is author (with Norman Levitt) of the book “Higher Superstition: The Academic Left and its Quarrels with Science” (Gross & Levitt, 1994). This book was critical of the STS movement and was a topic in the STS debate. Harry M. Marks has been on the faculty at Johns Hopkins University for many years where he has taught courses and performed research in the history of medicine. Harry M. Collins was at the time of the debate on the faculty at the University of Bath. He is now Professor of Sociology with the School of Social Sciences at Cardiff University. He has numerous publications on the nature of scientific knowledge. Sharon Traweek is on the faculty with the History Department at the University of California in Los Angeles. She has authored numerous papers and given numerous lectures on the history and sociology of science. Warren Schmaus is Professor of Philosophy at the Illinois Institute of Technology where he has conducted research resulting in many publications concerning the philosophy of science. Including a discussion of this nature in the research offers the opportunity to discover evidence that the findings of the research are either unique or not unique to institutionally offered programs—it becomes possible to gain some broader perspective as to the significance of the findings.

Table 12. Transcript Selection Parameters

Group	Discussion	Participants	Messages	Begin	End
Allaire HCI	Intuitiveness	26	35	02/02/2004	03/18/2004
	Usability Concepts	25	53	01/26/2004	02/18/2004
	HCI and the Web	26	39	01/22/2004	03/20/2004
WebCT HCI	Intuitiveness	24	61	01/31/2005	03/24/2005
	Usability Concepts	20	73	01/24/2005	03/04/2005
	HCI and the Web	21	62	02/07/2005	03/24/2005
STS	STS Under Attack	60	152	10/03/1994	11/9/1994

Conferencing Systems

Transcripts from courses conducted using WebCT and Allaire Forums were central resources for this study. In particular, RQ4 compared the results of the RST analyses from these conferencing systems and considered whether the features of these systems affected the characteristics of interactional coherence in asynchronous discussions. The WebCT and Allaire products have been used extensively for online learning at a variety of schools, and their features are representative of computer conferencing products used in providing asynchronous learning environments (Bayne & Cook, 2004; Bourne, 1998b; J. Clark, 2002; Kaiden, 2002; Sigmon, 1997; Veerman, 2003). The following provides a brief description of each system.

WebCT

WebCT was originally developed at the University of British Columbia in 1995 by Murray Goldberg. In 1997, Goldberg commercialized WebCT with support from the university and in the following years grew the product until it became it market leader in e-learning technology (L. Chan, 2005). In 2006 WebCT was acquired by its competitor, Blackboard (Roach, 2006). As a result of this merger the WebCT product is now longer licensed under the Blackboard name. The product version used was in this study WebCT Campus Edition 4.1.

The WebCT course management system provides an integrated set of resources for course preparation, communication, and assessment (WebCT, 2003). Preparation resources include Web page development, syllabus definition, and content development. Communication resources include both synchronous and asynchronous and discussion areas, private email, interactive calendar, and a whiteboard feature for real-time collaborative exchanges using text and graphics. Assessment resources include assignment management, online quizzes and surveys, and online self-test features for student review and immediate feedback. The focus for this investigation is on the WebCT asynchronous discussion areas, or forums. It is this portion of WebCT that comprises the conferencing system.

Allaire Forums

Prior to being released as an open source product in May, 2000 (Michael, 2000), Allaire Forums was a commercial product of Allaire, Inc. Allaire was subsequently purchased by Macromedia, Inc. (Sullivan, 2001), which was in turn more recently acquired by Adobe (Berman & Bank., 2005). The discussions to be analyzed in this study were created using a customized version of Allaire Forums release 2.0.5. Whereas WebCT provides a comprehensive course management system, Allaire Forums is limited to computer mediated discussion.

Although both conferencing products include numerous features for administration and customization, the features of interest here are those pertinent to creating, reading, and responding to messages. A list of the features to be considered is provided in Table 13. This list was created through a combination of examination of the products and a review of relevant documentation (Allaire, 1998; WebCT, 2003).

Table 13. Conferencing System Features

Post	Create a new message
Reply	Response to a previously posted message
Browse	When reading messages, the ability to scroll among sequential postings and responses
Email Notification	Receive email notification when new messages are added to the thread
Thread Support	Software and user interface support for representation of threads within a discussion.
Mark	Messages, once read, are marked as read
Quote	Automatically quote a message when creating a response to the message.
Preview	View how a message under construction will appear when posted.
HTML Editor	Software and user interface support for HTML formatting in messages
Attachments	Attach a file to be uploaded with a message

General Procedures

The procedures described in this section provide a systematic description of the process applied to each transcript used in the study, irrespective of research question. These procedures deal with transcript selection, preparation, segmentation, analysis, and related activities. Procedures specific to the research questions are described later in this chapter.

Select Transcripts

The transcripts were selected using the criteria presented earlier this chapter.

Prepare Transcripts

Preparation of each selected electronic transcript included changing the names of the participants, removing any other personally identifying information, and assigning each message a unique identifier. As part of the preparation for this study, the investigator submitted an Institutional Review Board (IRB) Protocol describing the research to be performed, its benefits, research subjects, risks, and other information necessary for assessing its appropriateness. The board reviewed the research protocol and granted approval on November 15, 2005. A copy of the approval document is provided in Appendix B of this report.

The research protocol called for assuring the confidentiality and anonymity of the subjects who names appear in the original transcripts. This included changing the names of the participants and removing any other personally identifying information. The procedure for doing this is as follows: 1) before the transcripts were made available to the researcher, the instructor-moderator removed all surnames, leaving only the participants' given names, and 2) upon receiving the transcripts, the researcher replaced all given names with identification numbers. If the transcripts contained other personally identifying information, the information was deleted. If a deletion would result in a loss of integrity to the text, it was replaced with a bracketed placeholder; for example, if a message contained an email address, the literal email address was deleted and replaced with "[email address]".

Each message was assigned a unique identifier. The identification convention used here consists of a four-part name for each message, as follows:

[Conference System ID][Topic ID]-M[Message Number]-P[Participant ID]

For example, the message identifier for the 21st message of the WebCT transcript on the topic of usability from participant 37 is:

W-Usab-M21-P37

For the analysis of the STS discussion, original names were retained since the identities of the participants have been disclosed previously (Dusek, 1998; Hert, 1997), and the transcripts themselves were, until recently, publicly available on the Web.[3]

The messages contained in the transcripts contain numerous typographical errors. When quoting from these messages, these errors have been preserved.

---

[3] The STS transcripts were formerly available from The Center for Academic & Research Computing at the University of Missouri, Kansas City, http://cctr.umkc.edu/ftp/anon_ftp/LIST_ARCHIVES/STS/STS94/

Create Response Maps

Response maps were created for each discussion. The Protégé 2000 ontology authoring tool was used to create and manage the response maps. The researcher created the simple message ontology, as shown in Figure 8. For the purposes of the response map, a message needed to be defined only in terms of its unique identifier and any messages to which it refers. Given this definition, it was possible to generate response maps by creating an instance of each message and indicating what other messages to which they responded. In the example shown in Figure 9, message M37 from P12 responds to M36 from P2. Both M36 and M35 respond to M34, which is a response to M33.

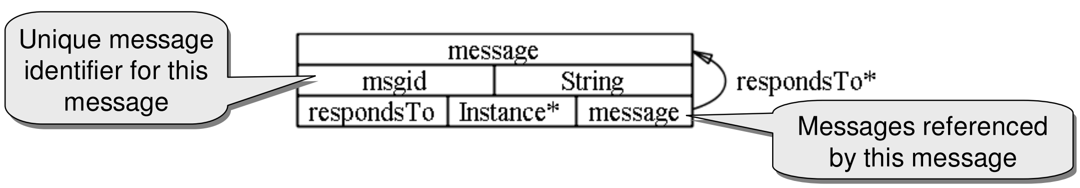

Figure 8. Simple Message Ontology

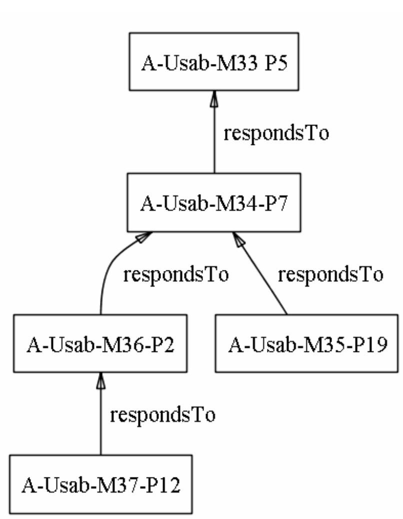

Figure 9. Example of a Response Map

Split Transcripts into Individual Message Files

The transcripts were split into individual message files to facilitate individual analysis. These files were named using the message identification convention described above.

Import Messages

Following preparation, each message was imported into RSTTool. This is a simple procedure using the RSTTool text import command.

Remove non-relational information

Non-relational information that would not be used in the analysis was removed from each message. This included message headers, dates, and conventional salutations and closings.

Segment Messages

Each message was segmented into units. As prescribed by RST (Mann & Thompson, 1988), the boundary for segmentation was generally be independent clauses. Exceptions were made when the message did not contain independent clauses. Messages in the STS discussion frequently contained quoted material from previous messages. Quotations were often extensive, consisting of multiple sentences and paragraphs. Each quotation was treated as a single segment, because the internal structure of the quote belongs not to the message containing the quote but rather to source from which it was drawn.

Perform RST Analysis

Once segmented, the messages were ready for analysis. The analyses consisted of several steps as described in detail in the following sections.

Analysis of RST Structures in Individual Messages

Analysis of RST structures in individual messages involved generating RST diagrams for each message. For each message, the steps were as follows:

1. Identify spans and relations between spans.
    a. Identification of spans and relations proceeded in a bottom-up fashion.
    b. For each pair of adjacent elementary units the researcher considered the possible relations. Relations were determined using the definitions provided in an appendix to this document.
        i. For a relation to be considered appropriate, it satisfied all constraints on the relation, the effect, and locus of effect as specified in the definition.
        ii. If no relation between elementary units seemed plausible, the researcher considered the possibility that either of the units related to a complex text span.

iii. Alternatively, inability to identify a relation would be indicative of incoherence in the text.

c. By this means, as the analysis proceeded, low-level structures emerged. These structures then formed the text-spans of higher-level structures.

2. The markup tool was used to specify the structures.
3. The process continued until all segments of the message were linked into the structure.

Identification of Inter-Message RST Structures

While RST analysis of individual messages provided insight into coherence, argumentation, topicality, and technology use of a message by message basis, identification of inter-message RST structures was necessary to obtain an understanding of the coherence of the discussions as a whole, the level of argumentation, the occurrence of topic drift, and the overall use of technology.

RSTTool and Protégé were used to model inter-message RST structures. RSTTool was used for simple interactions, where the inter-message relations could be captured in a few diagrams. Protégé was using for more complex analyses. Protégé was used to develop rhetorical networks representing each of the threads in the discussions. This was accomplished by augmenting the response map message ontology to include rhetorical relations. Using this ontology, each message was constrained to relate to zero or more messages using the defined relations, as shown in Figure 10. For presentation purposes, only a selection of RST relations is shown here.

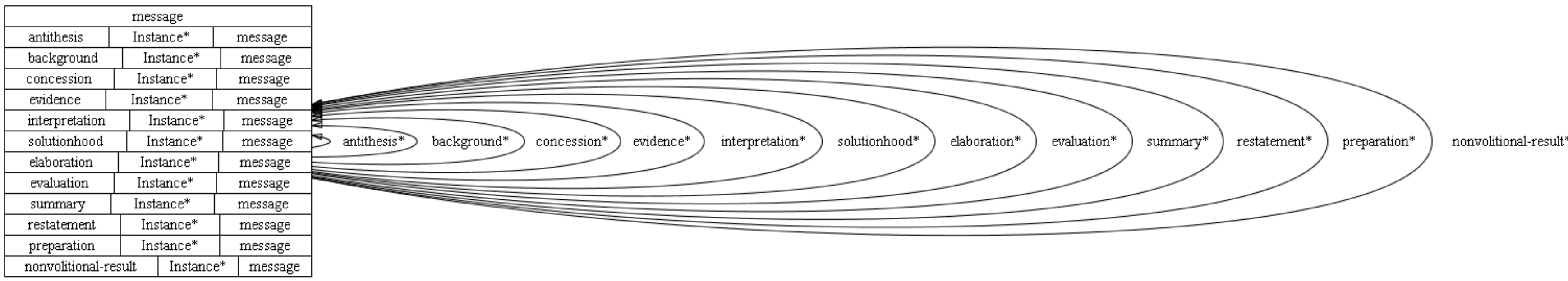

Figure 10. RST Message Ontology

RQ Specific Procedures

Beyond the general procedures, a set of specific procedures was used to address issues raised by Research Questions 2-4. Each of these procedures began upon completion of the general procedures.

RQ2 Specific Procedures

For RQ2 the researcher prepared summary information on the use of argumentative relations in the studied discussions. Relations regarded as argumentative included EVIDENCE, MOTIVATION, JUSTIFY, ANTITHESIS, and CONCESSION. The procedure used for this included determining the total argumentative relations used per message, the percentage of argumentative relations in each message, the total number of argumentative relations as a percentage of total relations for all messages in each discussion, and the total number of argumentative relations as a percentage of total relations for all messages in all discussions.

RQ3 Specific Procedures

For RQ3 the researcher examined the RQ1 analysis in search of evidence of parallel association, metatalk, and chained explanation in the analyses resulting from RQ1. The procedures used are as follows:

1. Identify instances of parallel association in the analyzed discussions, and identify the rhetorical relations used.
2. Identify instances of chained explanations in the analyzed discussions, and identify the rhetorical relations used.

3. Identify instances of metatalk in the analyzed discussions, and identify the rhetorical relations used.
4. Identify occurrences of discourse pivot in topic drifts in the analyzed discussions, and identify the rhetorical relations used.
5. Identify any instances of topic drift recovery in the analyzed discussions, and identify the rhetorical relations used.
6. Identify any instances of topic drift that do not seem to fall in the categories of parallel association, metatalk, or chained explanation.

RQ4 Specific Procedures

For RQ3 the researcher examined the rhetorical structures used by participants in the WebCT and Allaire environments in an effort to discover how the features lead to differences in interactional coherence. The procedures used are as follows:

1. Identify and describe the salient features of each of the conferencing systems.
2. Compare RST Structures for all messages in each conferencing system.
3. Compare Argumentative Structures for all messages in each conferencing system.
4. Compare Topic Drift for all messages in each conferencing system.
5. Compare average and greatest depth of reference for all messages in each conferencing system.

Chapter 4

Results

Introduction

The goal of the research was to develop a theoretical explanation of the nature, extent, and limitations of interactional coherence in asynchronous learning environments. The research sought to identify and describe the rhetorical structures that unify and integrate discourse elements, identify patterns of coherence and incoherence, and develop an exploratory discussion of the implications of interactional coherence for asynchronous learning environments. In support of achieving this goal, the following hypotheses were formulated:

H1: Asynchronous discussions can be plausibly analyzed using RST

H2: Argumentative structures predominate in discussions in asynchronous learning environments

H3: Hobbs' (1990) theory of conversational topic drift provides a plausible account of topic drift in asynchronous discussion

H4: The features of a computer conferencing system affect the characteristics of interactional coherence in asynchronous discussions

The results are organized into four main sections, with each section reflecting a hypothesis. The first section presents the results of the RST analysis of the Allaire, WebCT, and STS discussions. The second section provides an analysis of the argumentative structures used in these discussions. The third section provides the results of the topic drift investigation. The fourth section describes the features of the conferencing systems used and their possible effects on interactional coherence. Finally, the chapter concludes with summary of these results.

RQ1: RST Analysis of Asynchronous Discussions

With the first Research Question (RQ1) the researcher sought to determine the extent to which the discussions examined could be modeled using rhetorical structure theory, whether the ExtMT relation set was sufficient for the analysis, and whether structural modifications to the theory would be required. To support this part of the investigation, the following hypothesis was formulated:

H1: Asynchronous discussions can be plausibly analyzed using RST.

1.1 The ExtMT relation set is sufficient to define the RST relations used in asynchronous discussions

1.2 An RST analysis of asynchronous discussion provides a basis for describing discussions as jointly constructed integrated structures.

The results presented here are organized in two main parts. The first part presents the results of the analysis of individual messages, including information about patterns of segmentation, relation use, and structural features of the messages in the discussions studied. The second part presents the results of the inter-message analysis. This part presents results of the study of relation use and structural features of the threads comprising the discussions. The results of RQ1 then serve as the basis for defining the results of the remaining research questions.

Analysis of Individual Messages

Each message was segmented and analyzed using RSTTool. The messages analyzed ranged considerably in length, from as few as one segment to as many as 85, with a segment being roughly equivalent to a sentence. Messages of only a few segments were not uncommon, but many messages exceeded 25 segments, especially in the STS discussion. Messages posted to the STS discussion were on average twice as long as those posted to the Allaire and WebCT discussions. Although messages of only a few segments in length were common, messages exceeding 25 segments or more were frequent. Messages in the STS discussion frequently contained quoted material from previous messages. Although the WebCT conferencing system provided a feature to facilitate quoting, the feature was not used in any of the WebCT discussions. Further details concerning segmentation can be found in Appendix C.

Most of the relations defined in the ExtMT relation set were used in each of the groups. The ELABORATION relation was by far the most frequently used, with almost 33%, followed by BACKGROUND with 9% and ANTITHESIS with 7%. Only UNCONDITIONAL was never used in the analyzed messages. Other infrequently used relations were the RESTATEMENT-MN, DISJUNCTION, JOINT, UNLESS, PURPOSE, and OTHERWISE. Appendix D provides details of the relative frequency of RST relation use in individual messages.

That ELABORATION was the most frequently used relation was not surprising; Mann and Thompson (1988) observed that in their analyses of numerous types of texts, ELABORATION was the most frequently used, and that in some cases it was the only rhetorical relation used within a text. Indeed, this was occasionally observed in the messages analyzed. Figure 11 shows an example of this. The message began with an evaluative statement of a previous message. This was followed by four additional units, each of which elaborated further on the initial statement.

This is typical of the ELABORATION relation, which uses the nucleus-satellite schema; the nucleus precedes the satellite and the satellite presents additional detail about the topic, or some aspect of the topic, of the nucleus. Thus, it signals development of an idea. However, the structure need not be as simple as the one shown in Figure 11. In Figure 12, ELABORATION was used in half of the relations. The message began by identifying popup menus as a usability problem. This was followed by two elaborations that explained the problematic nature of popup menus. In the next part of the message, the writer raised the issue of Section 508 compliance. This was elaborated with the claim that the Web site did not comply with Section 508. This shows how the use of ELABORATION is integral to topic development.

Second to ELABORATION, BACKGROUND was the most commonly used relation. In the BACKGROUND relation, the satellite normally precedes the nucleus, providing prefatory information that enables the reader to understand the nucleus. The BACKGROUND and ELABORATION relations share the common trait that the satellite is used to provide additional information about the nucleus, with the principal distinction being that BACKGROUND precedes the nucleus and ELABORATION follows it. For example, in Figure 13, the writer provided a dictionary definition for the term *intuitive* as a way of preparing for a more elaborate discussion of intuitiveness as applied in human-computer interaction.

CONCESSION and ANTITHESIS were the third and fourth most frequently used relations. Unlike BACKGROUND and ELABORATION, CONCESSION and ANTITHESIS are used to indicate that one idea is being weighed against another. In CONCESSION, the writer recognizes an incompatibility between two statements, and while not denying the truth of either, expresses a clear preference for one over the other. In the example shown in Figure 14, CONCESSION was used to highlight the point that applying HCI principles to Web site design is difficult. In ANTITHESIS, the satellite and nucleus are in contrast to one another, and the writer indicates a clear preference for the nucleus over the satellite. This can be seen in the example shown in Figure 15. Two alternatives were contrasted, consulting an FAQ and asking a question, with preference being given to the latter.

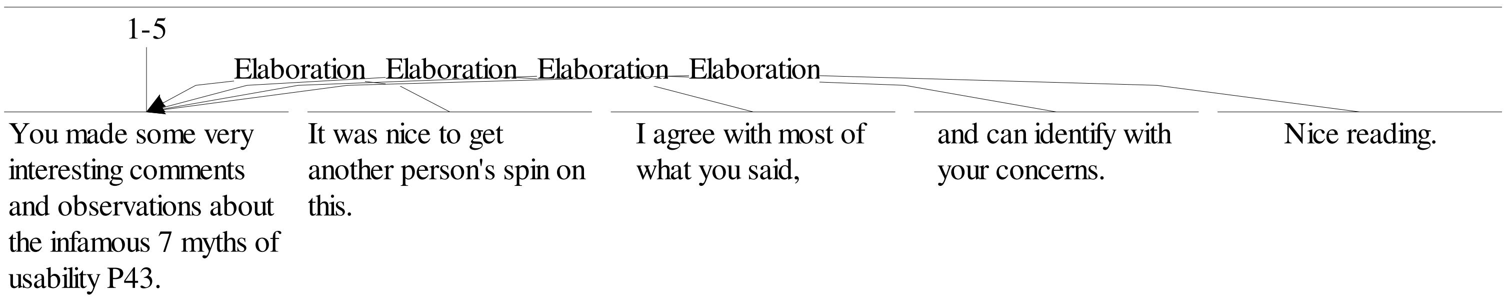

Figure 11. Extensive Use of the ELABORATION Relation (W-Usab-M31-P45)

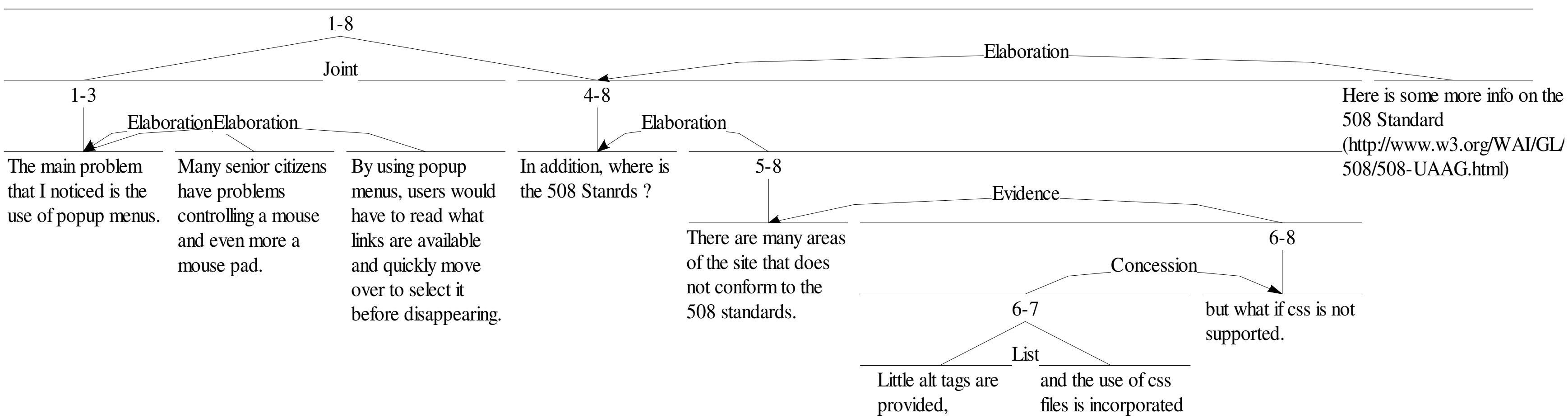

Figure 12. Use of the ELABORATION Relation for Topic Development (W-Web-M40-P37)

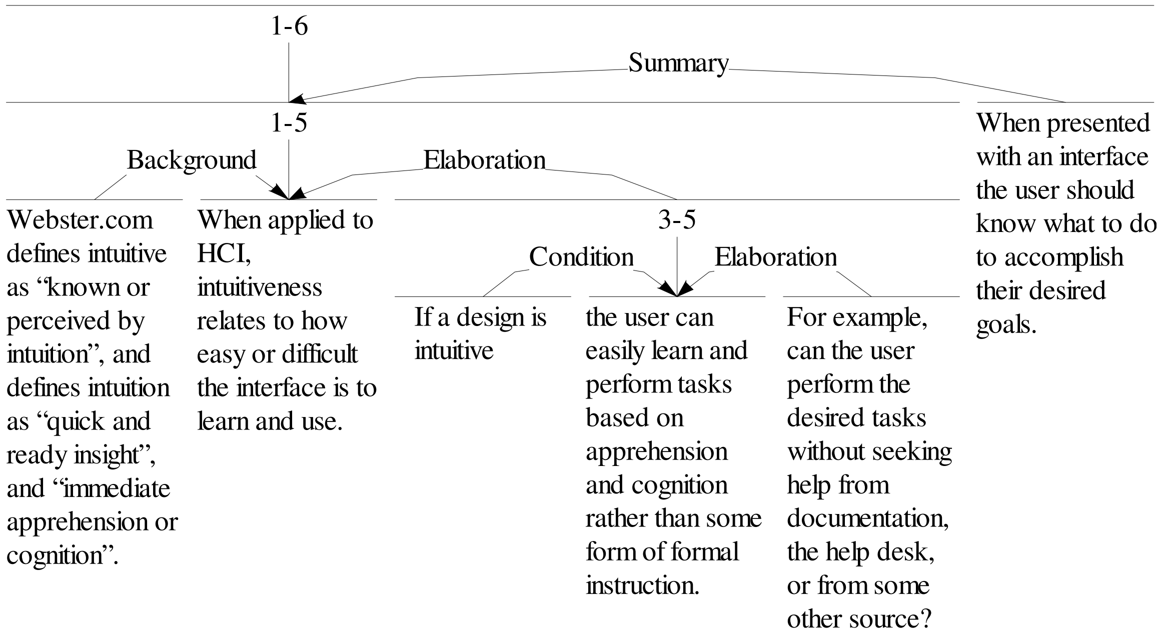

Figure 13. BACKGROUND as Prefatory Relation (A-Intuit-M16-P22)

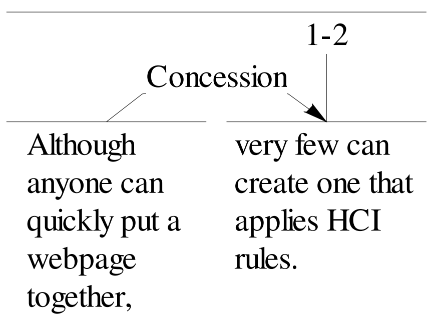

Figure 14. Example of CONCESSION Relation (W-Web-M26-P37)

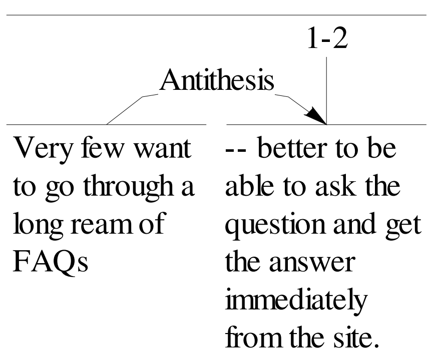

Figure 15. Example of the ANTITHESIS relation (A-Web-M20-P11)

To understand the rhetorical organization of the messages studied, it wasnecessary not only to identify the RST relations used, but to examine the structures as well. In RST coherence is defined in terms of four constraints: *completeness*, *connectedness*, *uniqueness*, and *adjacency* (Mann & Thompson, 1988). The completeness constraint requires that all units in the text be included in the structure. Connectedness requires that all units be related, either directly or by means of nested spans. Uniqueness stipulates that each span be engaged in no more than one relation. Adjacency requires that for any relation, the nucleus and satellite text spans must be adjacent to one another, or that if not adjacent, any intervening text spans must be satellites of the same nucleus. Thus, judgments as to the coherency of a message were based on whether it met the constraints of completeness, connectedness, uniqueness, and adjacency.

In all cases, the messages analyzed were found to meet the uniqueness and adjacency constraints. In some cases, the connectedness and completeness constraints could only be met by use of the JOINT relation. JOINT is a multi-nuclear relation used to indicate a lack of a rhetorical relation between the nuclei; as such it is technically not a *rhetorical* relation at all, but is rather an indicator of co-occurrence of rhetorically distinct textual structures within the same message. In the following example, the first and second paragraphs have no apparent rhetorical relation to one another, so the JOINT relation was used to complete the analysis (shown in Figure 16):

> An intuitive user interface is one that is easy to learn; users can "pick it up" quickly and easily. A good design includes making labels conform to the terminology that the application supports.

Ways to measure intuitiveness: # of user moves, times, and/or errors.

(A-Intuit-M5-P18)

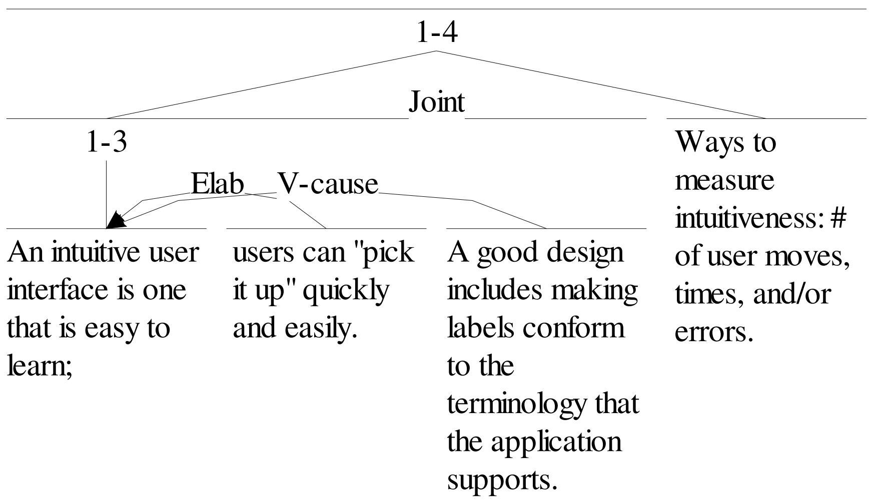

Figure 16. A-Intuit-M5-P18

Although the use of the JOINT relation presented prima facie evidence of incoherence, it was found useful to look more closely at the occurrences of JOINT to see whether there might be some alternative explanation. This examination revealed several situations that gave rise to the use of JOINT, as summarized in Table 14. First, *intertextuality* provides that when the coherence of a message could not be ascertained through analysis of the message alone, the analysis might take into account the context of other messages in the discussion (more generally, the term *intertextuality* has been used in describing the relationships of any text with its predecessors, with the implication that this relationship affects how a text is understood (Fairclough, 1992; Hoey, 2001, p. 43)). Second, o*rthogonal elaboration* refers to the use of explicit signaling devices to depart from the focus of the current topic to introduce another aspect of the same topic. In such cases, the elements of the JOINT relation might be interpreted as ELABORATION satellites of some unmentioned shared nucleus. Third, *subtopic escalation* is a tactical device for initiating topic drift by means of advancing some subtopic of the discussion to topic status. This term will come up again in the discussion of topic drift. Finally, *non sequitur* includes messages that are, insofar as the investigator was able to discern, incoherent. Only a few messages fell into this category, some 4 out of 475 messages studied in this investigation.

Table 14. JOINT Type Definitions

JOINT Type	**Definition**
Intertextuality	Coherence relies of informal relationships between the message and its predecessors, with the implication that these relationship effects how the text is understood
Orthogonal elaboration	Explicit signaling devices to introduce another aspect of the same topic. In such cases, the elements of the JOINT relation are interpreted as ELABORATION satellites of an unmentioned shared nucleus.
Subtopic escalation	A tactical device for initiating topic change by means of advancing a subtopic to topic status
Non sequitur	The topic change is incoherent

Intertextuality was found in 29 messages using the JOINT relation. In these messages the jointly related text spans were found to map to topics in a previous message. In the

Allaire and WebCT groups, this often occurred in student responses to the instructor's introductory message. Each discussion began with an introductory message in which the instructor described the parameters of the discussion. For example, the following message was used to open the discussion of intuitiveness in the Allaire Forums group:

> There is a popular HCI term often floating around called "intuitiveness". We often read about products being rated for intuitiveness -- how well a product can be learned or used without much instruction or help. From both a marketing perspective and a design perspective, this usability concept of intuitiveness requires full support in user interface design. Intuitiveness helps us with ease of use and ease of learning (both are noted usability attributes) in using new products and with continual use of familiar products. However, many products are being marketed as "intuitive", when in fact, their design falls short of the promise. We need to DEFINE intuitiveness and discuss how we can MEASURE intuitiveness in terms of usability and design.
>
> Let's try to address this issue of intuitiveness and how we can specifically measure it.
>
> (A-Intuit-M1-P11)

In their contributions to the discussion, several students chose to address both of the topics, definition and measurement, within a single message, but without relating the two. Message A-Intuit-M5-P18, presented earlier, is an example of this. By interpreting this message in light of the earlier A-Intuit-M1-P11, it becomes clear that the inclusion of jointly related comments was anything but arbitrary. They owe their coherence to the larger context into which they were posted. The instructor's opening message posed a problem for the students, to address the issues of definition and measurement, and the response was offered as a solution to that problem. Indeed this same pattern occurred four times in response to the instructor's message, as illustrated in Figure 17. That the students' messages proposed solutions to the problem presented by the instructor suggests there might be a rhetorical relationship between the messages. However, in these examples, there was no formal evidence that the students' messages were intended as responses to the messages: there was no use of threading mechanisms or forms of address that indicate responsiveness.

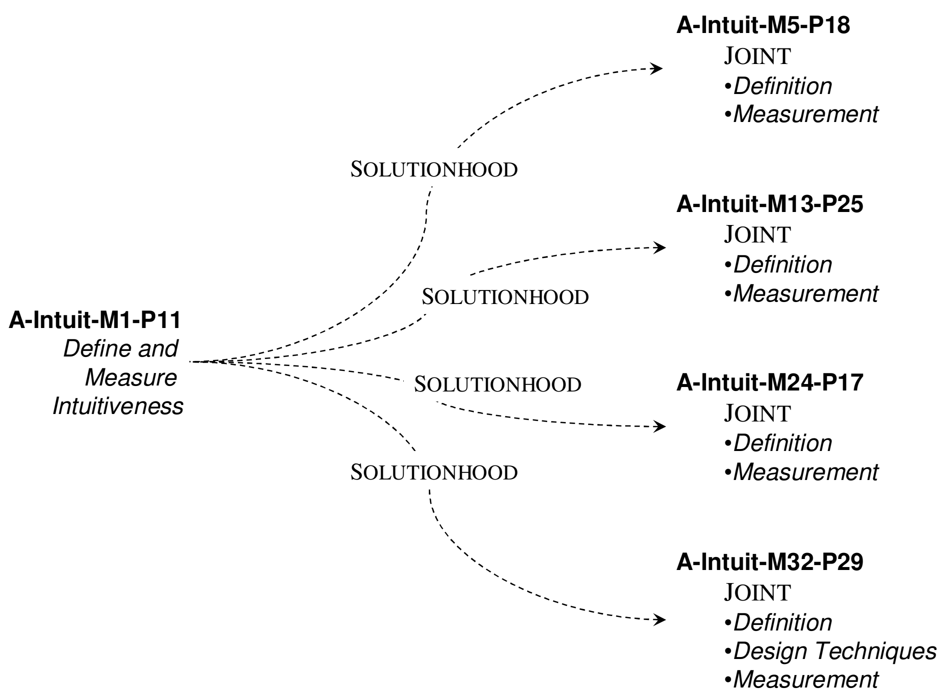

Figure 17. Intertextuality in an Allaire Discussion

While in intertextuality the nucleus of the jointly related text spans are in some other message, with orthogonal elaboration, the nucleus was unstated. Signaling was accomplished using phrases such as “oh by the way,” “on another note,” or “in addition.” However, these signals are not in themselves sufficient for identifying orthogonal elaboration. In some cases, a message read as if its text spans were orthogonally related, but the context of the message indicated that intertextuality would be a more appropriate designation. The message shown in Figure 18 contains two instances of JOINT. Reading the message as a standalone text might suggest that both were examples of orthogonal elaboration, but reading it in context indicates that this message was a point-by-point rebuttal of an earlier posting.

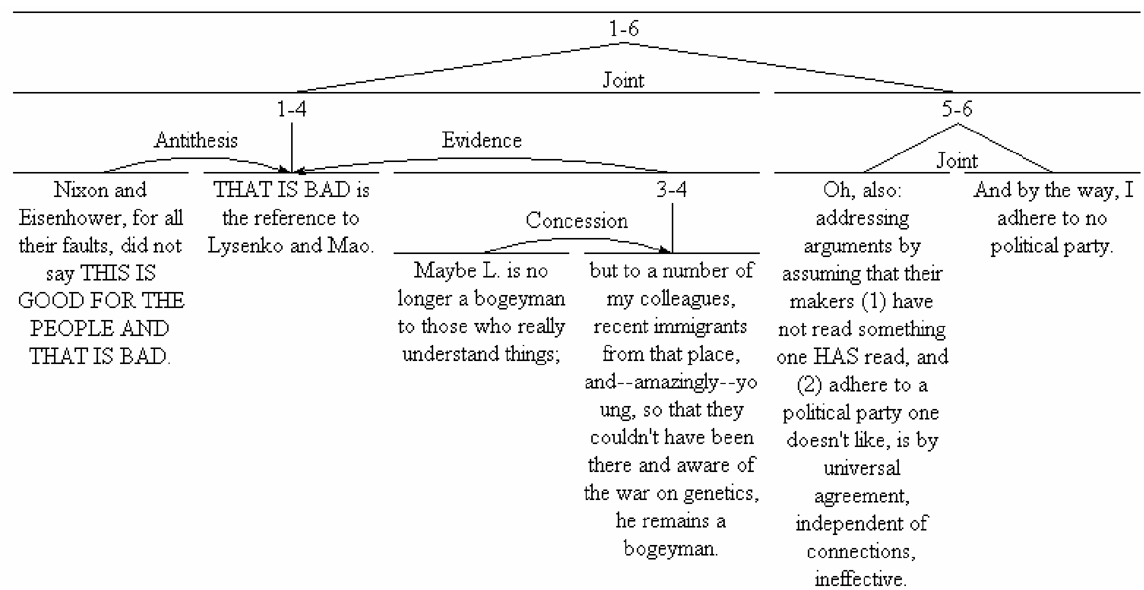

Figure 18. Orthogonal Elaboration in the STS Discussion (STS-Oct-M31-Gross)

Subtopic escalation is a device for initiating topic drift by means of promoting a subtopic to topic status. A short series of messages using JOINT, beginning with a message employing subtopic escalation, occurred in a WebCT thread on the topic of the use of right-handed keyboards by left-handed people, shown in Figure 19.

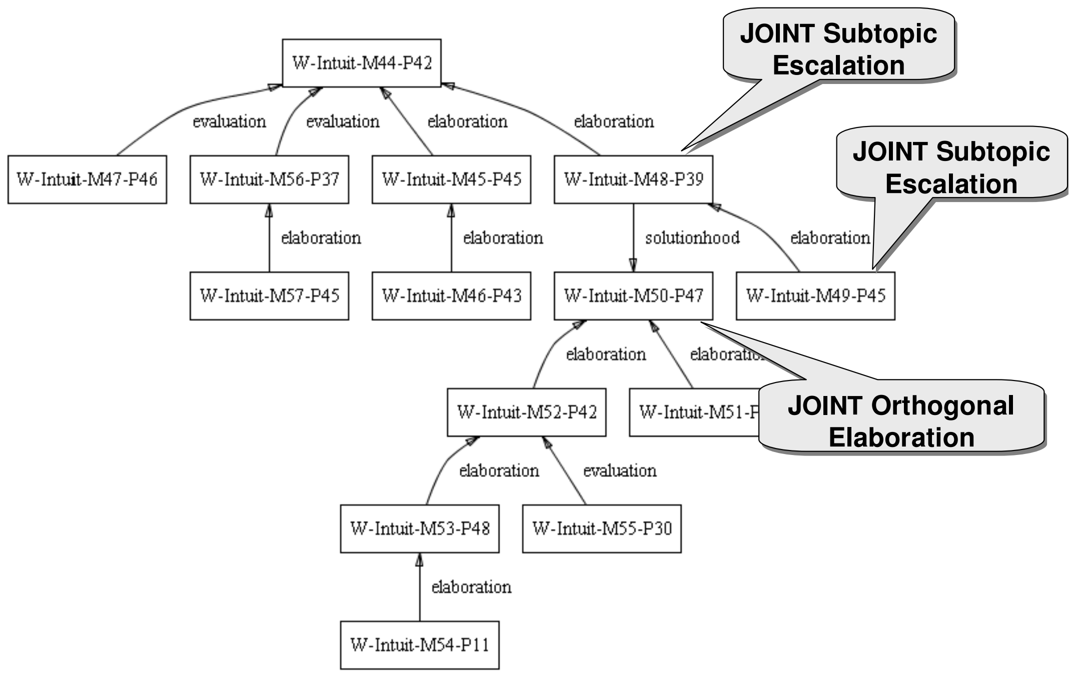

Figure 19. Use of JOINT in the Keyboard Design Thread

The initial pivot occurred in M48, when the writer used subtopic escalation to transition from keyboards to the origins of left-handedness. This can be seen in the rhetorical analysis, shown in Figure 20, where the topic abruptly shifted, using the JOINT relation. The next message (M49) picked up on the new topic and provided additional observations about left-handedness, but it also used an orthogonal elaboration to return the subject to the original topic (Figure 21). Next, message M50 used intertextuality to respond to both topics of M48 (Figure 22).

Although the JOINT relation indicates a lack of rhetorical relationship between parts of a text, it is clearly a useful mechanism in modeling coherence in asynchronous discussions. It can be used to maintain continuity of multiple topics within a thread, it can be used to make subtle changes in the topic, and it can be used, when so desired, to steer the discussion in a completely new direction. Despite its usefulness in managing coherence, JOINT also remains the relation of last resort when analyzing a text with weak coherence. The last category of situations giving rise to the use of JOINT is topic non sequitur. Non sequitur included messages that were, insofar as the investigator was able to discern, incoherent. There were only a few of these in the Allaire and WebCT discussions, and none was found in the STS discussion. Here is an example of non sequitur, taken from one of the Allaire discussions:

> There is no doubt that the HCI community plays an important role in raising the awareness and the importance of good web design, but since any one with little computer knowledge and probably with no web design knowledge can develop and publish a web site, we will continue to see more and more poorly designed web sites.
> The following HCI attributes are necessary for good web design: attractiveness, effectiveness, learnability, memorability and user-friendly.
>
> (A-Web-M27-P1)

Figure 23 shows the analysis of this message. Two topics were introduced, and although they both fell within the general subject area of human-computer interaction, there was no rhetorical relation between them. Thus, it was necessary to use the JOINT relation. However, it was important to avoid overstating the significance of the issue. Infelicities of this sort were minor and self-contained, and could hardly be held responsible for any interactional incoherence that might have jeopardized the comprehensibility of the discussion as a whole.

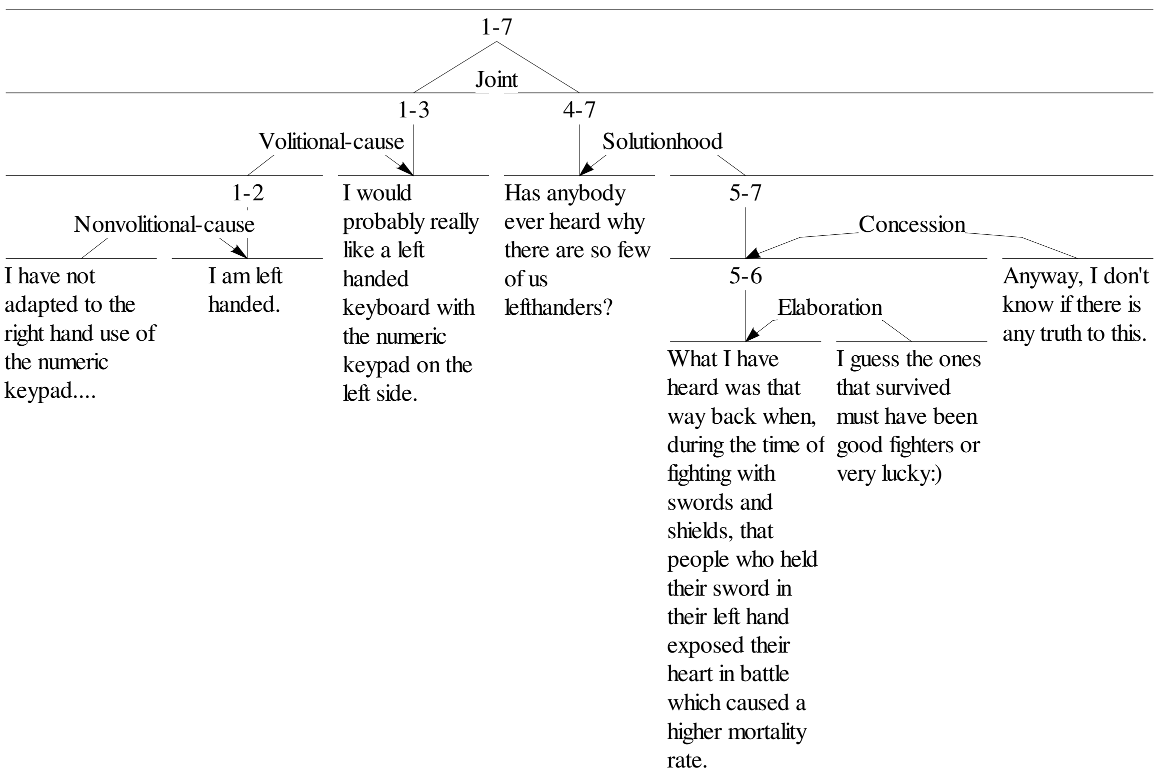

Figure 20. Subtopic Escalation Using the JOINT Relation (W-Intuit-M48-P39)

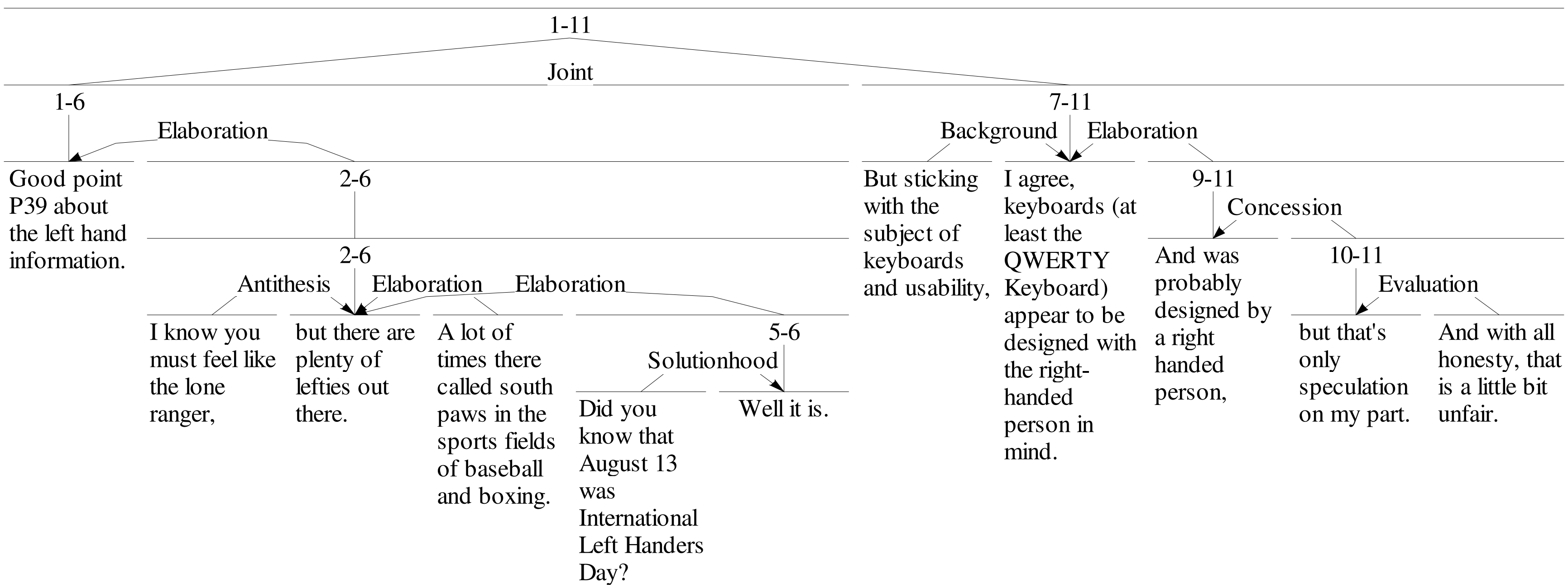

Figure 21. Topic Recovery Using Orthogonal Elaboration (W-Intuit-M49-P45)

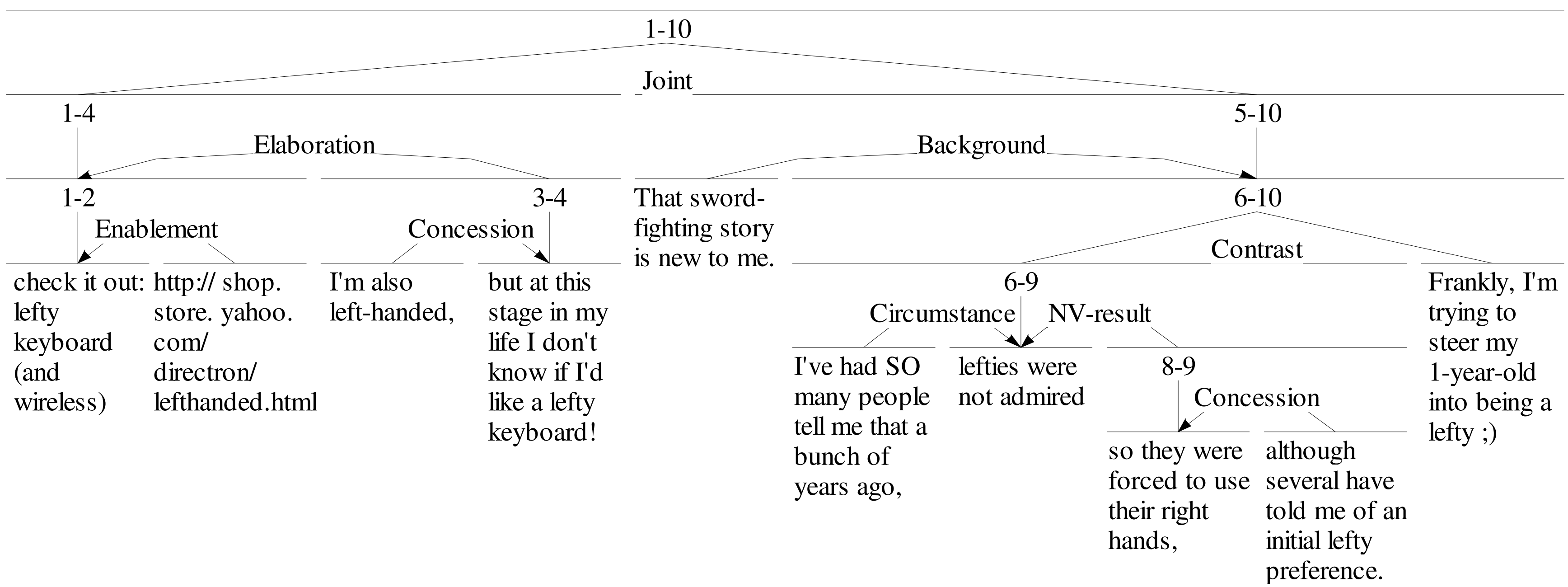

Figure 22. Intertextuality in Response to Subtopic Escalation (W-Intuit-M50-P47)

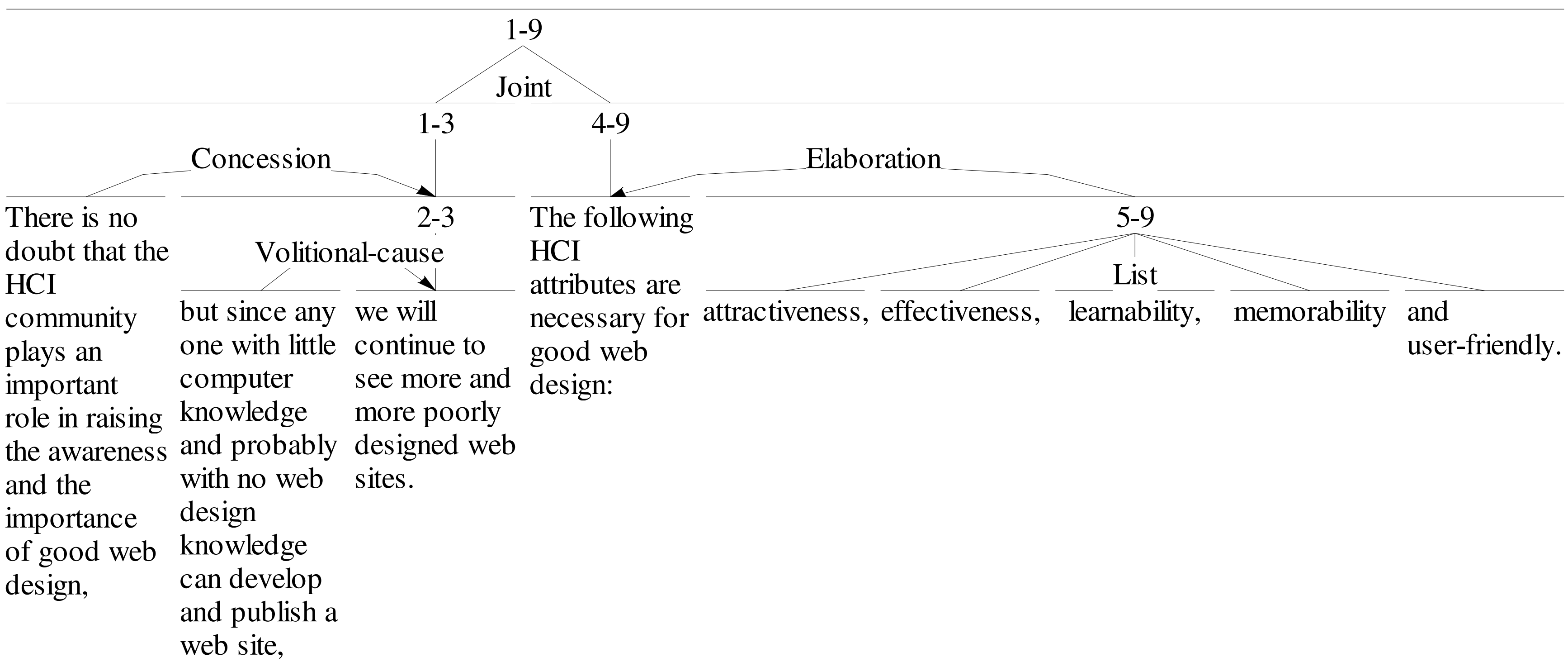

Figure 23. Non Sequitur (A-Web-M27-P1)

Analysis of Inter-Message RST Structures

As used in this study, the term *thread* is narrowly defined as a linked series of messages in an asynchronous discussion (Carlson, 1997). All messages in a thread either serve to initiate the thread or are posted in response to some member of the thread (Preece, 2000). The asynchronous discussions studied each consisted of a combination of threads and singleton messages.

The number of threads per discussion ranged between 6 and 14, and average number of interactions per thread ranged from as few as 1 to as many as 90. Not only did thread sizes differ, but also the tendency of participants to engage in threaded interactions varied from group to group. In the Allaire Intuitiveness group, less than one-third of the messages belonged to a thread; in the STS debate, almost all messages were part of a thread.

Only a small subset of RST relations was used in the interactions. The most frequently used relations were ELABORATION, ANTITHESIS, CONCESSION, EVALUATION, and EVIDENCE. As with individual messages, ELABORATION was the preferred relation. The frequent use of EVALUATION seems intuitive to the extent that messages might be likely to pass judgment on one another. Details on relation use frequency in inter-message relations may be found in Appendix E.

Asynchronous Discussion as Dynamic Process

More fundamental than patterns of relation use was the dynamic nature of inter-message structures. Unlike individual messages, whose structure remained static once the message was posted, inter-messages structures were observed to change as new messages were added contributed. In each of the discussions, there were multiple authors commenting on one another's messages and any individual message could be subject to diverse responses, some in support, some in disagreement, some seeking to develop further the topic, and some intent on changing the topic. As such, the inter-message structures developed over the course of the discussion. As will be developed over the course of this chapter, this had important implications for the application of RST to asynchronous discussions. The following example shows how this dynamic unfolded in one of the discussions. The example consists of 6 interconnected messages selected from a larger thread of 90 STS messages.

The exchange began with a message from Steve Fuller, in reply to earlier remarks from various participants. He rejected an earlier claim that philosophers of science do not see themselves as "underlaborers" of scientists. Fuller's argument was that philosophers of science have a vested interest in science, and are therefore presumably beholden to scientists:

> First off, SHANKS claims that philosophers of scinece don't see themselves as underlaborers to scientists, but in fact several have openly embraced this Lockean image. In his book of interviews with philosophers of science,

> Werner Callebaut observed this pattern very strongly. Some guys, like Robert Brandon, made it very clear that the scientists set the agenda for philosophers of science (at least teh ones he associates with). I made a big deal about this in the review I did of Callebaut's book in _Science_ (May 94). Philosophers involved in cognitive science also talk this way. (I recall Jerry Fodor invoking the underlaborer image a couple of times in his books.)…
>
> In any case, it does seem to me that philosophers of science -- of the underlaboring variety -- have a vested interest in science in a way that other philosophers do not have in other institutions. The only possible exception is the vested interest that many philosophers of religion have in the promotion of religion (by showing that those proofs of God's existence really follow). But even then, the philosophers of religion tend to be committed to broader conceptions of religion (i.e. not so tied to a particular sect) than philosophers of science vis-a-vis science.
>
> (STS-Oct-M57-Fuller)

In the next message, George Gale rejected Fuller's arguments, accusing Fuller of overgeneralization, and while conceding that philosophers of science might have a vested interest in science, he maintained there was nothing unusual about the situation:

> First, you don't seem to have admitted the existence of any other sort of philosopher of science THAN the underlaboring variety, so, on that basis I

take it that you are indicting the entire genus "philosopher of science." I'm willing to be disabused of your intention on this.

Secondly, it seems to me that philosophers of science do, in fact, have a vested interest in science, to with: Philosophers of science have a discipline only if science exists. That's plain enough. But if we were to replace the closest occurrence of "philosophers" with "sociologists" or "historians" or "psychologists", the claim would still remain the same. Is this your point?

(STS-Oct-M58-Gale)

In the third message, Niall Shanks responded to Fuller with arguments fully conceding to Fuller’s claim that philosophers of science are underlaborers of scientists, but he went on to argue that this is not in itself a bad thing. He then posed a number of questions regarding the validity of external criticisms of science and finally, he undertook an extended defense of objectivism:

…All I was trying to suggest is that philosophers of science were legitimate participants, along with the scientists themselves (theoretical and experimental), in shared enterprises with (some) shared goals. I sense that some participants in this debate would like to "down-size" science -- and as usual, the first to go are the underlaborers…

The sense in which philosophers of science might legitimately be called underlaborers is the sense in which, if there was no science, there would be no philosophy of science. The "underlaborer" image has other connotations. Some of the great artists had underlaborers -- skilled artisans who completed their works and put in the details. Very important work too. I guess you don't have to be a simpering lackey to be an underlaborer…

Here are some questions. Are all external criticisms of science equally valid? Or are some more valid than others? What is the standard for making a judgement here? Are evidential considerations relevent? If so, we run the danger of sneaking across the (internal/external) border into the province of science -- where the grading of evidence for quality is one of the hallmarks of the activity properly done…

If most scientists did not believe they were aiming at the truth, and did not try to uphold the highest standards of rational inquiry (sometimes falling by the wayside -- for even science has sinners), they would not behave the way they do (e.g, examining the contents of test tubes for properties of interest, as opposed to throwing the tubes against the floor or out of the window.) Science succeeds because the belief that rational inquiry is more likely than irrational inquiry to get you in TRUTH's ballpark, is itself true. There is obviously much more to science than this (the economics of big-ticket projects, and so on), but it nevertheless seems to be correct that truth and rationality have explanatory value…

(STS-Oct-59-Shanks)

A. J. Soyland then replied to Shanks' questions in yes-or-no fashion, followed by a caveat, that science is not unique in its treatment of external criticism:

In order: no, yes, scholarship, yes.

> But there is no danger here - science is not the only thing that takes evidence into consideration: think of the law, of literary criticism, of history. Try a thought-experiment: come up with any old rubbish about Keats and imagine trying to get it published in an academic journal: it will be debated, judged and thrown out (as it should). But, of course, you don't think you are doing science in the process...
>
> (STS-Oct-M61-Soyland)

Finally, Lon S. Felker responded to Gale with a proposed solution to the divide between practicing scientists and philosophers of science. Felker proposed that philosophers use thought experiments as a way to provide science with new ideas for research:

> Being neither an enemy of the philosophy of science, nor one who places uncommon store by the scientific method, which I understand is frequently more observed in the breach than in the normal course of day-to-day science, I would suggest a "common ground" where philosophers of science and practicing scientists may meet--in the tradition of the gedanken experiment.
>
> This noble device provides a medium for the deployment of philosophy of science qua science, as well as the opportunity for critical discourse between scientist and philospher. There have been numerous and productive gedanken experiments in physics, biology and chemistry, as well as the

> more applied sciences. Quantum mechanics owes much to the gedanken experiment as a means of active dialogue in understanding the phenomenon. Indeed, one might consider Einstein's imaginative image of himself as a beam of light approaching the speed of light and the consequences of this on mass as one example of the successful fruits of a gendanken experiment. If it is empirical claims for the role of the philosophy of science that we seek, then where better to look than in the gedanken experiment? I would suggest that if philosophers have a role in science, it lies in the imaginative use of the thought experiment as a way of suggesting new and fertile avenues of research.
>
> (STS-Oct-M63-Felker)

When both Shanks and Gale responded to Fuller, they did not do so as a concerted response, but as two independent interactions—this is reflected in the redundancy of their responses. If the discussion is viewed as a sequence of discrete interactions, then a synoptic analysis is possible, such that each interaction is considered in isolation from the rest of the discussion. Using such an approach, it is possible to analyze the discussion as a set of independent RST models. There would be one model of Shank’s response to Fuller and another separate one of Gale’s response to Fuller. However, this approach imparts little information about the structure discussion as a whole. Modeling the discussion as a whole gives a view of the overall interactional dynamic, also shown in Figure 24. However, in this dynamic model, both Shanks and Gale used Fuller’s message as a satellite. In RST, the uniqueness constraint prohibits using a span as satellite to more than one nucleus. While this challenges the RST uniqueness constraint, it accurately reflects the dynamic nature of the discussion structure.

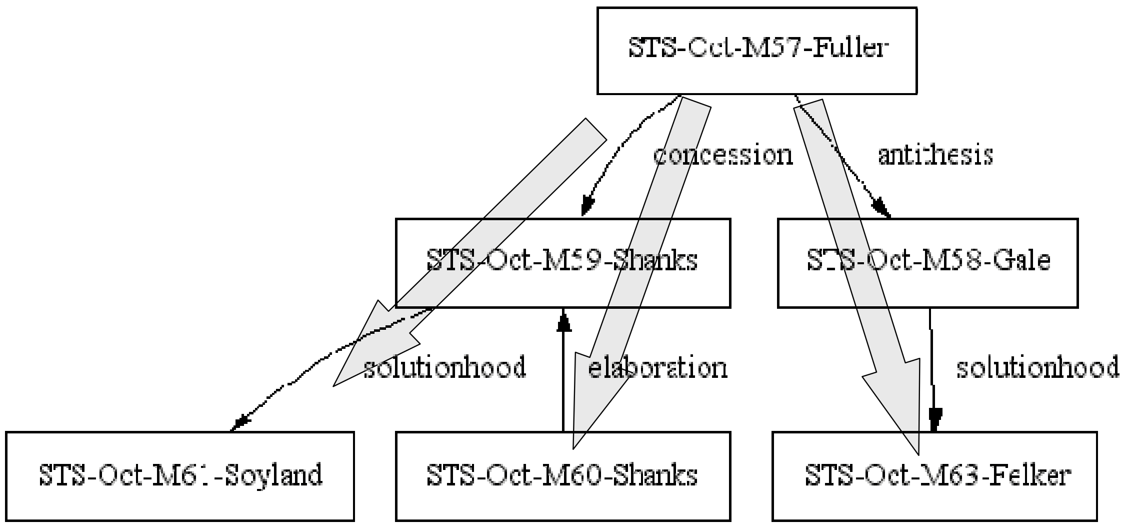

Figure 24. Multiple Interaction Paths in a Thread

This issue may be further illuminated through examination of the use of the BACKGROUND relation. Only one instance of the BACKGROUND relation was found in the inter-message analysis; however, it affords an opportunity to explore the issue of dynamic structure further. With BACKGROUND, the satellite is used to present prefatory information that will enable the reader to understand the nucleus. Like ANTITHESIS and CONCESSION, the satellite normally precedes the nucleus. However, unlike ANTITHESIS and CONCESSION, the satellite does is not merely a point of disagreement, but rather it *explains* the nucleus. To this extent it may viewed as anticipating the nucleus. In an inter-message structure, this is problematic. The question arises as to how one message can explain another, when the other is yet to be written, moreover by some other author. The answer seems to be that it is up to this later author to decide whether the previous message provides useful background material for the new message that is about to be written. The author of the original message has little control its destiny once it has been posted. As Bathes (1977) might have said, the work, once written, passes from the purview of writer to that of the reader.

As noted earlier, only one instance of BACKGROUND occurred as an inter-message relation. This occurred in a particularly rich thread that is used as example several times in this report. For the moment, however, the focus is limited to a particular transition, identified in Figure 25.

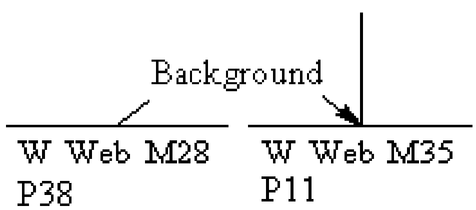

Figure 25. Inter-Message BACKGROUND Relation

The initial message (M28) was posted by a student and the follow-up (M35) came from the instructor a few days later. The student's message provided a brief overview of the Internet as an information resource for senior citizens and identified some of the requirements for senior-friendly Web page design:

> The internet has evolved from a new marketing and advertising venue to a tool that provides a means at acquiring information like never before. The

past decade has slowly reversed the way in which our society views the internet; many were fearful of this technology and intimidated. Many people who we once perceived as "those who rejected the internet" are surprisingly those who are now possibly benefiting from it the most. Senior citizens who were once believed to refute technology have surprisingly beginning to embrace this source of useful information.

The internet, providing a vast amount of various information and services, has given seniors the opportunity to research and access vital online health information. It gives them a source for vital information that might otherwise not have been accessible to them. Senior citizens who have chronic illnesses or who may be homebound see this as an opportunity to seek answers to a myriad of questions they may have. This is why utilizing the internet has become much more appealing to this demographics.

Web designers now have the task of meeting the needs of senior users as well as others. There are more factors to consider when trying to equate the usability factors that should be considered. Senior friendly designs have to accommodate for aging processes such as vision, cognition, and other physical impairments. Site issues such as fonts, color, graphics and poor navigation may hinder older adults from fully utilizing these online resources. The NIA (The U.S. National Institute on Aging) along with the NLM (The U.S. National Library of Medicine) has recognized the usability

> problems for senior citizens and have published guidelines for designing senior-friendly sites in an effort to remedy this issue.
>
> (W-Web-M28-P38)

The response, posted by the instructor, praised the student for initiating the thread and suggested that the students examine the Medicare Web site as an example of a Web design developed for seniors:

> This is an excellent topic of discussion. Kudos to P38 for getting this started. Those of you who have responded have acknowledged the importance of designing for specific target groups, in this case, seniors. Here's something we could do for fun. We're all probably aware about the government's approval of the Medicare Prescription Card Program. Apparently, there are over 70 Medicare-approved drug discount cards to choose from. Where does a senior start? One resource seniors are referred to is http://www.medicare.gov, the Medicare website. What can we say about the design of this website? Is it "senior citizen user centered"? Check it out when you get a chance...
>
> (W-Web-M35 P11)

If the instructor's message had simply praised the earlier message, or offered additional information, it could have been analyzed as an EVALUATION or ELABORATION satellite to the student's message. By proposing to refocus the discussion, the instructor introduced a pedagogical pivot into the thread, using the previous posting as BACKGROUND for the new discussion. This can be seen more clearly by examining the RST analysis of the instructor's message. As shown in Figure 26, the message has four major parts: PREPARATION, MOTIVATION, ENABLEMENT, and finally the activity for which the reader has been prepared, motivated, and enabled. The PREPARATION satellite leveraged the previous message to provide orientation for this new message; MOTIVATION proposed an activity that will be fun; ENABLEMENT identified the URL that was the means for the fun activity, and lastly, there was the identification of the activity itself.

From this, it becomes clear that the instructor's message was *about* the student's message only to a limited extent. Its main thrust was to push the discussion forward, and to provide a concrete example with which to do so. Without the student's message as background, the instructor's initiative might have seemed arbitrarily placed; by using the student's message as satellite, the instructor was able to transition the discussion seamlessly to its new focus.

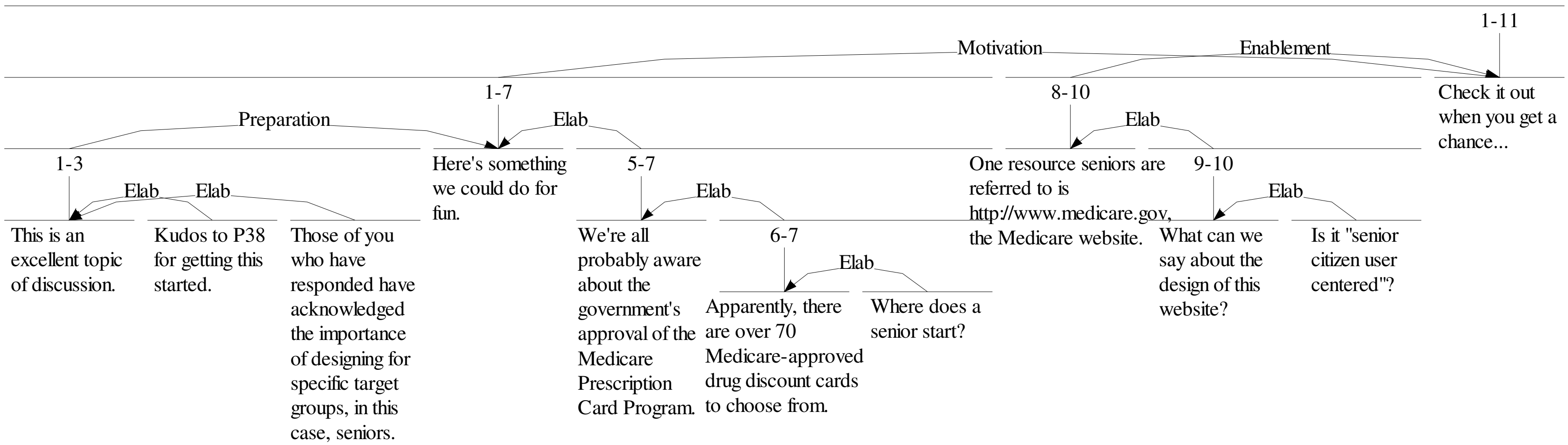

Figure 26. Inter-Message BACKGROUND Nucleus (W-Web-M35-P11)

Thread Convergence

Convergence provided additional insight into the dynamics of discussion structures. Convergence occurs when elements of a thread are brought together into a single comprehensive perspective (Hewitt, 2001; Moran, 1991). In the discussions studied, convergences fell into two categories: *direct* and *general*. Direct convergence specifically identified its linkage to its predecessors using rhetorical relations to produce a comprehensive topical perspective. General convergence provided a comprehensive perspective, but without specifically identifying the predecessors converged. Figure 27 shows an example direct convergence.

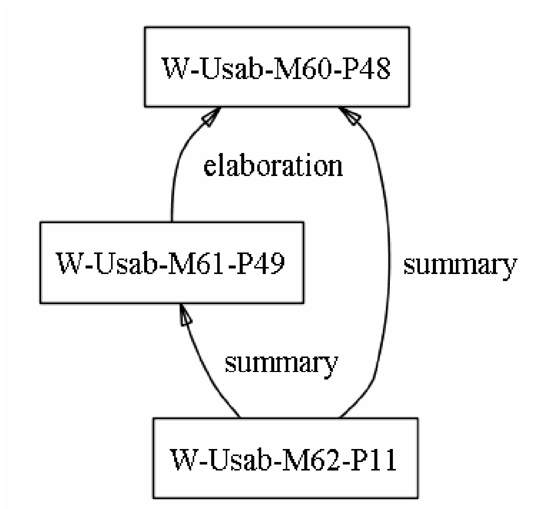

Figure 27. An Example of Direct Convergence

In this example, message M62 has summarized messages M60 and M61. The linkage of the convergence message to its precedents was established using a combination threading support provided by the WebCT conferencing software and direct reference; that is, the message was crafted as a response to M60, but overcame the limitation of being able to respond to only one message by addressing the authors of both M60 and M61, as shown in Figure 28.

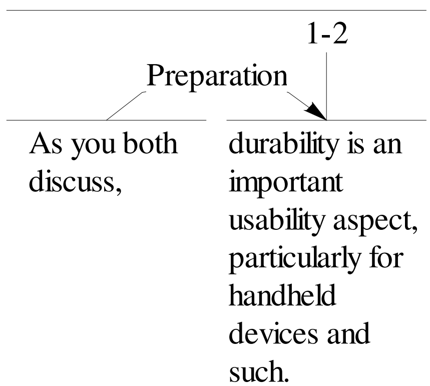

Figure 28. Reference to Multiple Messages

With general convergence, identification of the messages converged can be difficult. In the following message from the STS discussion, the writer seemed to be referencing multiple participants, but without identifying any of them in particular:

> Promoters of STS as either the conscience or the efficiency expert of the research community might prudently keep in mind the observation of E.W.R. Steacie (czar of Canadian official science 1952-62) when asked why his organization did not offer advice to government more often:
> "Why pitch when there's no catcher?"
>
> (STS-Oct-M94-Phillipson)

Direct and general convergences were used with about equal frequency. The STS group used convergence more extensively than the Allaire and WebCT groups, with about 20% of the STS messages being convergent as compared to less than 5% in the other groups (See Appendix F for details). In the Allaire and WebCT groups, the instructor authored most convergent messages. The instructor used convergence to provide assessment, to find closure on divergent threads, and to intervene with pedagogical pivot.

An example of pedagogical pivot was presented earlier in the discussion of BACKGROUND as an inter-message relation. In that example, the instructor refocused the discussion by introducing a pedagogical pivot into the thread. The new focus for the discussion was for the students to assess the usability of the Medicare Web site. The responses to that request, and the subsequent convergence provided by the instructor, demonstrate an interesting dynamic in the formation of convergence structures. The student responses to the instructor request were wide-ranging:

> Well, outside of being ugly as sin, there are a few problems with the site, in terms of being senior-citizen user centered. The first thing I noticed was that you have to use the scroll bar on the right to view the information below, where you have the FAQ, contact information and more...
>
> (W-Web-M36-P45)
>
> The first thing that grabbed me when going to this site was the white area in the center of the web page. It was hard to read because all the topics that

were underlined, but they were close together. The items that were under the "Seach Tools" area were really odd and hard to read….

(W-Web-M37-P39)

I found the website to be friendly and easier to use for senior citizens. The font was clear and the content was clear….

(W-Web-M38-P30)

I agree that the site does have a clean look to it. The reading is set to its targeted audiance with the fonts set at a comfortable size where its not to small nor to big.

(W-Web-M39-P32)

The main problem that I noticed is the use of popup menus.

(W-Web-M40-P37)

Thus far, the structure of the thread followed a familiar pattern, using the EVALUATION and ELABORATION relations shown in Figure 29. Then the instructor followed up these responses with this convergent SUMMARY:

I love all the responses so far about the design of the Medicare website. It does have a simple design, but I find there is too much information that is nested within the website that can cause some heartache with navigability. Simple designs work best when sufficient use of white space is used.

(W-Web-M42-P11)

Up to this point the structure is acceptable by RST standards. Now the convergence has the effect of aggregating the previous messages into a LIST. A LIST is a multi-nuclear relation such that each item is comparable to others. Because LIST is multi-nuclear, each of these messages is now both a nucleus in the LIST structure and a satellite the instructor's previous message. Uniqueness prohibits this from happening in RST. Again, it would be possible to explain this away using a synoptic view of the dialogue—that the contexts of messages as satellites and messages as nuclei in a multi-nuclear relation are separate documents. This remains a useful approach for considering individual interactions; however, it sheds no light on the interactional coherence of discussion. But the difficulty posed for RST is not limited to uniqueness. The analysis also encountered problems with adjacency.

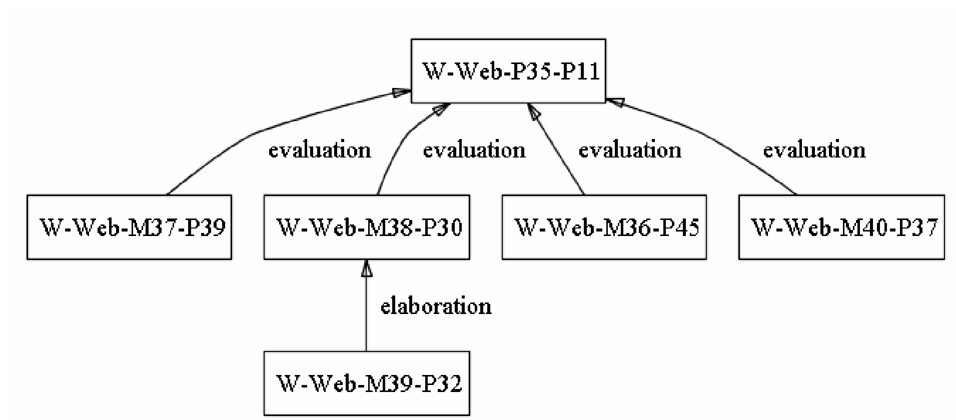

Figure 29. Medicare Site EVALUATION Structure before Convergence

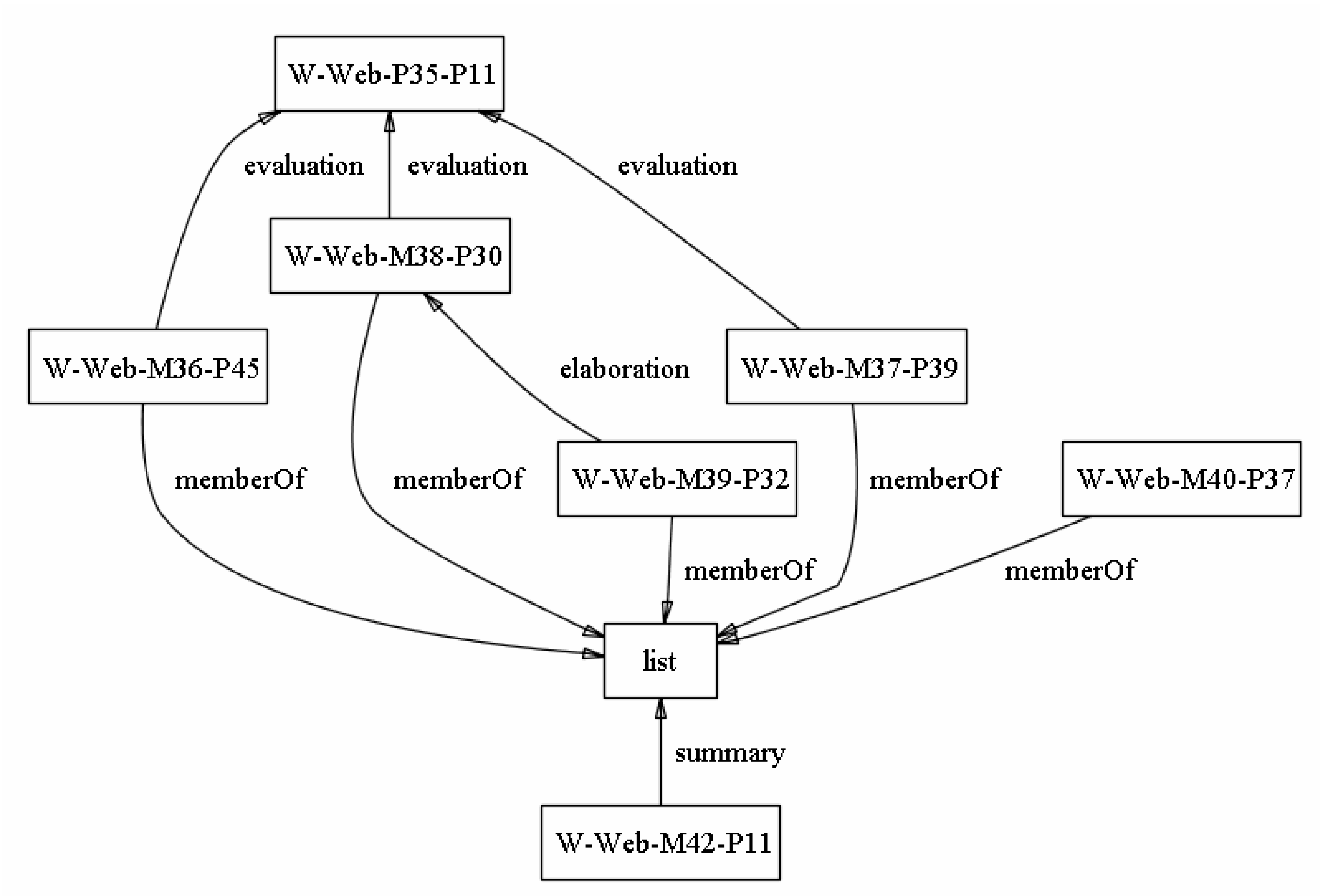

Figure 30. Medicare Site EVALUATION Structure after Convergence

Problems of Adjacency

In her application of RST to spoken dialogue Taboada (2004a) found it necessary to relax the adjacency constraint. Asynchronous discussion was not different in this regard. In an asynchronous discussion, any message may refer to any other message.[4] References may use the threading mechanisms of the software, or they may resort to other means, such as intertextuality, direct reference, or general convergence. This rich interconnectivity means that references may occur irrespective to the presence of other intervening messages. The result can be a loss of structural adjacency, as shown in Figure 31. Lack of adjacency was not unusual in the discussions analyzed.

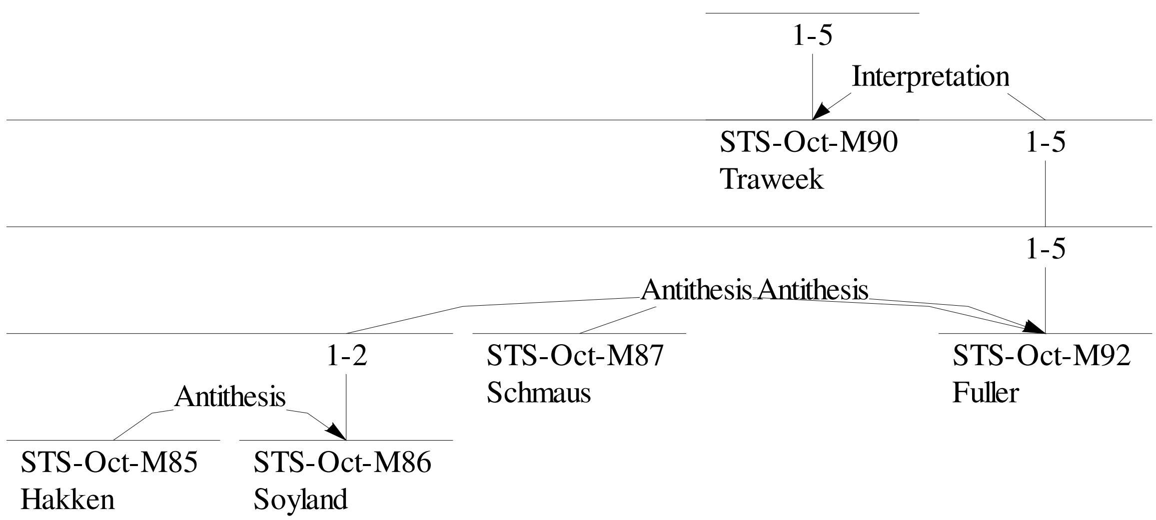

Figure 31. Non-adjacency in an RST Structure

[4] Any message may refer to any other message, except for those composed simultaneously to it.

Rhetorical Networks

The dynamic character of discussions has important implications for the application of RST. Messages contributed to discussion were often coerced into becoming satellites to later contributions, as was shown in the analysis of the CONCESSION, ANTITHESIS, and BACKGROUND relations. Entire structures were also be transformed, as demonstrated in the examination of convergence. The rich interconnectivity of messages allowed linkages to occur without regard for the presence of other intervening messages, as described in the discussion of adjacency.

When multiple messages coerce some other message into becoming a satellite, the uniqueness constraint is violated. When inter-message references cross intervening messages, the adjacency constraint as violated. It was therefore necessary to modify RST to permit rhetorical modeling without the benefit of the adjacency and uniqueness constraints. This problem was addressed through creation of a modified RST called *rhetorical networks*.

A rhetorical network is a directed graph. The graph edges lead from satellite to nucleus. The vertices, or nodes, represent messages, and the edges identify relations between the nodes. Like conventional RST analyses, rhetorical networks are subject to the constraints of completeness and connectedness. Unlike conventional RST analyses, rhetorical networks are not subject to the constraints of uniqueness and adjacency. This permits them to be used to model richly interconnected interactions.

Rhetorical network structures are defined in terms of two schemas, the satellite-nucleus and nucleus-satellite schemas. Both schemas consist of a satellite, nucleus, and a relation. The schemas imply a temporal ordering. In the satellite-nucleus schema, the satellite precedes the nucleus, and in the nucleus-satellite schema, the nucleus precedes the satellite. Graphically, applications of the satellite- nucleus are represented with the satellite above the nucleus and the arrow pointing downward. Applications of the nucleus-satellite schema are represented as a satellite below the nucleus with an arrow pointing upward from the satellite to the nucleus.

Some relations are associated with a specific schema type. The associations are based on the implied temporal considerations of the relation. For example, EVALUATION uses the nucleus-satellite schema because the satellite must follow the nucleus if it is to evaluate it. The association of relations to schemas includes only a limited subset of the ExtMT relation set. These associations are shown in Table 15.

Table 15. Relation-Schema Associations

Schema	**Relation**	
Satellite-Nucleus	ANTITHESIS	CONCESSION
	BACKGROUND	PREPARATION
	CIRCUMSTANCE	
Nucleus-Satellite	ELABORATION	RESTATEMENT
	EVALUATION	SOLUTIONHOOD
	EVIDENCE	SUMMARY
	INTERPRETATION	

Figure 32 shows an example of a rhetorical network. In this graph the initial message has elicited several responses. The first of these adopted a concessionary relationship to the original message. Here one can see that the satellite-nucleus schema has been applied, resulting in the original message being satellite to the response. This first response was followed by another, one that summarized the two preceding messages. This second response was a nucleus to two satellites, and in both cases the nucleus-satellite has been applied. The final response of the discussion evaluated the original message, and it too used the nucleus-satellite schema. Using this modified form of rhetorical structure theory, it was possible to create models of each of the threads in the discussions.

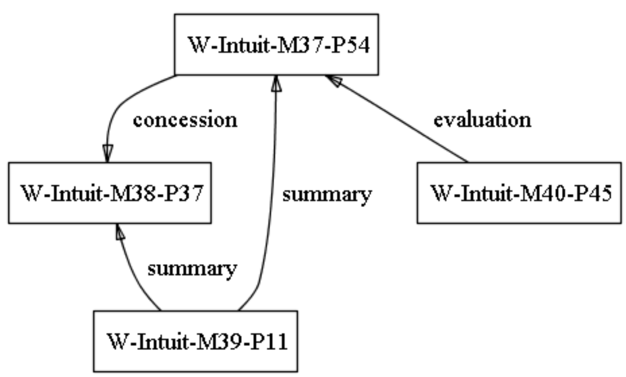

Figure 32. Example of a Rhetorical Network

Agreement and Disagreement in Message Interactions

In studying the transcripts of the discussions, it seemed that matters of agreement and disagreement were important to the participants. This was reflected in the use of explicit statements of agreement in the messages. Messages commonly began with the statements such as “I agree” or words to that effect. In the Allaire discussions, 30% of inter-message interactions included explicit statements of agreement; in the WebCT group, this was 12%, and in STS only 7%. Based on this observation, the analysis included an examination of the rhetorical structures of agreement and disagreement.

Some rhetorical relations were found useful for expressing agreement, others for disagreement. This follows, in part, from the definitions of the relations, and in part from their use in the discussions. Table 16 identifies the relations most often used in expressing agreement and disagreement.

Table 16. Agreement and Disagreement Inter-Message Relations

Agreement	**Disagreement**	**Either**
BACKGROUND	ANTITHESIS	Evaluation
ELABORATION	CONCESSION	
EVIDENCE		
RESTATEMENT		
SUMMARY		

The satellites of BACKGROUND and ELABORATION provide additional information about their nuclei, and hence are by definition supportive. The BACKGROUND relation was seen earlier in the discussion of inter-message relations. In the example presented there, the nuclear message provided a positive appraisal of the satellite and proposed to refocus the discussion for further development. Had the nucleus offered a negative rather than positive appraisal, then the relation would not have been BACKGROUND, but ANTITHESIS or CONCESSION.

ELABORATION presents additional detail about the situation or some element of subject matter, which is presented in nucleus. As the most frequently used inter-message relation, this practice was common in the discussions. For example, in the following messages, student P19 made the claim that intuitiveness should be specified as a requirement in software engineering. P19 supported this claim by arguing that most end users do not understand the technology they are using, and nor should they need to:

> Intuitiveness should be clearly included as a requirement specification in software engineering.
>
> Lets take an example of using an online banking application. Humans to need substantial intelligent computer support in dealing with the technical aspects of the banking site, for example, security, encryption, password protection, etc. A majority of the users are not and will never become information technology specialists. They do need computers that are not only tools, but assistants to the user. Users and their computer assistants have to talk in an intuitive way to each other.
>
> (ID: A-Intuit-M27-P19)

In responding to this message, P26 elaborated on a point made in P19's example and used this as an opportunity to opine that businesses have misdirected their marketing efforts toward technically savvy customers:

> I agree with you when you say that the majority of users will never become information technology specialists. It's funny how the new trend in marketing for many coorporation is targeted towards the tech-savy generation. Those users who are from a non tech savvy world are often puzzled as they do not know how to use many applications. Many applications are apparently not intuitive to many users. Applications for Banking sites (as in your example) are good examples of sites that need a extra pinch of intutiveness built in for the novice user.
>
> (A-Intuit-M28-P26)

In the EVIDENCE relation, the satellite provides evidence used to increase the reader's acceptance of the nucleus. In the following message, the writer identified several attributes of effective Web interface design:

> A web interface should help an end-user be as productive as possible. Also, it should be:
>
> •Easy to learn.
>
> •Effective for the tasks the user needs to perform.
>
> •Designed with a feature to protect the user from making many errors.
>
> (A-Web-M6-P18)

The response to this message provided evidence in support of the attribute, that a Web site should be designed to protect the user from making errors:

> Verifying that a website is programmed to deter errors, when users provide input into the site is important. This precaution is usually executedd by adding dialog boxes which specified the restricted range of the field. If the users in on a website for the first time and they input unrecongized information into the site which the program software is not equip to handle, (especially for a novice user), the user is less likely to return to this website. And since there are so many options for a consumer in any industry, that business will probably never see that individual, again.
>
> (A-Web-M7-P17)

This message was not merely an elaboration of its predecessor. It provided grounds for accepting the view that error prevention is important—namely that a site that is conducive to error-prone interaction is bad for business. Thus, use of the EVIDENCE relation not only indicates agreement, it provides grounds for agreement.

In the SUMMARY relation, the satellite presents a concise restatement of the content of nucleus. As can be seen in the following example, the value of the SUMMARY satellite is to capture the essence of the information presented in the nucleus. In this example, the nucleus identified various aspects of user interface learnability, defined some but not all of them, and noted that by breaking down learnability into these attributes, it could be more easily measured:

> Learnability is a critical attribute for a new interface or application. Today's user doesn't have time to waste trying to learn the ins and outs of a new system. Preece sees learnability as a measure of how easy a system is to learn to use (2002). Learnability may further be described in quantifiable areas such as familiarity, consistency, predictability, simplicity, and generalizability (Usability 101, 2003). Familiarity is the extent to which a piece osf software or interface builds upon the user's prior knowledge of similiar applications or interfaces.
>
> Consistency points to the attribute of only having to learn a task within the application once and allows the user to perform the same task in the same manner every time. Breaking down learnability into sub areas makes it easier to evaluate.

(W-Usab-M19-P31)

To this message, the instructor responded with the following:

> Yes, indeed, to effectively measure learnability, one has to break the concept down into related parts such as familiarity and the like.

(W-Usab-M20-P11)

The satellite includes an explicit statement agreement with the nucleus. This need not be the case, however. Nor need it be the case that the summary message refers only to one other message. It may refer to multiple messages, as was seen in the discussion of thread convergence.

ANTITHESIS and CONCESSION were used to express disagreement with a previous message. In this message, the writer made the case that in addition to usability, the Web site must be designed to meet the needs of client as well:

> Although users are extremely important when designing websites, they are not the ones paying the bills for a web site. Web sites may be enjoyable for the user and engaging, but may not meet the requirements of the client. Gergle (1999) prescribes a method of web design that takes into account user needs as well as focusing on the client; the bill payer. A series of forms and checklists were developed to facilitate the development of sites. The web designer is able to achieve usable sites while working within the constraints set forth by the client, or the company the designer works for. Gergle's method for web design is broken into basic stages: planning, analysis, mockups and prototypes, production, testing, launch, and maintenance. Following these steps make a happy user, but perhaps most importantly, a happy client.
>
> (W-Web-M16-P31)

This resulted in the following response, in which the writer conceded that the client must be satisfied, but argued that client satisfaction and usability are often incompatible:

> You are absolutely right that the people writing the check must be happy, but in my experience 98 out of 100 times, those same people have nothing

> resembling a clue. I remember a client that wanted leopard spots for the background. We said, no, please, no, you can't have leopard spots. Her check cleared, she got leopard spots. And it is, to this day, the ugliest website I have ever seen. A business plan does not an artist make.
> I am excited to learn that someone (Gergle) may have worked out a matrix that allows both the client and the user to be happy. Thanks for the info on that.

(W-Web-M17-P51)

The relations discussed so far share the common characteristic that, in addition to expressing agreement or disagreement, all involve the provision of additional information. The BACKGROUND satellite provides information that makes the nucleus more comprehensible. The ELABORATION satellite provides detailed information about the nucleus. The EVIDENCE satellite provides evidentiary support for the nucleus. The SUMMARY satellite restates the nucleus, but in fewer words. The ANTITHESIS and CONCESSION nuclei make counter-claims to their satellites. However, it is possible to agree or disagree without offering any substantial additional information. This can be accomplished using the EVALUATION relation.

The EVALUATION relation may be used for either agreement or disagreement. That is, the satellite provides an assessment of the nucleus, and it could be positive or negative. Because the satellite need not present any additional information about the nucleus, when used to express disagreement, EVALUATION does not include any counter-claim to the one deprecated. It may not include any information at all other than to pass judgment. In the following example the writer expressed agreement with a statement in an earlier message, but offered no further development of the topic:

> P40, I agree with you that Dreamweaver Mx is an excellent program to design [Web sites].
>
> (W-Usab-M44-P30)

That a small set of relations could be identified as signaling agreement or disagreement is significant because suggests the possibility of characterizing the agreeableness of discussions based on relation use. A discussion containing a high volume of CONCESSION and ANTITHESIS structures could be predicted to be more disagreeable than one predominated by BACKGROUND, EVIDENCE, and SUMMARY. This, in turn, might support prediction of the ability of asynchronously communicating groups to reach consensus.

Jointly Constructed Texts

Rhetorical structure theory provides a means to distinguish coherent texts from arbitrary collections of textual segments. A coherent text is one that is analyzable using RST. An incoherent text is one that is not. From a coherent text, it is possible to produce a structure describing the rhetorical relationships of its segments. In an incoherent collection of sentences, no such organization is discernible.

This study has shown that RST is applicable, albeit in modified form, to asynchronous discussions. From this, several consequences follow. The first is that RST is a useful tool for the investigation of coherence in these discussions: a coherent discussion is one that is analyzable using RST. A second consequence is that natural texts and asynchronous discussions have structural similarities. These include the presence of schema applications using rhetorical relations and adherence to the RST constraints of completeness and connectedness.

Therefore, to the extent that RST can be used to designate some texts as coherent and others as not, and for those which are, to identify the structures that establish coherence, it appears that the discussions analyzed for this study contain coherent texts. While it is tempting to infer from this that asynchronous discussions share other features associated with expository or literary forms, any move in that direction should be taken with caution, and are beyond the scope of the current study. Of more immediate concern is the identification of the properties of asynchronous discussions *qua* texts. In other words, having established that asynchronous discussions contain texts, what, as a result of the RQ1 investigation, can now be said about them?

First, it is important to note that the discussions contain jointly constructed texts, but are themselves not texts. Each of the discussions consisted of a combination of threads and singleton messages that neither responded to any other message nor received any response. Only threads are jointly constructed. While it might be argued that a single message may be a coherent text, from the perspective of interactional coherence, this is irrelevant. Second, there are threads within threads. The investigation of the use of JOINT showed that messages within a thread support multiple strands of coherence that manifest themselves in various ways, including intertextual relationships, orthogonal elaboration, subtopic escalation, and non-sequitur.

Third, it was noted that agreement and disagreement are signaled using a small subset of relations. The relations used to signal express agreement are BACKGROUND, ELABORATION, EVIDENCE, RESTATEMENT, and SUMMARY. The relations used to express disagreement are ANTITHESIS and CONCESSION. The EVALUATION relation may be used for either agreement or disagreement. These results are intriguing because they suggest the possibility of characterizing discussions based relation use.

Finally, it was found that the structures of interactions evolve over time. As new messages are added to a thread, they transform existing structures into new ones. As part of this transformation, messages sometimes come to participate in multiple structures simultaneously as they are used as satellites by other messages. In view of this dynamic aspect, it may make sense to speak of asynchronous texts as processes rather than things, and the RST analyses presented here are then snapshots of the processes at salient points during their development. This notion will be revisited in the discussion of the RQ2 results, where a series of snapshots is used to describe the development of argumentation.

RQ2: Argumentative Structures

The RQ2 research studied the nature and extent of argumentative structures in asynchronous discussions. It was anticipated that argumentative structures, as defined by Azar (1999), would be predominant, and that argumentative messages would loosely follow the form of Taboada's (2004b) general argumentative form of asynchronous messages. The hypothesis for this research question was defined as follows:

> **H2**: Argumentative structures predominate in discussions in asynchronous learning environments.

2.1 The use of argumentative structures in asynchronous learning environments is comparable to that in an asynchronous scholarly debate.

2.2 Using Azar's (1999) identification of argumentative relations it is possible to make a plausible distinction between discussions that are argumentative and those that, although rhetorically persuasive, offer little actual support for their claims.

2.3 Argumentative messages loosely follow the form of Taboada's (2004b) general argumentative structure of asynchronous messages.

The research entailed an identification of argumentative structures, an examination of these structures and their dynamics, and comparison of argumentation patterns in the discussion groups.

Identification of Argumentative Structures

An argumentative structure is an RST structure that uses one of the five relations designated by Azar (1999). These include the following:

- ANTITHESIS
- CONCESSION
- EVIDENCE
- JUSTIFY
- MOTIVATION

Azar (1999) claimed that these relations are argumentative because their locus of effect is in the nucleus, and that the intended effect is to persuade, move, or otherwise influence the reader to accept the content of the nucleus. In other words, the satellite provides impetus for accepting the nucleus. Argumentative structures were identified at both the individual message and inter-message levels.

A second measure of argumentativeness was whether messages conformed to Taboada's (2004b) proposed generic form of argumentative asynchronous messages. According to Taboada, argumentative messages typically open with a link to a previous message, followed by an optional statement of the author's viewpoint, objections to previous argument, statement or restatement of the author's viewpoint, optional examples, and an optional disclaimer.

Argumentative Structures in Individual Messages

In individual messages, the use of argumentative relations ranged from about 14% in the Allaire Usability discussion to 26% in the STS discussion. ANTITHESIS, CONCESSION, and EVIDENCE were used most often. The JUSTIFY and MOTIVATION relations were rarely used. As shown in Figure 33, the STS group preferred ANTITHESIS and CONCESSION, the Allaire group preferred the EVIDENCE relation, and the WebCT group preferred EVIDENCE and CONCESSION.

No messages were found to meet all of Taboada's criteria, so an assessment was performed to determine how many messages met at least the mandatory portions of the criteria, which consisted of identification of messages that opened with a link to previous discussion, followed by objections to previous argument and statement of the author's viewpoint. Almost 60% of the STS messages met these criteria, but the Allaire and WebCT messages ranged between 5% and 12%.

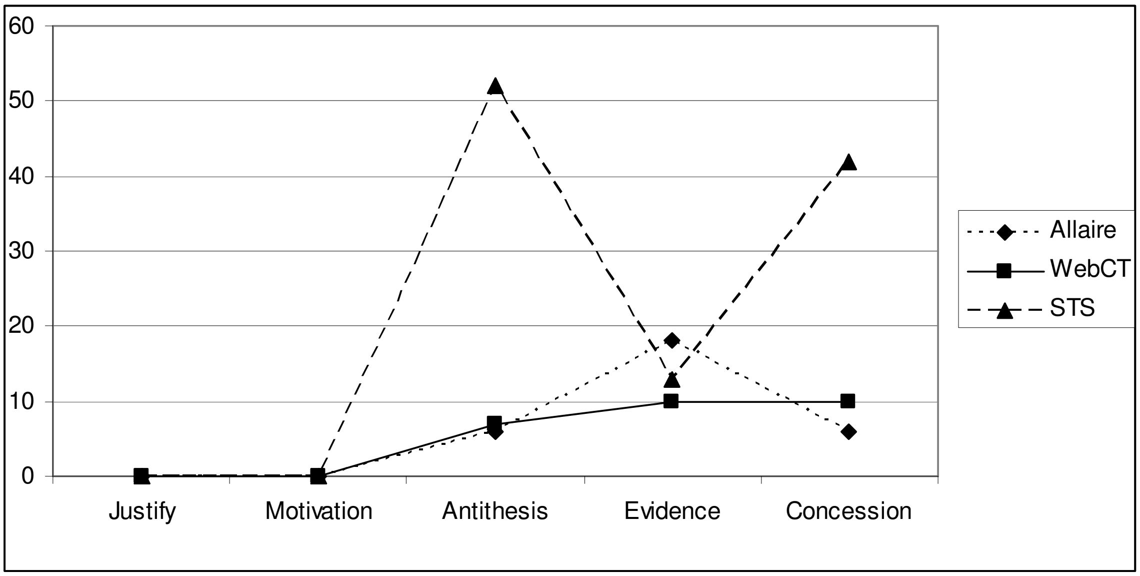

Figure 33. Argumentative Relation use in Messages by Group

Inter-message argumentative structures

Inter-message argumentative structures used only ANTITHESIS, CONCESSION, and EVIDENCE argumentative relations. The JUSTIFY and MOTIVATION relations were not used. ANTITHESIS was the most frequently used relation, followed closely by CONCESSION and EVIDENCE. Much of the use of ANTITHESIS and CONCESSION occurred in the STS group, as shown in Figure 34. These account for about 85% of argumentative interactions within the STS group. EVIDENCE was the preferred inter-message argumentative relation in the Allaire group, while EVIDENCE and CONCESSION were the same in the WebCT group.

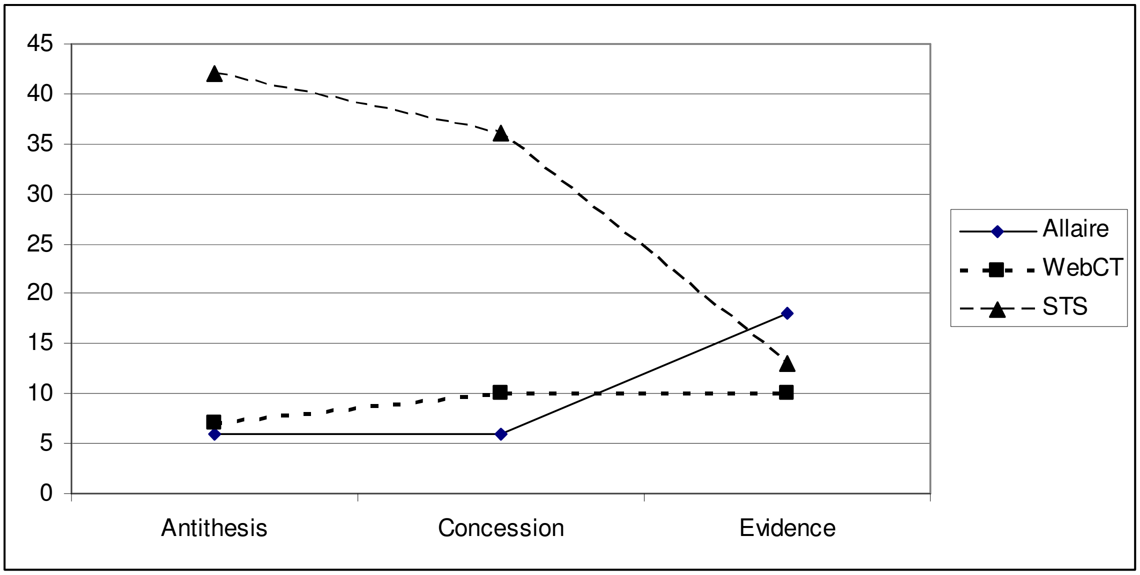

Figure 34. Inter-message Argumentative Interactions by Group

Argumentation in STS

Earlier in this report, in the results for RQ1, it was observed that the ANTITHESIS and CONCESSION relations were used for expressing disagreement whereas EVIDENCE, along with several other relations, was useful for expressing agreement. On this basis, it would seem the preferred mode of interaction in the STS discussion is one of disagreement—or as Hert rather mildly put it, the discussion revealed "a heterogeneity of goals among the participants" (Hert, 1997, p. 329).

The following example demonstrates the dynamics of argumentative development by examining a selection of STS messages taken from a larger thread of 54 messages. This sub-thread consists of 14 messages that were posted in response to a message from Steve Fuller in which he advocated democratization of science though science education. This selection is instructive because it incorporates elements of argumentative and non-argumentative interaction using a variety of rhetorical relations.

The first message from David Hakken conceded that while democratization of science could be achieved through science education, he argued that an approach based on education at the exclusion of other options would be doomed. Hakken suggested that an area where STS could contribute would be in aiding scientists in engaging with practitioners in industries that share many of the same concerns as the STS community.

Responding to Hakken, A.J. Soyland remarked on several things he regarded as odd about the debate (see Figure 35). These include assumptions that members of the STS and scientific communities needed to engage in dialogue, that STS needed to be recognized by scientists in order to legitimize its existence, and that there was a general assumption that academic research in STS ought to have an impact on science. Soyland challenged these assumptions, and argued that there was no more need for scientists to care about STS studies than there was for novelists and artists to care about literary and art critics, or for politicians to care about historians.

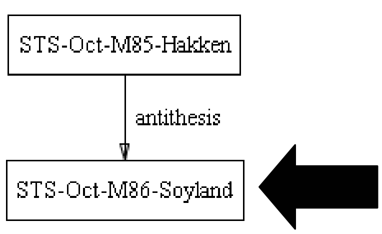

Figure 35. A Disagreement in the STS Discussion

The next two contributions were critical of the overall discussion, but without responding to any specific messages. In the first of these, Warren Schmaus espoused the view that the debate came down to a “chicken-and-egg” question: getting scientists involved in STS activities would remain difficult so long as the STS community failed to make clear what it had to offer to science. Although some groups, such as ethicists, were successful in getting the attention of scientists, the STS community lacked the political and economic clout of ethicists. In the second convergent message, Sharon Traweek began by saying that she and some two dozen of her colleagues agreed that the ongoing STS debate was both tragic and comic (Figure 36). She said that she and her colleagues regularly engaged in communication with members of the scientific community, that many of her invited talks were to scientists, and that she did not regard herself as unusual in that respect. She advised that such working relationships could only be brought about through hard work and "a complete absence of any dominance/submission moves" (STS-Oct-M90-Traweek).

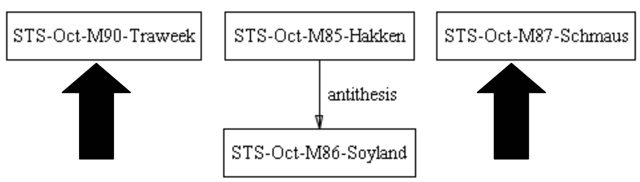

Figure 36. Two General Convergences in the STS Discussion

Following these general convergences, Steve Fuller used direct convergence in responding to Hakken, Soyland, Schmaus, and Traweek. As shown in Figure 37, Fuller supported Hakken, using the EVIDENCE relation; he disagreed with Soyland and Schmaus, using ANTITHESIS; and professing to fail to understand Traweek's remarks, Fuller offered an INTERPRETATION. Fuller then proposed that Hakken, Soyland, and Schmaus were each working from different models of how STS-scientist interaction should proceed, and that these differences led them to different views of the work they do. Schmaus's view of the STS practitioner, according to Fuller, was one of ethicist or public relations expert for science. Fuller rejected this because it was reactive rather than proactive, and amounted to little more than bailing out science when it gets into trouble. Hakken's view, according to Fuller, was that the STS community should cultivate marginalized scientists with the aim of highlighting what he called the "disunity of science." Fuller approved of this and claimed that it would shed light of class stratification issues within the scientific professions. Turning to Traweek, Fuller professed not to understand from what model she was working. He suggested that perhaps she could clarify what it was about her work that would be of interest to scientists:

> As for TRAWEEK, I am not clear what model of STS-scientist interaction she's working with. One way to relieve (at least my) unclarity would be to hear why scientists would want to use your work in their courses, and why they're interested in hearing you talk in the first place -- and whether those reasons relate to why you'd want them to use your work and to invite you to speak. In other words, do you detect a mutual interest or common understanding in your interactions with the scientists? Of course, it is possible for STSers and scientists to dwell in the same space, so to speak, but each get something quite different out of the exchange. But I would consider that a fairly minimal model of interaction.
>
> (STS-Oct-M92-Fuller)

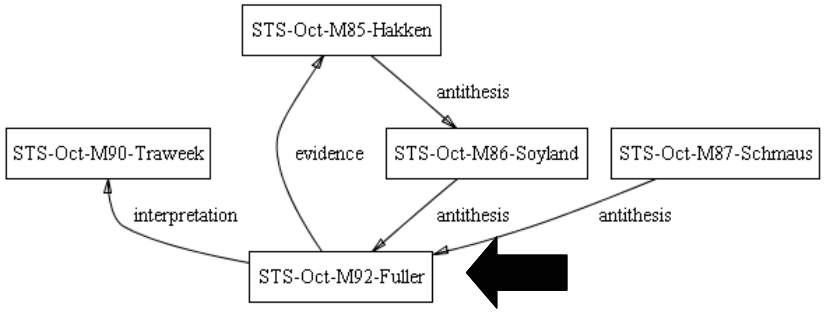

Figure 37. Direct Convergence in the STS Discussion

Before any response to Fuller's position was posted, there were two interventions in behalf of Traweek, one from Deborah Heath and the other from Alan Stockdale (Figure 38). Heath thanked Traweek for expressing the view that an ethnographic approach to science criticism could lead to benefits. Developing this idea further, she observed that scientists, technicians, and clinicians should be treated as sources rather than objects of research. Stockdale responded to both Heath and Traweek, saying that he too was disturbed by the ongoing STS debate, that he regarded the polarization as a retreat from the position of close involvement of STS with science. He recommended that for members of the community who want to accomplish something, they should go to where the scientists are and study them:

> Let me just quote Mike Lynch's therapy: "Stop talking about science! Go to a laboratory - any laboratory will do - hang around for a while, listen to conversations, watch the technicians work, ask them to explain what they do, read their notes, observe what they say when they examine data, and

watch how they move equipment around!" (from Scientific Practice and Ordinary Action).

(STS-Oct-M94-Stockdale)

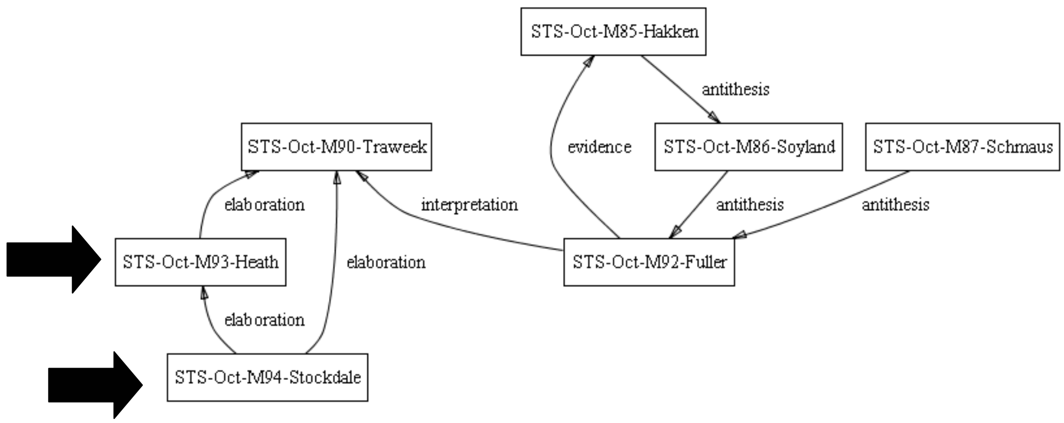

Figure 38. Agreement and Additional Convergence in the STS Discussion

Next, Traweek posted a lengthy response to Fuller, saying she was reluctant to reply because she did not want to allow Fuller to define the terms of the discussion. Regarding Fuller's remark that he did not understand what model she uses, she responded that she never used models, because they obstruct clear thinking. This was because models place constraints on how one interprets information. Further, she stated that Fuller presumably already knew that she did not use models; hence, his question was merely for effect.

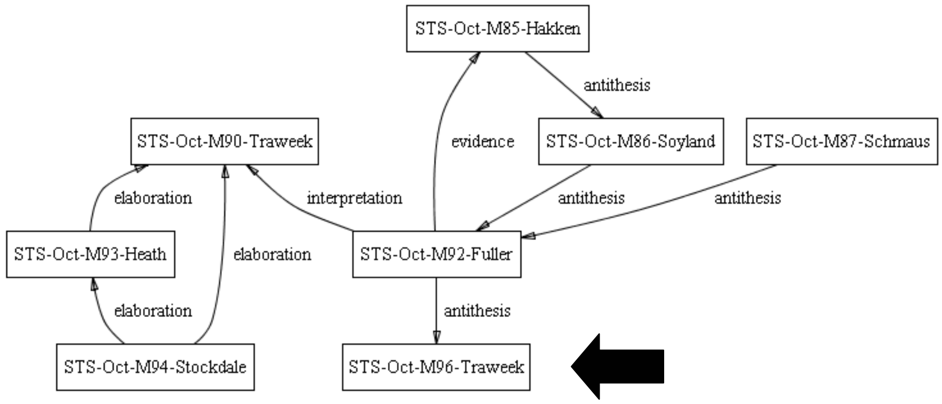

Figure 39. Disagreement in the STS Discussion

As to why scientists would take an interest in her work, it was, Traweek said, because it gave them an opportunity to discuss a common sense view of their work, and to discuss what it was about their work that was important. She observed that Fuller's failure to understand her position was an "agonistic" academic display, and that Fuller's subtext was that Traweek had failed to make her position clear and was therefore deserving of a bad grade:

> We're at the red pencil in the margins stage; that is, I have been classed as the bad student. In ethology that sort of gesture is called a dominance move. I pass.
>
> (STS-Oct-M96-Traweek)

Traweek continued at length in this vein, deconstructing Fuller's wording to his disadvantage, but responding to the questions he had posed. To this, Fuller responded, first by thanking Traweek for addressing his questions and apologizing for being "unduly agonistic." He then offered an explanation for why he asked the questions, saying that he was unclear as to the nature of the STS-science interaction being proposed, and suggesting that if he now understood them correctly, they seemed to him akin to the approach he had been advocating:

> Now, in her answer, TRAWEEK noted that physicists found her work useful in understanding why students might not be picking up physics concepts in class, and how that situation might be remedied. I may be mistaken, but this strikes me as being in the spirit of exchange relations discussed above. The physics teacher is always interested in improving teaching practice, and the anthropologist has something to offer her in that regard.
>
> (STS-Oct-M97-Fuller)

Having made that CONCESSION (Figure 40), he nevertheless insisted on the importance of maintaining a critical stance:

> There is nothing wrong with this sort of interaction, I suppose, except that it seems to presume that the scientists are fine doing what they're doing, as long as they cooperate with the STSer in her research assignment. Is there NO place for critical engagement in this picture, or am I just not looking at things the right way?
>
> (STS-Oct-M97-Fuller)

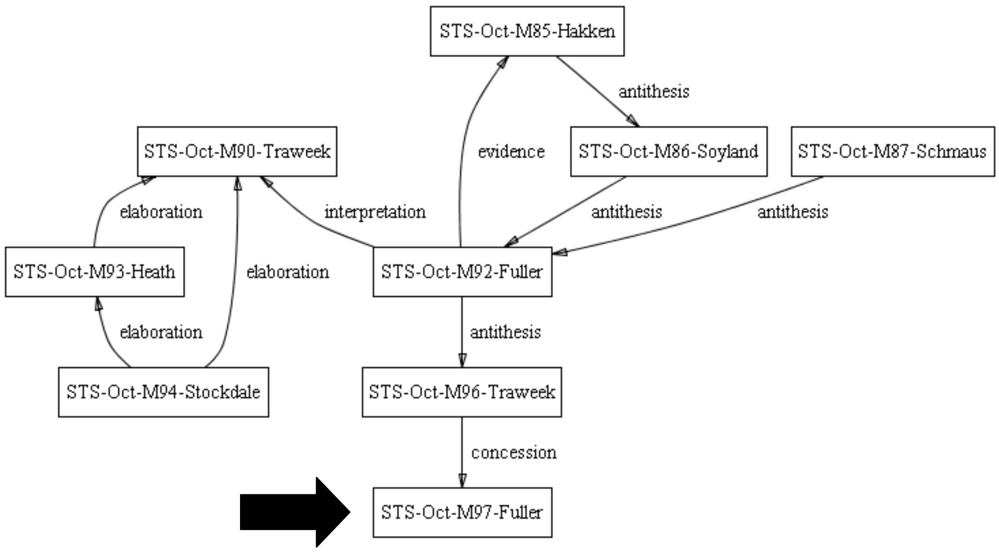

Figure 40. CONCESSION in the STS Discussion

Next, Roddey Reid responded to Traweek (Figure 41), Heath, and Stockdale with a positive appraisal, and with some general disparagement for other unnamed contributors to the debate:

> Traweek's, Heath's, and Stockdale's interventions are a breath of fresh (and cool?) air amidst the expressions of panic and hand-wringing and I was wondering when someone was going to bring up the fact that a different dynamic has been going on for a long time between researchers and scientists that involves other processes than pure "othering" and having the last word. Good going, so to speak!

(STS-Oct-M100-Reid)

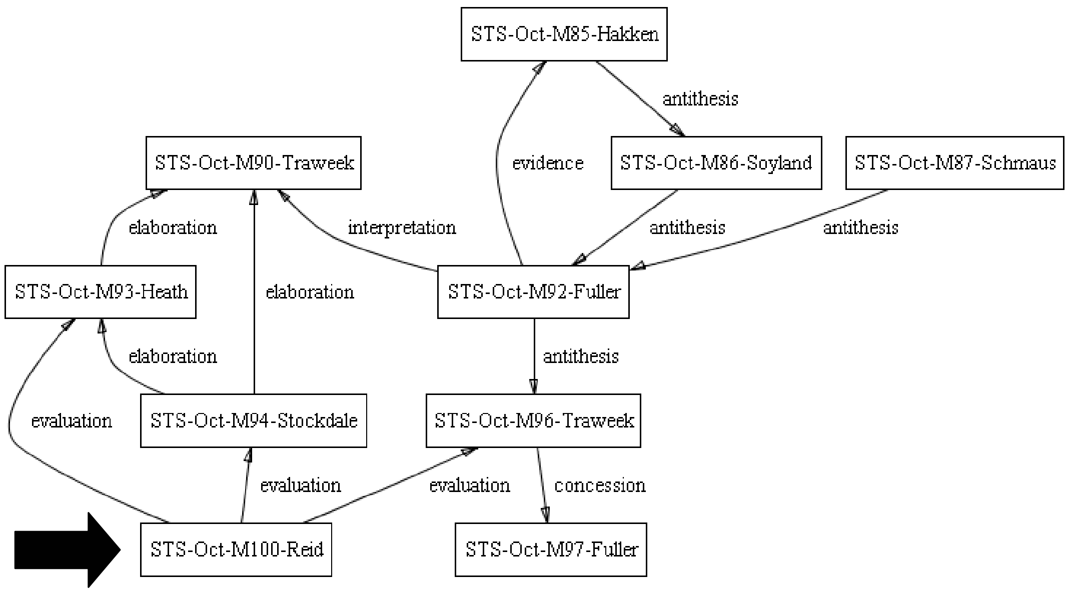

Figure 41. Additional Direct Convergence in the STS Discussion

There followed two more messages critical of Fuller, one from Mark Hineline, and the other from Schmaus. Hineline criticized Fuller's model as impractical, while conceding that his ideas were interesting (Figure 42). Schmaus said he thought maybe Fuller did not understand what he had said earlier about the comparison of ethicists with STS. The role of the ethicist was not purely reactive, but proactive as well. Schmaus went on to accuse Fuller of misuse of rhetoric.

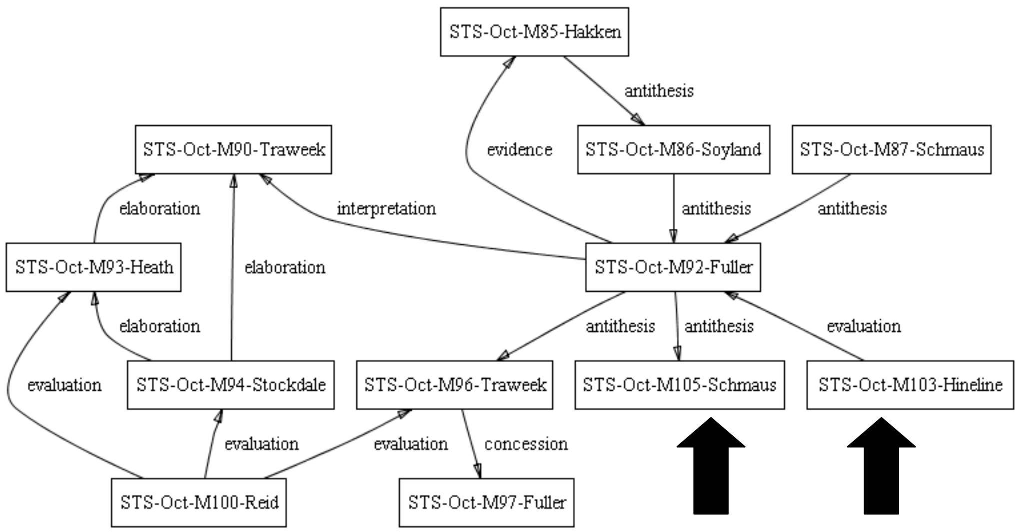

Figure 42. Additional Disagreement in the STS Discussion

Fuller, in responding to Schmaus, belittled the idea that philosophers might have motivated professional to adhere to ethical standards, but if that were true, it might address some serious questions (Figure 43). More likely, he said, others had appropriated the ideas of philosophers for their own ends. Schmaus responded that Fuller might or might not be correct in his views about philosophical influence, but if the outcome was that people were better able to give voice to their views, that would be commendable.

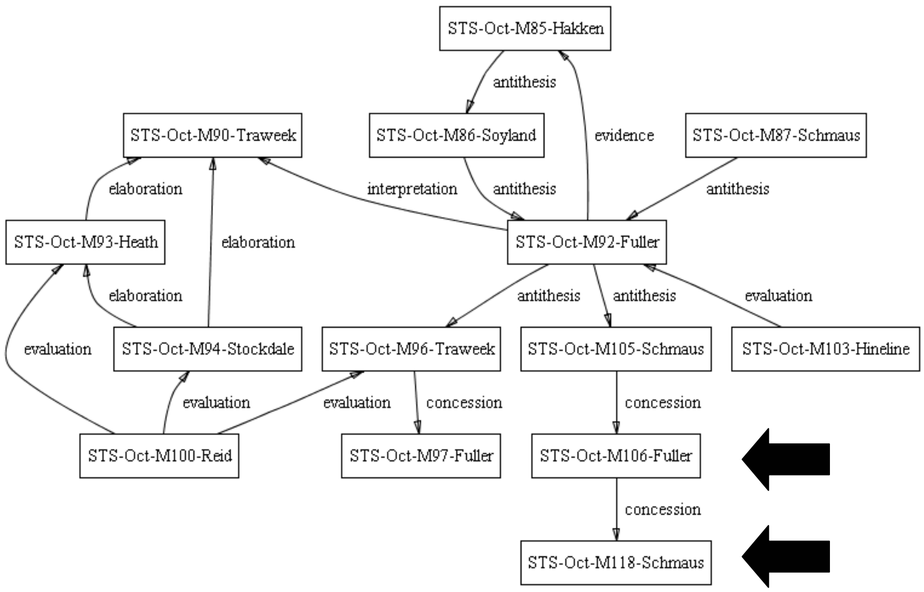

Figure 43. Final Concessions in the STS Discussion

In the foregoing example, half the inter-message relations used were argumentative. Of these, ANTITHESIS was the relation of choice, followed by CONCESSION, and trailed by EVIDENCE. Interestingly though, EVALUATION and ELABORATION were used as often as ANTITHESIS and CONCESSION. The presence of EVALUATION and ELABORATION was due mainly to their use the messages posted in support of Traweek. These messages formed an area of agreement within the overall argument that was largely unconnected from the other messages, as shown in Figure 44. Heath, Stockdale, and Reid provided encouragement to Traweek, who did battle against Fuller. However, it would be a mistake to assume that the use of these relations signaled agreement, their agreement was on their disagreement with other unspecified messages in the thread. Thus engaged in meta-talk, these messages are an example of topic drift, which will be discussed in detail in the results of RQ3.

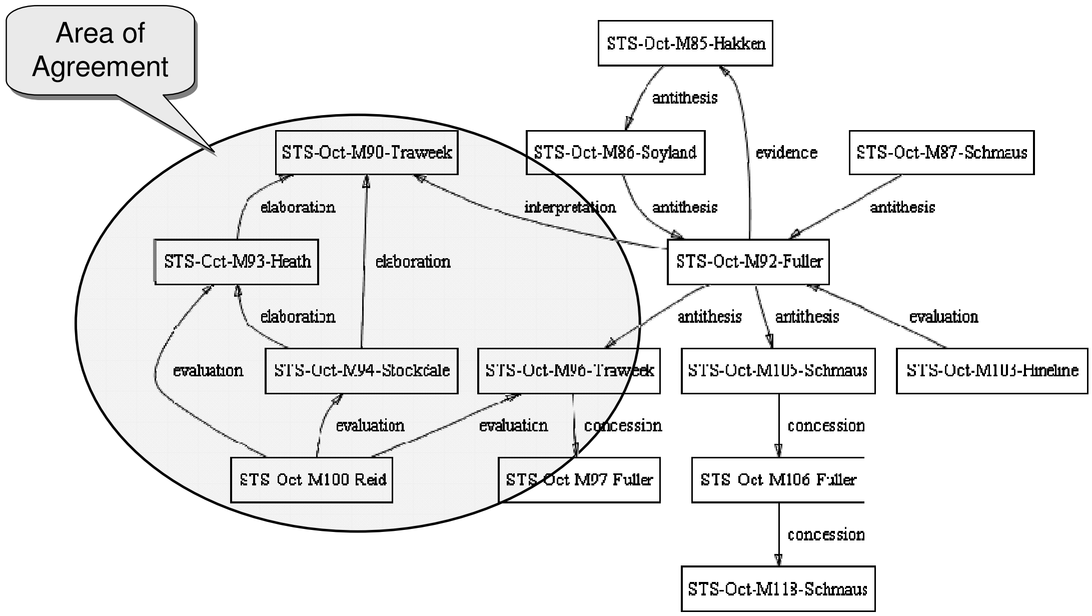

Figure 44. An Area of Agreement in the STS Discussion

Argumentation in WebCT and Allaire

In the WebCT and Allaire asynchronous learning environments, inter-message argumentation was generally constructive and agreeable, tending to rely on the EVIDENCE relation. An illustrative example of this was found in the Allaire Intuitiveness thread. The overall structure of this short thread is shown in Figure 45. The thread consisted of a single nucleus followed by two satellites. Both satellites related to the nucleus using the EVIDENCE relation. The nucleus argued that intuitiveness involved knowing what to do without being given instruction:

> I think intuitiveness can be defined as the next logical step to take without further instruction. This makes a website or software program easy to follow and learn. Nothing is easier than to navigate in a program/website that is

built with intuitiveness in mind; of course, what is logical to some might not be logical to others.

(A-Intuit-M2-P24)

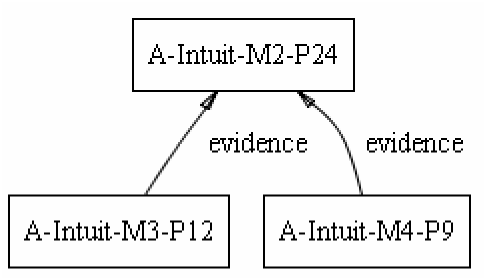

Figure 45. An EVIDENCE Interaction in the Allaire Intuitiveness Discussion

The next two messages followed up on this claim with additional evidence. The first response argued that knowing what to do without being given instruction would come more easily if it could be related to a frame of reference:

> I agree with the idea that intuitiveness refers to knowing what to do without instruction. The level of intuitiveness must be related to the frame of reference of the user. Novice users are less likely to find much intutitive as compared to someone with experience.
>
> Also to be intuitive, I think the interface needs to be clear an relatively unambiguous for the average person. That would mean selections that are clear and make sense. This would also mean some level of consistency with other interfaces so that users can relate to something they have experienced.

(A-Intuit-M3-P12)

The next response expanded the theme further, and argued for the elimination of other possible interpretations of what intuitiveness is:

> I agree with P24 because....
>
> The impression that the phrase "this interface feature is intuitive" leaves is that the interface works the way the user does, that normal human "intuition" suffices to use it, that neither training nor rational thought is necessary, and that it will feel "natural."
>
> In common parlance, intuition has the additional flavor of nearly supernatural ability humans possess in varying degrees. Given these connotations, it is as uncomfortable a term in formal HCI studies as it is a common one in non-technical publications and in informal conversation about interfaces.

(A-Intuit-M4-P9)

Thus, in contrast to the STS discussion, this example shows that it is possible to interact argumentatively while remaining constructive and agreeable. However, not all argumentation in the Allaire and WebCT groups was agreeable. There were several inter-message disagreements, usually employing the CONCESSION relation. For example, in one thread in the WebCT Usability discussion, student P31 identified several elements of user interface learnability, and noted that when broken down into its constituents, learnability was easier to evaluate:

> Learnability is a critical attribute for a new interface or application. Today's user doesn't have time to waste trying to learn the ins and outs of a new system. Preece sees learnability as a measure of how easy a system is to learn to use (2002). Learnability may further be described in quantifiable areas such as familiarity, consistency, predictability, simplicity, and generalizability (Usability 101, 2003). Familiarity is the extent to which a piece osf software or interface builds upon the user's prior knowledge of similiar applications or interfaces. Consistency points to the attribute of only having to learn a task within the application once and allows the user to perform the same task in the same manner every time. Breaking down learnability into sub areas makes it easier to evaluate.
>
> (W-Usab-M19-P31)

P37 responded to this by acknowledging the value of the learnability factors, but asserted that the “Ten-Minute Rule” was preferable because if a user cannot figure out to use an application in 10 minutes, he or she would be unlikely to be satisfied with the application:

> While I agree with the additional factors that you include in understanding learnability, I like the Ten-Minute Rule described in our text. Unless the application is complex, the user should be able to learn how to use the system in under 10 minutes. Frankly, I find that I have behaved much that way in my own experience. Unless I want to sit down and become an expert I prefer to see progress and some results; fast.
>
> A current example for me is completing my income tax. While occasionally I have needed professional assistance, I tried a couple of packages until I found one that is easy to "learn".
>
> (W-Usab-M21-P37)

The instructor followed up, summarizing the Ten-Minute Rule as an ideal for providing users with rapid and effortless functionality. There were further elaborations in this thread, but no further argumentation. This was typical of the learning environments. Unlike argumentation in the STS discussion, argumentative interactions were not sustained. In arguments involving disagreement, the threads were short-lived.

RQ3: Topic Drift

Topic drift is the tendency of discussions to drift incrementally, and sometimes irrecoverably, away from their announced topic (Hobbs, 1990). The primary expectation for this research question was that the devices used in effecting topic drift in asynchronous discussions would be similar to those of spoken conversation as identified by Hobbs. In his study of topic drift in spoken conversation, Hobbs identified three types of topic drift. These are *parallel association*, *chained explanation*, and *metatalk*. Parallel association occurs between two text spans when the spans are related tangentially to one another. Parallel association is achieved using a mechanism Hobbs calls *discourse pivot*. A discourse pivot forms a link between two otherwise unrelated topics. Discourse pivot incorporates some associations in the preceding text with those of the emergent topic, thus smoothing the transition from one topic to another. Chained explanations occur when an explanation becomes a topic of discussion, requiring further explanation in its own right. When this occurs over a series of exchanges, and without return to the original topic, the explanations are said to be chained. Metatalk changes the topic by shifting it to the goals of the topic—that is the topic of discussion becomes the discussion itself.

A second set of expectations concerned the ways in which these topic drift devices would manifest themselves in RST analysis. The researcher expected that for each device, a specifiable subset of relations would tend to be prominent. A final expectation for RQ3 concerned topic recovery. Here again it was expected that a select subset of RST relations would be used. In support of the RQ3 investigation, the following hypothesis was formulated:

> **H3**: Hobbs' (1990) theory of conversational topic drift provides a plausible account of topic drift in asynchronous discussion.
>
> 3.1 Devices used in topic drift include parallel association, chained explanation, and metatalk.

3.2 In parallel association, ANTITHESIS and CONCESSION are salient.

3.3 In chained explanation, ELABORATION, EVIDENCE, PURPOSE, SOLUTIONHOOD, VOLITIONAL-CAUSE, NONVOLITIONAL-CAUSE, VOLITIONAL-RESULT, and NONVOLITIONAL-RESULT are salient.

3.3 In metatalk, EVALUATION relation is salient.

3.5 Chained explanation will combine with metatalk and parallelism to push the topic progressively further from its origin.

3.6 Topic recovery uses the RST relations RESTATEMENT and SUMMARY.

The results of RQ3 are organized as follows: first, the uses of parallel association, chained explanation, and metatalk are discussed. This is followed by a discussion of topic recovery, as found in the discussions. Finally, there is an analysis of how the devices of drift were combined to effect topic drift, and the role of recovery maneuvers in bringing a discussion back to its original topic.

Parallel Association

Parallel association was used frequently in the discussions. ANTITHESIS and CONCESSION accounted for almost half of the relations used in Parallel Association; this comprised a four-fold increase in overall use of these relations. The analysis suggested that there are several types of parallel associations. These include *lateral association*, *subtopic escalation*, *pedagogical pivot*, and *redirection*. Lateral association is an association between the main topic of a message and its response. In subtopic escalation, the respondent to a message responds to a subtopic within the previous message, without acknowledging the primary topic. Pedagogical pivot entails a deliberate intervention by the instructor to shift the topic into alignment with learning objectives. In topic redirection, the respondent dismisses the previous message and proposes a new approach. Redirection is similar to pedagogical pivot, except that the writer carrying it out is not the course instructor. Redirection was seen only in the STS discussion. Examples of each of these subcategories are given in Figure 46. In the discussions studied, subtopic escalation occurred in instances of parallel association, chained explanation, and metatalk. Lateral association and redirection were found in instances of parallel association and chained explanation. Pedagogical pivot occurred only in parallel association.

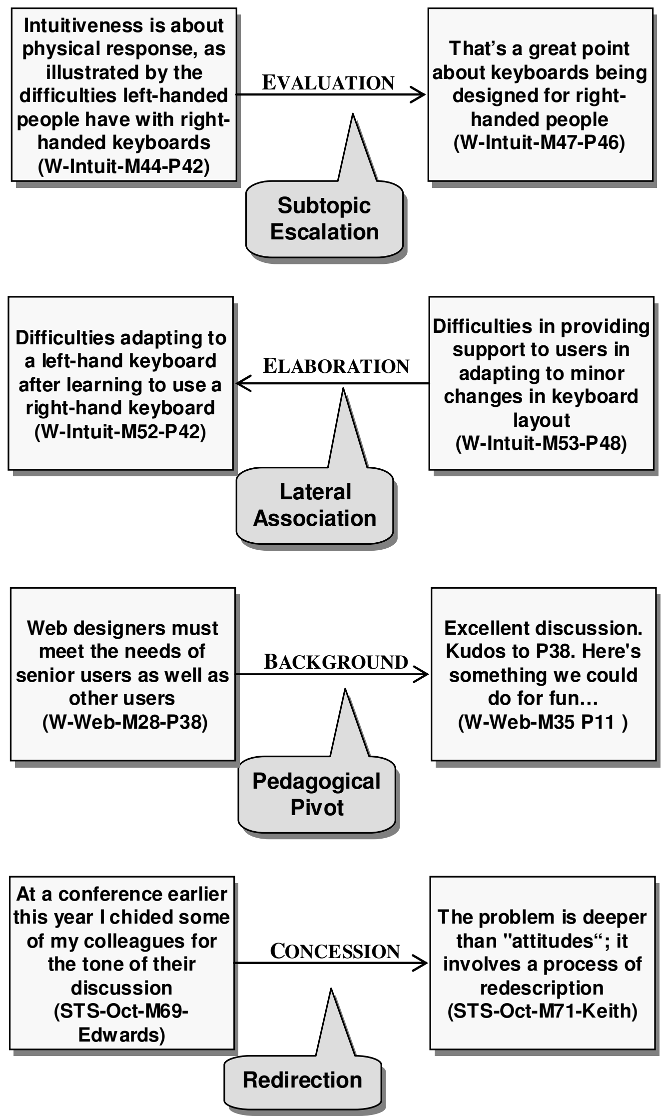

Figure 46. Topic Drift Subcategories

The analysis of parallel association suggested that topic drift does not occur as a matter of chance. Participants use the devices of topic drift in order to adapt the discussion to a topic of preference. An instructive example occurred in the WebCT Intuitiveness discussion when one of the students advanced an argument in support of the claim that "intuitiveness is about physical response":

> Take for example the keyboard which was designed for right handed users. All of the additional features of the keyboard (the number keypad and the insert/delete keys, etc) are located on the right side of the keyboard. Over the years I've become familiar with the key pad and insert/delete keys, but the use of them took me years to master because of the locaction and the lack of flexibility with my right hand. They have yet to come out with a left handed keyboard designed with these functions on the opposite side. I've noticed right handed users are able to quickly learn the keystrokes and are able to touch type on the number pad.
>
> Physical response and intuitiveness is something they attempted with the keyboard, but they missed the mark with at least a few users. Unfortunately I don't think now it would matter. The keyboard is standardized, and even left handed users have learned to adapt physically.
>
> (W-Intuit-M44-P42)

In the ensuing discussion, consisting of 13 responses, none addressed the claim made in the original posting. While the claim concerned the physicality of intuitiveness, the responses focused on keyboards. One response recounted an earlier paper the student had done on Dvorak keyboards. Another noted that mice could be programmed for either left or right handed usage, but that most left-handed users are unaware of this. Yet another speculated on the causes of the relative infrequency of left-handedness:

> I have not adapted to the right hand use of the numeric keypad....I am left handed. I would probably really like a left handed keyboard with the

> numeric keypad on the left side. Has anybody ever heard why there are so few of us lefthanders? What I have heard was that way back when, during the time of fighting with swords and shields, that people who held their sword in their left hand exposed their heart in battle which caused a higher mortality rate. I guess the ones that survived must have been good fighters or very lucky:) Anyway, I don't know if there is any truth to this.
>
> (W-Intuit-M48-P39)

This led to discussion of a variety of topics related to left-handedness, including the use of the term “southpaw,” International Left-Handers Day, social pressure on left-handed people to use their right hands. Several left-handed students posted messages with their personal opinions about keyboards and the relative advantages and disadvantages of keyboards designed for left-handed use. Most agreed that switching to a left-handed keyboard after having become accustomed to a right-handed keyboard would not be worth the effort. One student posted a message on the general usability problems arising from minor variations in keyboard layout.

Most of the shifts in topic in this thread used parallel association, as shown in Figure 47. Subtopic escalation was used to transition the discussion away from the original topic (the role of physical response in intuitiveness) to a secondary topic (left-handedness and keyboard layout), and lateral association was used to sustain the discussion thereafter. None of the respondents addressed the central claim of the original message, but almost half the students in the class were interested in discussing the keyboard example, with one student responding three times. Discussions such as this one moved freely among a variety of loosely related topics.

Thus, parallel association seemed uniquely suited for adapting a discussion to an individual's interests or competencies. The writers leveraged previous discussion as an opportunity for posting messages about favorite subjects. If the students were attracted to the opportunity to share their experiences with keyboard related issues, a corollary inference might be that they avoided the more abstract concept of the relation of physical response to intuitiveness.

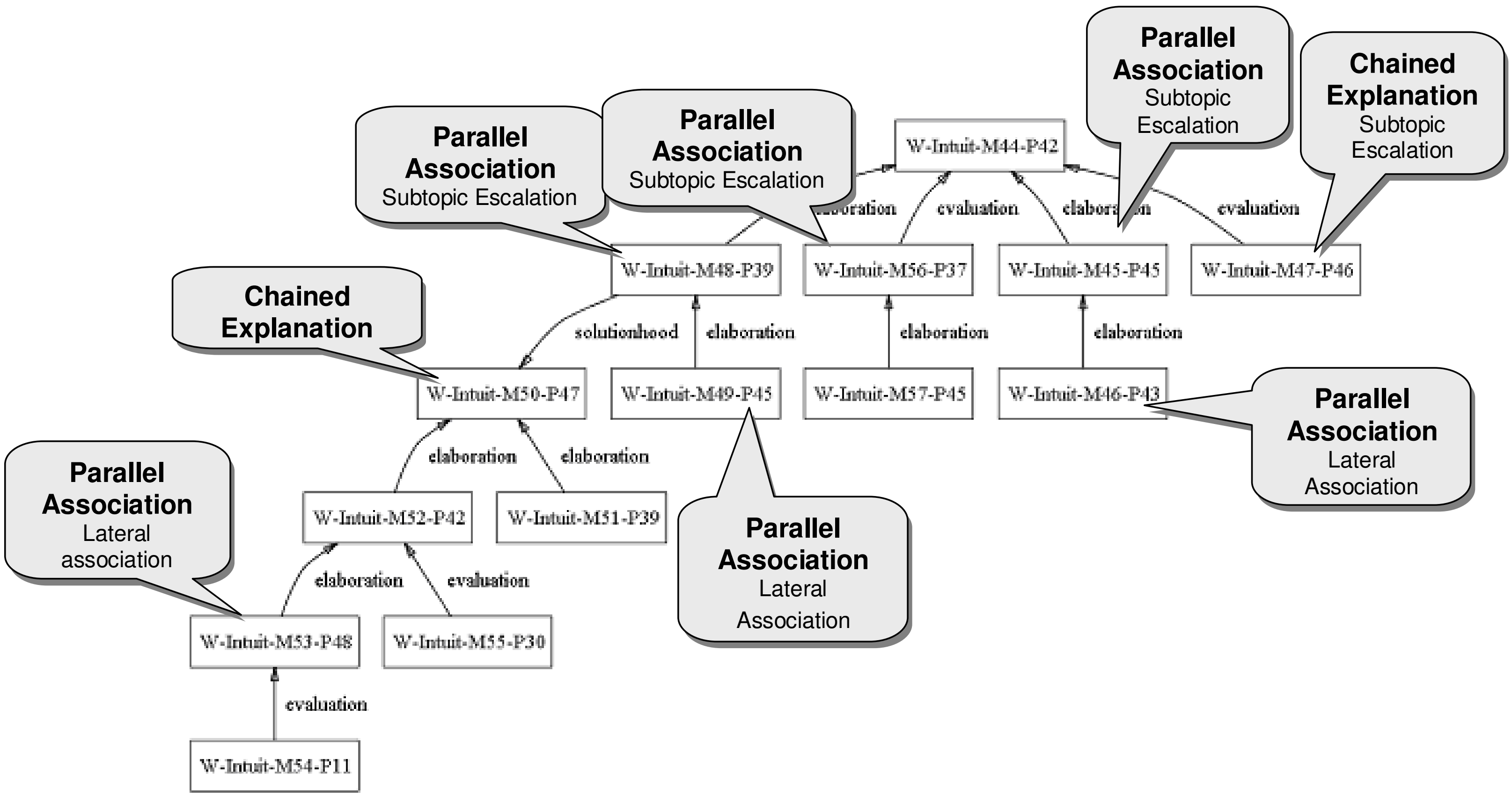

Figure 47. Topic Drift in the WebCT Intuitiveness Discussion

Not all use of parallel association was as casual as this, however. As mentioned earlier, pedagogical pivot entails a deliberate intervention to shift the topic into alignment with learning objectives. The effect of these interventions can have a dramatic effect on the structure of discussion. One such example occurred in the Medicare Web site thread, which was presented earlier in RQ1.

The thread opened with a message on the topic of senior-friendly Web site design. The message focused on the Web as an information resource for senior citizens. This was followed by several messages that elaborated on this topic. One student countered that senior citizens valued the Internet less as an information resource and more as a means for staying in touch with friends and family. The instructor then posted the following message:

> This is an excellent topic of discussion. Kudos to P38 for getting this started. Those of you who have responded have acknowledged the importance of designing for specific target groups, in this case, seniors. Here's something we could do for fun. We're all probably aware about the government's approval of the Medicare Prescription Card Program. Apparently, there are over 70 Medicare-approved drug discount cards to choose from. Where does a senior start? One resource seniors are referred to is http://www.medicare.gov, the Medicare Web site. What can we say about the design of this website? Is it "senior citizen user centered"? Check it out when you get a chance...
>
> (W-Web-M35-P11)

This had the effect of changing the topic from general issues associated with senior friendly design to a specific evaluation of the Medicare Web site. The shift in topic can clearly be seen in the diagram shown in Figure 48. All subsequent contributions to the thread were posted as follow-ups to this message.

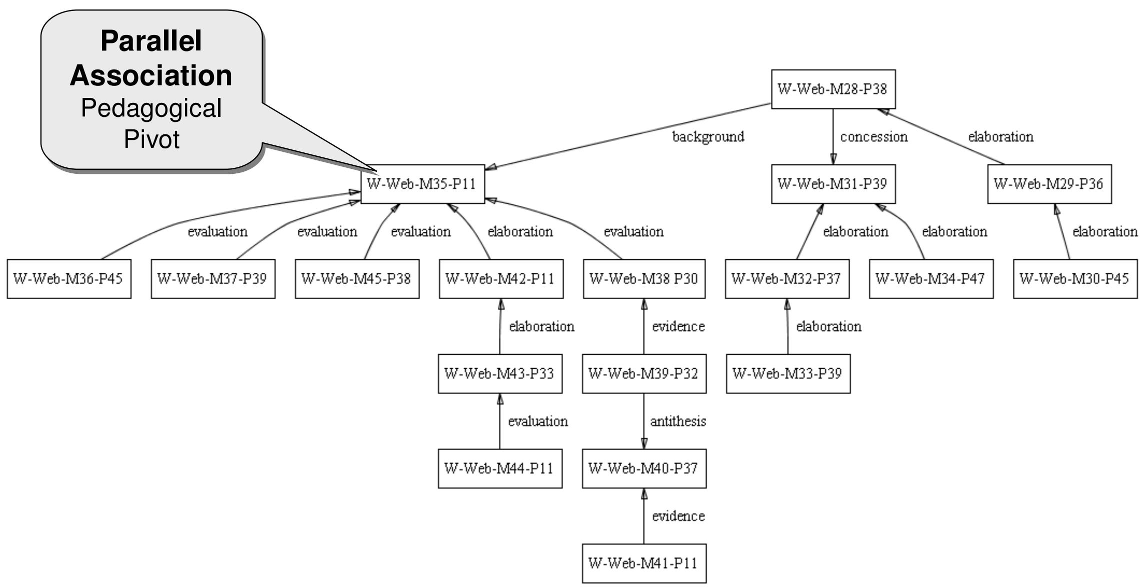

Figure 48. Pedagogical Pivot

Chained Explanation

Chained explanations occur when an explanation becomes a topic of discussion, requiring further explanation in their own right. When this occurs over a series of exchanges without return to the original topic, the explanations are said to be chained. It was expected that the RST relations used here would include those associated with giving explanations, namely ELABORATION, EVIDENCE, PURPOSE, SOLUTIONHOOD, VOLITIONAL-CAUSE, NONVOLITIONAL-CAUSE, VOLITIONAL-RESULT, and NONVOLITIONAL-RESULT.

However, although ELABORATION accounted for almost half of RST relations used in chained explanation, the other explanatory relations were seldom or never used. Instead, ANTITHESIS, CONCESSION, and EVALUATION were frequently used.

Chained explanations commonly used subtopic escalation; that is a response would focus on explaining a subtopic within a previous message, and this subtopic would then become subject to a series of chained explanations. A example of this occurred in the WebCT Usability discussion, shown in Figure 49.

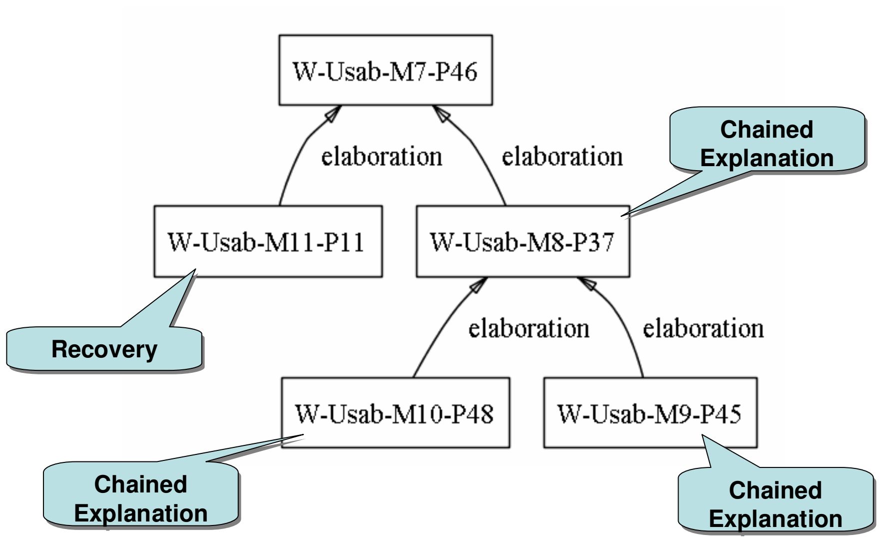

Figure 49. Subtopic Escalation in Chained Explanation

In the first message of this thread, student P46 student offered a personal view of user interface flexibility, and then corrected this with a more detailed definition based on research. This was amplified with an example based on the Microsoft Paint application and the observation about the flexibility of Microsoft Windows applications in general:

> When I think of the term flexibility, what comes to mind is an interface/system that allows the user to accomplish a task in more than one way. However, my definition is actually too narrow. According to Dix et al (1998), there are five design principles related to flexibility, two of which are "substitutivity" and "customizability." An example of substitutivity is how paint programs, such as Microsoft Paint, allow you to define the size of an image in either pixels or inches. Customizability is the ability to modify the interface (Dix et al). For example, with the fixed asset software we use, you can make rename fields. I think that most of the Windows program I use have decent flexibility.
>
> (W-Usab-M7-P46)

Responding to these observations, student P37 challenged the notion that Windows programs are flexible:

> Certain MS products are flexible and not without their share of problems. If you can remember Frontpage95/98. They were very inflexible that actually decrease flexibility. Now, Frontpage XP is fairly decent but now comparable to be BBEdit or Dreamweaver. The one thing that MS has its advantages is the flexibility with other MS products, eg. Excel spreadsheet in Word or Power point.
>
> (W-Usab-M8-P37)

This response is that it ignored the central ideas of the previous message and focuses entirely on the example. The next message continued with the discussion of Microsoft FrontPage:

> Good observation P37. I hear what you are saying. I used to use Frontpage 95/98 all of the time. But its been a while now since I've done so. I have to admit, I have not tried Frontpage XP, but I will check it out later today.
>
> (W-Usab-M9-P45)

The next message also responded to P37, still sticking with matters specific to Microsoft products:

> I agree with you 100% on the point that MS has its advantages by being quite flexible with other MS products. This makes it so easy for the consumer/end-user when working on this platform. Practically every MS product in the Office Suite "speaks" to eachother in a sense. Everything can be imported, exported, merged, etc. This is a wonderful benefit to any user.
>
> (W-Usab-M10-P48)

Finally, the instructor commented on the original message, in a manner that recovers the original topic:

> That's a good point about flexibility -- there should be more than one way to do a task but without incident or error.
>
> (W-Usab-M11-P11)

However, there were no further contributions to the thread. This is consistent with the notion that discussion participants seek to manipulate the topic to areas they are comfortable with. Discussing the shortcomings of applications they were familiar with was easy, but developing the concept of flexibility would have been challenging.

Metatalk

In metatalk the topic of discussion becomes the discussion itself. There were no instances of metatalk in the Allaire and WebCT discussions. Metatalk was used several times in the STS discussion. When used, metatalk was interwoven with other comments of a more substantial nature. In the following example, metatalk was used to express appreciation for the contributions of certain participants and to criticize the character of the discussion, while at the same time providing an interpretation of the significance of those contributions:

> Traweek's, Heath's, and Stockdale's interventions are a breath of fresh (and cool?) air amidst the expressions of panic and hand-wringing and I was wondering when someone was going to bring up the fact that a different dynamic has been going on for a long time between researchers and scientists that involves other processes than pure "othering" and having the last word. Good going, so to speak!
>
> (STS-Oct-M100-Reid)

It was expected that in metatalk, EVALUATION relation would be salient. EVALUATION accounted for one-third of the relations, and ANTITHESIS accounted for one-third. Other relations used included CONCESSION and ELABORATION. ANTITHESIS and CONCESSION were used to take exception to previous discussion, and ELABORATION was used to continue metatalk from a previous message.

Topic Recovery

Topic recovery is an attempt to return a discussion to a previous topic. It was infrequently used in the Allaire and WebCT discussions. It was used several times in the STS discussion. The salient relations for topic recovery were ANTITHESIS, CONCESSION, and ELABORATION. The researcher had expected that RESTATEMENT and SUMMARY would be used, but RESTATEMENT was used only once for topic recovery and SUMMARY was never used for topic recovery. When used with ANTITHESIS and CONCESSION, topic recovery expressed dissatisfaction with the current topic:

> There seems to be a few odd things about the general line in this debate…
>
> (STS-Oct-M86-Soyland)

> It is seeming rather odd that John Bailar's two week old query about what STSers might wish to do in the way of changing the world has turned into a kind of soul-searching exercise about the identity of the social "scientists" engaged in observing, writing about science/scientists...
>
> (STS-Oct-M98-Marks)

When used with ELABORATION, topic recovery continued a recovery effort begun in a previous message:

> Harry Marks has said it well. I have been veryglad indeed to learn from all the mail about Respect, but much of it has not addressed my continuing concern.
>
> (STS-Oct-M99-Bailar)

Combined use of topic drift devices

Topic drift develops over the course of a series of exchanges. It was anticipated that through a combination of chained explanations with metatalk and parallel association, the discussions would, with each additional message, move relentlessly further from their original topics. Analysis of topic drift as developed over the course of a thread suggests that the process is indeed progressive, but there was no discernible pattern in the choice of topic drift devices.

The Allaire and WebCT discussions were not well suited for study of the progress of topic drift. Response patterns in these discussions were typically diffuse, resulting in response patterns that are more wide than deep, such as the thread shown in Figure 50. While such discussions may include topic drift devices, the devices are typically dispersed horizontally across the thread. These diffuse topographies afford little opportunity for topic drift development.

Since the Allaire and WebCT discussions included no threads suitable for this part of the investigation, the researcher selected a thread from the STS transcript for in-depth exploration. The contentious exchange between Steve Fuller and Sharon Traweek was introduced earlier with the results of RQ2. However, it was useful to revisit that portion of the discussion, because it offered good examples of the use of metatalk, parallel association, recovery, and chained explanation. The analysis of this discussion is shown in Figure 51.

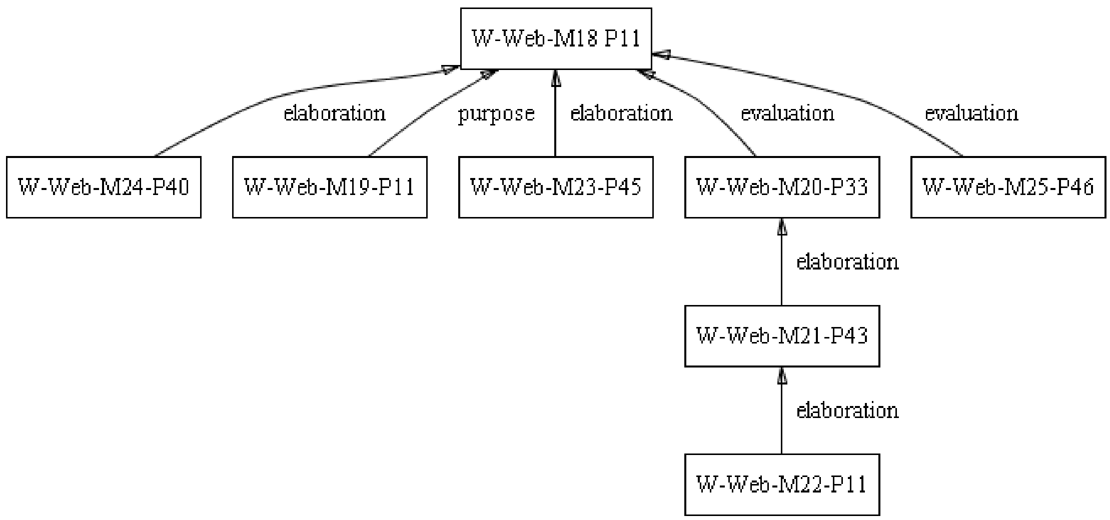

Figure 50. Example of a Diffuse Thread Topography

The discussion began with a series of metatalk devices, interspersed with attempts at recovery from Fuller, albeit on his own terms. In the first message, Traweek criticized the ongoing discussion, saying she and about a dozen unnamed colleagues had agreed that the ongoing STS discussion was both tragic and comic. She went on to explain that she and her colleagues worked in a cooperative atmosphere, sharing their work with scientists, and enjoying the mutual benefits of long-term collaborative engagement. This message evoked several responses, most of which continued Traweek's critique by elaborating on her appraisal of the disturbing character of the discussion, as exemplied by the remarks quoted earlier from Roddey Reid. However, not all responses were so positive. Steve Fuller, as recounted earlier, raised the question of what conceptual model she was using. In responding, Traweek observed:

> I am exceedingly reluctant to 'reply' to Fuller's remarks, not only because that would require a long posting, but also because, unless I'm careful, that merely puts him in the position of defining the terms of discussion, which, of course, is the problem.
>
> (STS-Oct-M96-Traweek)

As she proceeded to deconstruct Fullers remarks, she made frequent use of metatalk, critiquing not only the content of the discussion, but the manner in which it was expressed:

> Back to Fuller's [oops, that should be FULLER's] s l o w l y delineated queries to "TRAWEEK" as if I were still the dull witted student being red lined [why in the world have other readers of this list put up with this when their messages are being dissected in this desicated way?]:
>
> > In other words, do you detect a mutual interest or common
>
> > understanding in your interactions with the scientists?
>
> Ah, he's on to me, using that word 'detect.' He probably knows that I've written a lot about physicists' detectors and written about my own inquiries among them as 'detecting.' What a deceptively simple question, asking if I've noticed a 'mutual interest or common understanding.' I'll answer in the same deceptively simple style: Yes. Oh, phooey, I'll add just a bit more: we

> have a mutual interest and common understanding about the nuts and bolts of doing research.
>
> (STS-Oct-M96-Traweek)

As discussed in RQ2, Fuller responds by apologizing for being “unduly agonistic,” and continues the discussion without acknowledging the severity of Traweek’s invective. However, neither the discussion nor the metatalk ended here. Another participant, Harry Marks, soon followed up with both Traweek and Fuller with these observations about the discussion:

> It is seeming rather odd that John Bailar's two week old query about what STSers might wish to do in the way of changing the world has turned into a kind of soul-searching exercise about the identity of the social "scientists" engaged in observing, writing about science/scientists… I feel like I'm back in the high school gym with the kids over on the wall, trying to scope out the kids over on the other wall….
>
> (STS-Oct-M98-Marks)

This received no reply from Fuller or Traweek, but it did elicit a response from John Bailar, whose two week old query Marks referred to. (In fact, this entire was a digression from a question posed previously by Bailar.) Bailar used the occasion to attempt to recover the original topic:

> …What is the ultimate purpose of doing STS and related things? Unless we have some notion about this, we can hardly tell whether we are doing our work well, nor can we tell whether there are ways to do it better…
>
> (STS-Oct-M99-Bailar)

This posting received four responses, three of which are on topic, but none of which resulted in sustained on-topic discussion. Among the on-topic responses, Brian Martin and George Gale responded with personal accounts as to the value of STS. In Martin's view, the goal is a world without war, and he described a project aimed at using science and technology to improve the effectiveness of nonviolent struggle. There were no responses to Martin's posting.

Gale described his long-term collaboration and friendship with a theoretical physicist and his personal goals for their collaboration. Neither Gale nor Martin made any pretense of generalizing their goals across the STS community. In enumerating his goals, Gale made this somewhat perplexing reference to Sharon Traweek:

> …My greatest accomplishment in our personal friendship was to finally convince him that particles were a waste of his talent, and that general relativity was 'where it was at'! Sorry, S. Traweek!...
>
> (STS-Oct-M101-Gale)

This prompted another excursion into metatalk from Traweek:

> I do not understand this last sentence of the first entry in Gale's goals list; why in the world would I have an investment, one way or the other, in what he persuaded a theorist to do?
>
> (STS-Oct-M104-Traweek)

There was no response to Traweek's posting. Fuller's response to Bailar began with the promise of topic recovery and convergence:

> Back to Basics: What's the Point
>
> Maybe I'm not alone in finding it quite confusing who is and is not addressing BAILAR's original query about the point of STS. Take for instance the dichotomy of 'insular' vs. 'public' which several people have been tossing around.
>
> (STS-Oct-M107-Fuller)

However, the message quickly downshifted into a comparison of the opposing views Fuller saw represented in this dichotomy, with little question as to which view he favored:

> For me, to be 'insular' is to take a 'business as usual' attitude to the research that we do in STS, as if we're just like the physicists, literary critics, and other tillers in the groves of academe. Everybody minds their own turf, and that's the end of that.

(STS-Oct-M107-Fuller)

Having taken this tangent, Fuller made no further reference to Bailar's original query.

The fourth response to Bailar's appeal was from Paul Edwards, and it was the only response that resulted in substantial discussion. Edwards argued for a role for STS in providing a broad, balanced approach to techno-science education. In making his argument, Edwards noted that his engineering students had no concept of interacting with users, and that they preferred to assume the technical problems they solve would reflect the needs of the marketplace, as defined for them by their employers. Edwards argued that engineers need to see themselves not merely as technologists, but as social engineers, and he cited work by Terry Winograd in developing a program in human-computer interaction as an example of how the gap between technology and its potential users might be narrowed.

In the messages responding to Edwards, chained explanation is used to move the discussion away from the goals of STS, first to the effects of meddling with the marketplace, and then to the role of the government in managing technology development. Robert Frost responded to Edwards, arguing that any attempt to meddle with marketplace mechanisms would lead to unfavorable circumstances (STS-Oct-M111-Frost). As examples, he cited monopolistic behavior within the software industry and the dampening effects patent grabbing practices in the pharmaceutical industries have on innovation. To enlighten students about market imperfections would be to risk inciting cynicism and disappointment, according to Frost.

Michael Andrew Turton then responded to both Edwards and Frost, noting that they raised interesting issues concerning the effects of the marketplace on technology development (STS-Oct-M112-Turton). Turton then argued that it was the role of government to rectify failures in the marketplace, such as those that Frost cites. “One can imagine,” suggested Turton, “a technology policy which actually responds to human needs, rather than dictating them.”

Finally, Scott Hauger then responded to Turton, arguing that there was no need to be theoretical, that there were actual programs in place that serve to make technology responsive to human needs (STS-Oct-M113-Hauger). As examples, he cited the National Institute for Disability and Rehabilitation Research, the Department of Veterans Affairs, and the U.S. Department of Education’s Office of Special Education Research. Hauger mentioned his own research in reading machines for the blind, and argued that democratization of technology development through government intervention tends to enhance innovation rather than stifle it.

Thus the discussion proceeded, with each participant pushing an agenda, and only occasionally pausing to develop the ideas of the other participants. Even attempts at recovery seemed to aimed towards either criticizing the views of others rather than orderly topic development. Under such anarchic circumstances it is little wonder that the topic wandered, and perhaps would be amazing had it done otherwise.

It would be incorrect to infer, however, that the disputative character of the STS debate was solely the result of some aspect of the technology of asynchronous communication. While the technology is apparently conducive to contentious behavior (Dery, 1994; Kayany, 1998), in this instance there were other factors at work. First, given that many of the participants in the STS debate were experts in the topic under discussion, they had a stake in the outcome of the discussion. Indeed, a recurring complaint during the debate was that researchers in the hard sciences had access to a disproportionate share of research funds.

Second, the debate occurred within a larger historical context. This context, known as the *science wars* (Gross, 1997; Kovel, 1996), took place during the 1980s and 1990s as a series of aggressive critiques on science launched by scholars in the social sciences (Goldman, 2006). These attacks, as described by Goldman, characterized science as an inappropriately privileged source of truth, and they sought to explain science (and scientists) as socio-economic phenomena. The STS debate concerned what many participants perceived as a counter-attack on their position and ultimately on the legitimacy of their research.

Although the use of asynchronous technology may have exacerbated the intensity of disagreement, this acrimony should be viewed as the manifestation of a larger process. In contrast, the Allaire and WebCT discussions took place among students in a virtual classroom, under the moderating influence of the instructor. Fahy (2002) and others have shown that factors such as instructor presence, assigned tasks, and grades were likely to reduce the intensity of online interaction. It should be no surprise, then, that argumentation in the learning environments was relatively subdued as compared to the STS debate.

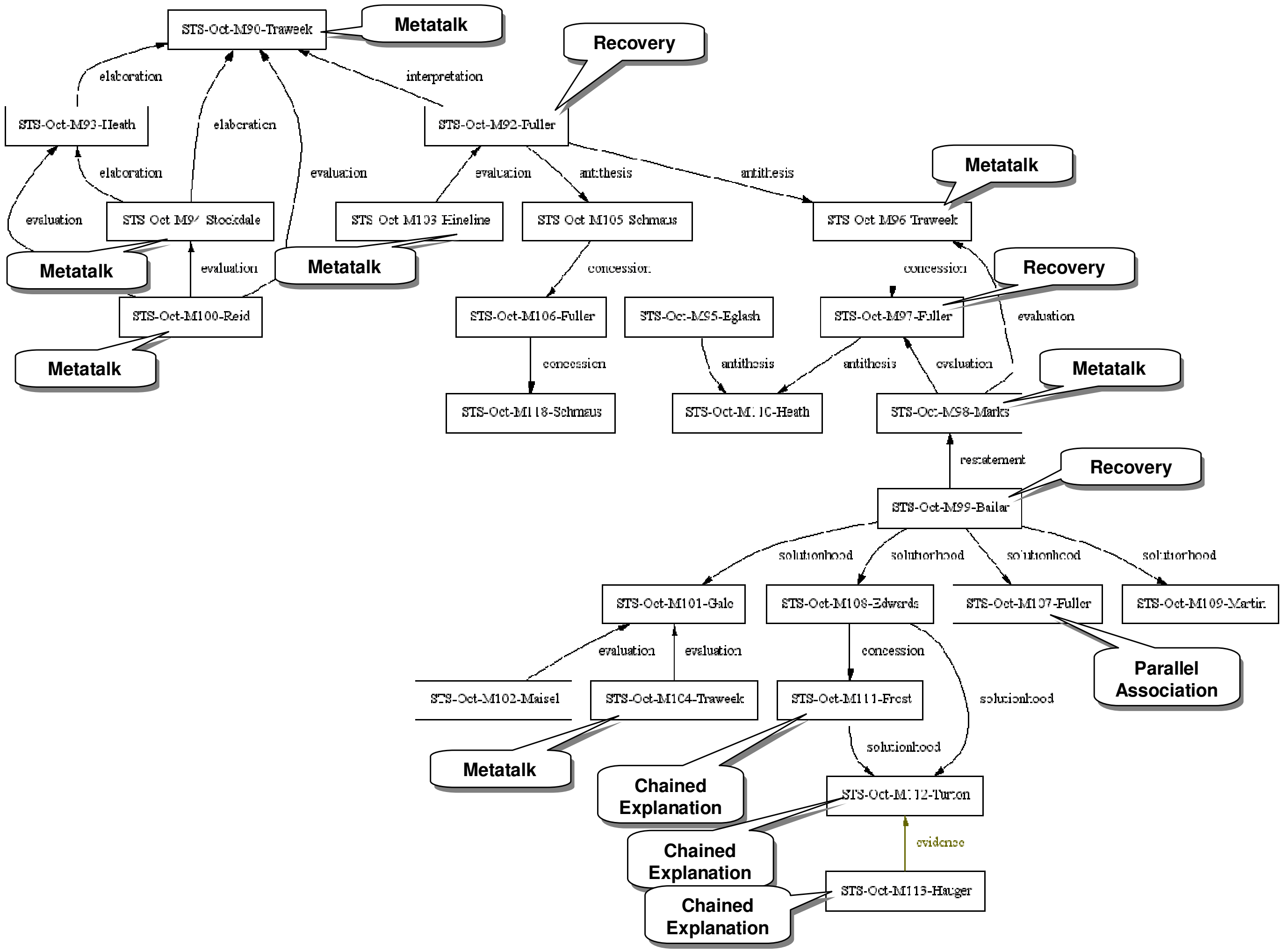

Figure 51. Fuller-Traweek Exchange

RQ4: A Comparative Perspective

Whittaker (2003) and others have observed that the features of a computer conferencing environment influence the nature of the interaction. Features of thread management, for example, differ from one conferencing system to another. Some systems provide strong support for threading, such that each message's position within a thread is clearly indicated, while others provide weak thread support, where messages are presented to the user in order of composition, without regard for their logical interrelationships (Pincas, 1999). In systems lacking thread support, participants resort to various forms of reference in order to maintain the integrity of the discussion (Kear, 2001; Pincas, 1999; Preece, 2000; Reed, 2001). They may, for example, resort to *ad hoc* typographical conventions in order to distinguish material quoted from a previous message from new information (Pincas, 1999). Sometimes, as participants await a response to their messages, they may post further messages, resulting in overlapping exchanges, interleaved threads, interruptions, and loss of thread coherence (Herring, 1999b). The RQ4 investigation examined the rhetorical structures used by participants in the WebCT and Allaire environments in an effort to discover how differences in features in these systems lead to differences in interactional coherence. In support of this investigation, the following hypothesis was formulated:

> **H4**: There is suggestive evidence that the features of the computer conferencing system used to support asynchronous discussions affect characteristics of interactional coherence.

4.1 There are discernible differences in the use of argumentative rhetorical relations in the discussions from the two computer conference systems.

4.2 There are discernible differences in patterns of topic drift in the discussions from the two computer conference systems.

4.3 There are discernible differences in patterns of recovery from topic drift in the discussions from the two computer conference systems.

Although the WebCT and Allaire conferencing systems included numerous features for administration and customization, the features of interest here were those pertinent to creating, reading, and responding to messages. These products had many similarities in this regard, but there were some differences. Table 17 summarizes these similarities and differences. Both supported the ability to post, read, and respond to messages. Both provided thread support to make it easy to discern which messages are in response to which, both provided the ability to preview a message before posting, and both permitted users to upload files with their posted messages. Distinguishing characteristics included email notification, marking, quoting, and HTML editing. Allaire’s email notification option permitted users to receive an email whenever a new message was contributed to the discussion. WebCT’s marking feature made it easy for the user to see which messages had already been read and which had not, and allowed the user to manage which messages were marked as read or unread. WebCT’s quote feature provided automated support for incorporating another user’s text into a message when composing a reply. Each line of the quoted text would be preceded by the “>” character, a convention that is common in many email and conferencing systems (Crystal, 2001). WebCT’s HTML editor provided a graphical environment for adding rich formatting to messages. Although Allaire Forums processed HTML tags correctly, the user was required to manually encode any HTML tags directly into the message. Despite the availability of the quoting and HTML features in WebCT, neither was used in any of the discussions included in this study.

Table 17. Conferencing System Features

Feature	Description	Allaire	WebCT
Post	Create a new message	X	X
Reply	Response to a previously posted message	X	X
Browse	When reading messages, the ability to scroll among sequential postings and responses	X	X
Email Notification	Receive email notification when new messages are added to the thread	X	
Thread Support	Software and user interface support for representation of threads within a discussion	X	X
Mark	Messages, once read, are marked as read		X
Quote	Automatically quote a message when creating a response to the message		X
Preview	View how a message under construction will appear when posted	X	X
HTML Editor	Software and user interface support for HTML formatting in messages		X
Attachments	Attach a file to be uploaded with a message	X	X

Relation Use in Individual Messages

RST relation use in the Allaire and WebCT messages was similar. In both forums, ELABORATION was most commonly used. Relation use for the most frequently used relations in the Allaire Forums discussions is summarized in Figure 52. ELABORATION was by far the most frequently used relation, with a 40% frequency. The second and third most commonly used relations were CONCESSION and BACKGROUND.

The most frequently used relations in the WebCT group are identified in Figure 53. Here again, ELABORATION is the most frequently used relation, with 30%. The second and third most commonly used relations are EVIDENCE and BACKGROUND.

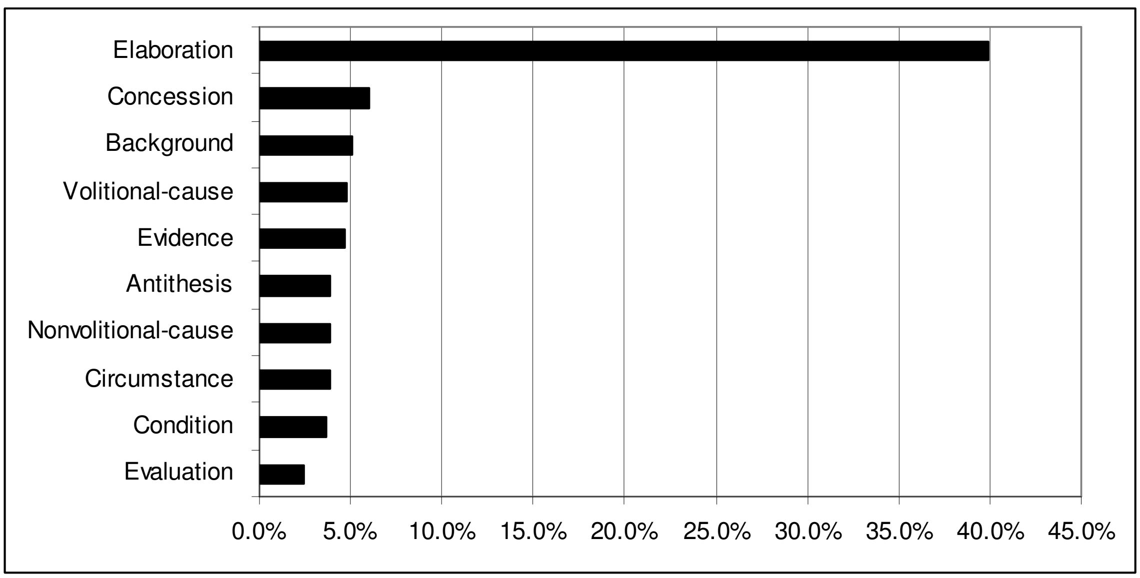

Figure 52. Relation Use in the Allaire Group

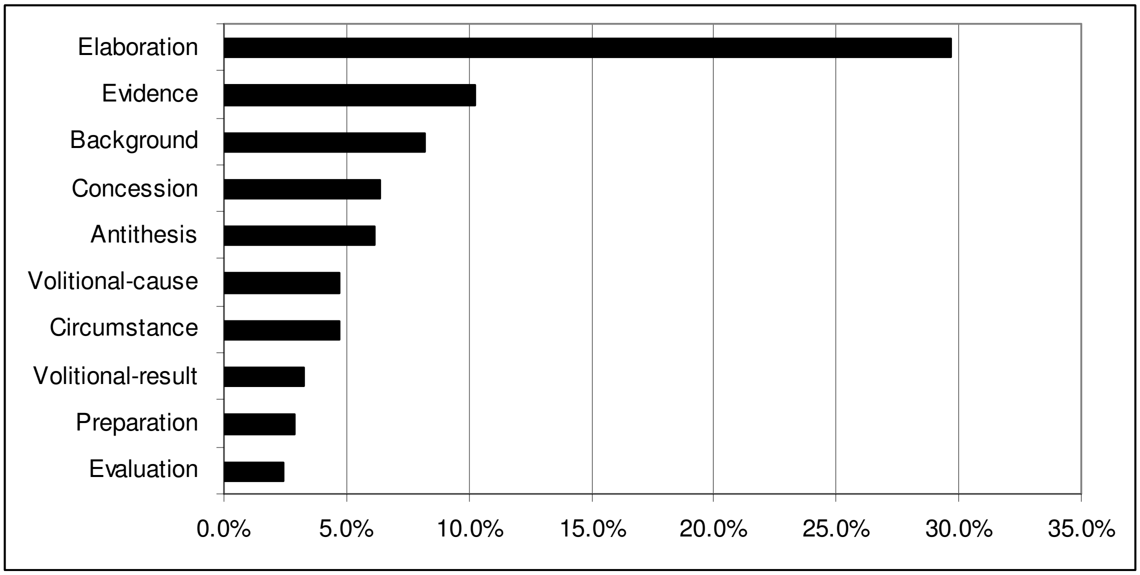

Figure 53. Relation Use in the WebCT Group

Allaire and WebCT Relation use in Inter-message Structures

In both the Allaire and WebCT groups, the most frequently used inter-message relations were ELABORATION, EVALUATION, and EVIDENCE, as shown in Table 18. These three relations account for over 70% of inter-message relations. However, there was considerable variation between the two groups. ELABORATION was the most frequently used relation. However, it was used with considerably higher frequency in the WebCT group (48%) than in the Allaire group (28%). This raises a question—if Allaire participants made less use ELABORATION, then what relation was used instead? The answer seems to be that Allaire participants made more frequent use of the EVIDENCE relation, with 30% of Allaire inter-message structures using this relation compared to just 7% in the WebCT group. An additional difference between the two groups was in the use of the EVALUATION relation. The WebCT group EVALUATION with 21% frequency while Allaire used it only 12% of the time.

Table 18. Allaire and WebCT Relation Use in Inter-Message Structures

	Allaire		WebCT	
Relation	**Total**	**Percent**	**Total**	**Percent**
ANTITHESIS	6	10	7	5
BACKGROUND			1	1
CONCESSION	6	10	10	7
ELABORATION	17	28	72	48
EVALUATION	7	12	31	21
EVIDENCE	18	30	10	7
INTERPRETATION			3	2
NONVOLITIONAL-RESULT			1	1
PURPOSE			1	1
SOLUTIONHOOD	2	3	8	5
SUMMARY	2	3	6	4
VOLITIONAL-CAUSE	1	2		
VOLITIONAL-RESULT	1	2		
Total	60	100	150	100

Allaire and WebCT use of Argumentative Structures

The overall use of argumentative structures within individual messages was roughly equivalent between the Allaire and WebCT groups. In the Allaire group, argumentative structures accounted for about 16 % of RST relations used, and in the WebCT group, argumentative structures accounted for about 20%. In both of these groups, the argumentative relations most frequently used were ANTITHESIS, CONCESSION, and EVIDENCE. JUSTIFY and MOTIVATION relations were used only occasionally.

In inter-message structures, argumentative structures included ANTITHESIS, CONCESSION, and EVIDENCE, as shown in Table 19. The JUSTIFY and MOTIVATION relations were not used. In the Allaire group, EVIDENCE was predominant, accounting for 60%. In the WebCT group, the use of argumentative relations was roughly evenly distributed. As a percentage of overall inter-message structures, argumentative relations accounted for 50% in the Allaire group and 18% in the WebCT group.

Table 19. Allaire and WebCT Argumentative Relation Use in Inter-Message Structures

	Allaire		**WebCT**	
Relation	**Total**	**Percent**	**Total**	**Percent**
ANTITHESIS	6	20	7	26
CONCESSION	6	20	10	37
EVIDENCE	18	60	10	37
Total	30	100	27	100

Topic Drift

By definition, topic drift can only occur within a thread, and the longer the thread, the greater opportunity there is for topic drift. In the Allaire group, less than half of the messages belonged to a thread, with the remainder being posted as singletons. In contrast, almost 80% of the messages in the WebCT group were in threads, as shown in Table 20. Further, the Allaire threads were quite short, averaging about three messages in length, with the longest thread containing 10 messages (Table 21). Many of the threads consisted of a single interaction between two messages. This provided little opportunity for topic drift. The WebCT threads were somewhat longer, with an average of five messages per thread.

Table 20. Thread Participation Summary

	Discussion	**Threaded Messages**	**Percent Threaded**
Allaire	Intuitiveness	11	31
	Usability Concepts	32	60
	HCI and the Web	17	43
WebCT	Intuitiveness	50	82
	Usability Concepts	59	81
	HCI and the Web	46	74

Table 21. Thread Length Summary

Discussion		**Threads**	**Interactions Per Thread**		
			Average	**Minimum**	**Maximum**
Allaire	Intuitiveness	6	1.8	1	4
	Usability Concepts	10	3.2	1	9
	HCI and the Web	10	1.7	1	4
WebCT	Intuitiveness	8	6.3	1	20
	Usability Concepts	14	3.8	1	11
	HCI and the Web	12	3.8	1	17

Although the threads in the Allaire group were relatively short, there were some occurrences of topic drift devices. Over half of these were chained explanations, and one third were parallel associations, as summarized in Table 22. The WebCT group, however, preferred parallel association; a little over one-third of its topic drift devices were chained explanations. With respect to the subcategories of topic drift, both groups made extensive use of subtopic escalation. Pedagogical pivot occurred more frequently in the Allaire group than in the WebCT group.

Table 22. Topic Drift Devices in Allaire and WebCT Groups

	Allaire		WebCT	
Topic Drift Device	**Occurrences**	**Frequency**	**Occurrences**	**Frequency**
Chained Explanation	7	58	9	36
Parallel Association	4	33	14	56
Metatalk	0	0	1	4
Recovery	1	8	1	4
Total	12	100	25	100

Table 23. Topic Drift Subcategories in Allaire and WebCT

	Allaire		WebCT	
Subcategory	**Occurrences**	**Frequency**	**Occurrences**	**Frequency**
Subtopic Escalation	5	45	13	52
Lateral Association	3	27	11	44
Pedagogical Pivot	3	27	1	4
Total	11	100	25	100

Depth of Reference

In his study of the use of quoting in asynchronous conversation, Reed (2001) found that participants tended to limit the depth of the history of the discussion as revealed in the quoted text. Reed found this depth usually extended to no more than two or three messages, and never exceeded five, regardless of the number of predecessor turns in the thread.

In the Allaire and WebCT discussions, the depth of reference rarely exceeded more than one message. The only occasions when the depth exceeded this were in messages from the instructor, in which she sought to elaborate, evaluate, or summarize previous discussion. An example of this occurred in the WebCT intuitiveness discussion, shown in Figure 54.

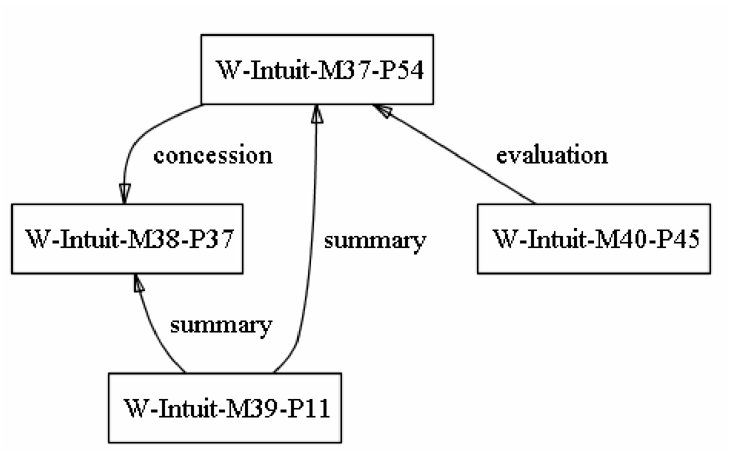

Figure 54. Multiple Depth of Reference in a WebCT Discussion

In this thread, P54 began with a review of a report by Santos and Badre (1995) on learnability evaluation:

> In an article that discussed a low-cost method to learnability evaluation Santos and Badre (1995) equated intuitiveness with initial ease of use. Santos and Badre (1995) claimed that many designers place too much focus on intuitiveness rather than learnability over long-term use. They also described a system that favored intuitiveness and fast learning (system A)

and another system that promoted performance for the expert user (system B), they claimed there is a point at which the more complicated system actually becomes easier to use. Santos and Badre (1995) described this concept…

(W-Intuit-M37-P54)

To this P37 responded, agreeing with P54's main point, but suggesting that the study might be flawed with respect to its selection of subjects:

I accessed the article you referenced and I agree with your assessment that intuitiveness should mean overall ease of use not just during the initial period. However, the article's study seemed to be based on a random set of students and I wonder if the study itself might be flawed in that it did not start by determining what the user problem and work flow was about...

(W-Intuit-M38-P37)

The instructor then responded to both of these messages, evaluating and summarizing their observations:

P54 and P37, excellent discussion here. It could very well be that the sample size was limited in size and representation. I agree that intuitiveness should be supported for a variety of user experience levels (novice, intermediate, expert). As experience builds over time and effort, so too does the intuitive

> quality of a product. We need representation from various user experience levels to see how this plays out.
>
> (W-Intuit-M39-P11)

Because the conferencing systems did not support convergent threading, messages making reference to multiple postings indicated their intent by explicit reference. In the above example, the instructor accomplished this in the opening salutation. As noted in the earlier discussion on the dynamics of asynchronous discussion, references to previous messages were sometimes general, as in this message from the Medicare thread:

> This is an excellent topic of discussion. Kudos to P38 for getting this started. Those of you who have responded have acknowledged the importance of designing for specific target groups, in this case, seniors…
>
> (W-Web-M35 P11)

References like this were somewhat problematic when constructing rhetorical networks. The conferencing software clearly indicates that the message is in reply to a single message, as shown in Figure 55. However, the same message could be encoded as convergent on all predecessor messages in the thread, as shown in Figure 56. Just as the conferencing software supported order and regularity on the discussion, it also limited the ability of users to interact with one another openly. This was true of both the Allaire and WebCT systems. Interestingly, in email lists such as the STS discussion where there was only limited support for threading, multiple levels of reference were not uncommon. In that discussion, users signaled which messages they were responding to using a variety of devices, including email headers (“To:” and “Subject:” lines) and explicit references within the messages.

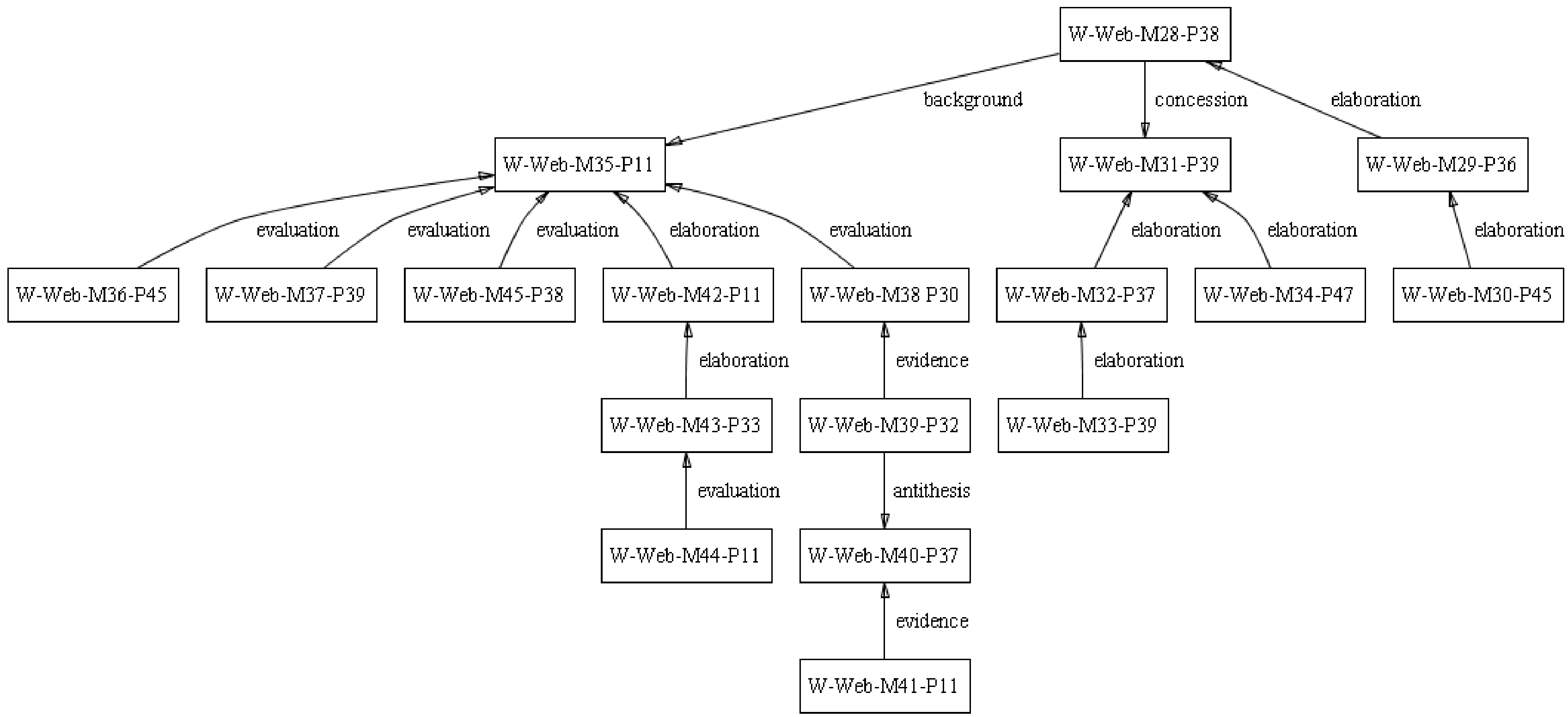

Figure 55. Convergent Response as Reply to Single Message

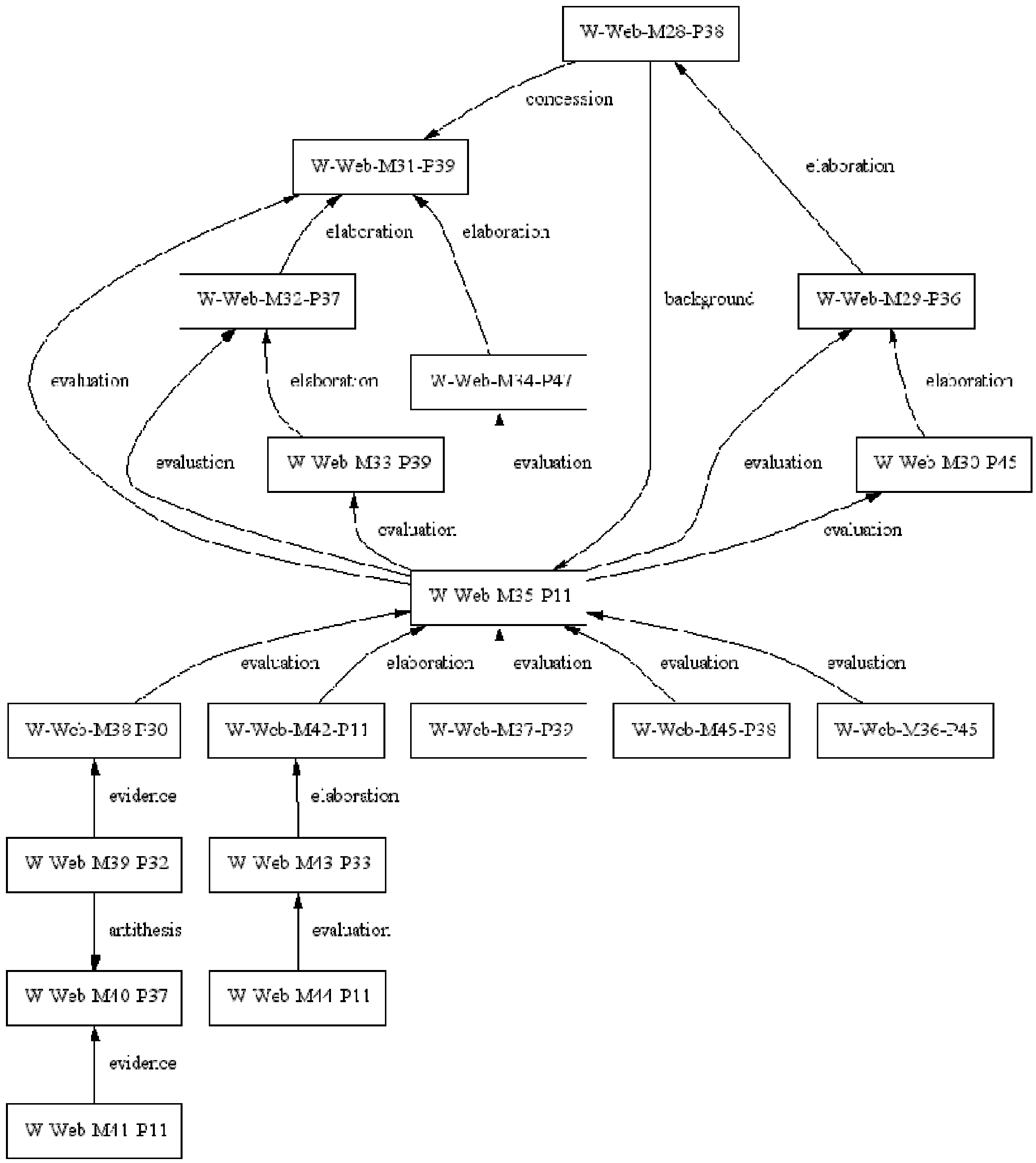

Figure 56. Convergent Reply

Overlapping threads

Overlapping threads have been mentioned as one of the manifestations of interactional coherence (Herring, 1999b). Overlap occurs when the messages comprising multiple threads are intermixed with one another in their delivery to the user, such that the user is left to distinguish which message responds to which (Herring, 1999b; Pincas, 1999). By this account, the result would be akin to the disarray one would expect on encountering a document composed of the freely interleaved pages from various other documents. However, this view does not seem to bear up well under scrutiny. In conferencing systems with weak thread support, such as email lists, subscribers seem to be able to make sufficient sense of their inboxes so as to continue their membership in the lists (L-Soft, 2007). The STS discussion is an example of such a list.

STS email messages were dispatched to list members in the order received (Simon & Gale, 2002). They were received as email messages along with any other email messages the member might receive. So the STS threads were not only interleaved among themselves, but they were also intermixed with other messages as well, some of which included private email on the same topics being openly discussed on the STS list. This sometimes resulted in confusion. Sometimes messages were accidentally sent to individual members when intended for the list; often messages were sent directly to members as well as to the list; sometimes messages were resent because their authors were unclear whether they had reached the list; and sometimes participants forwarded messages received privately that they assumed were intended for the list.

Because both Allaire and WebCT provided strong thread support, messages were organized as threaded structures. Consequently, there were no instances of overlapping threads in the two conferencing systems. As essentially closed systems, there was no intermixing of messages with other online communication. Had the levels of interaction in the Allaire and WebCT groups been comparable to that in the STS discussion, it would have been interesting to see how well their threads would have held up, or whether they too would have needed to resort to informal mechanisms to ensure thread integrity.

Singletons and Intertextuality

One striking difference between the Allaire and WebCT discussions was in the level of threaded interaction. In the Allaire less than half of the messages were threaded. In the WebCT group, almost 80% of the messages were threaded. One possible reason for this could be that the WebCT conferencing software itself was more conducive to posting threaded responses rather than singletons. If the reason were the conferencing software, then it might be the case that in the Allaire discussions participants resorted to other means for interaction other than the threading features of the software.

Indeed, in the discussion of message intertextuality in RQ1, it was found that some messages could only be understood by reading them within the context of their predecessors. To the extent that this is the case, it is possible that some singleton messages achieved interactivity without availing themselves of the software threading mechanisms. Clearly, the singleton messages in the Allaire intuitiveness discussion, for example, addressed the assigned topic. They simply did not happen to be linked into the discussion using a threading mechanism. Given the possibility of discerning intertextual relationships among messages, as was done in RQ1, then it should also be possible to characterize those relationships in terms of RST relations. In RQ1, several examples were identified in which the instructor's opening message in the discussion posed problems for the students, and the students' singleton messages provided solutions to the problems. It was suggested that, but for the lack of threaded linkage, these messages might be viewed as having SOLUTIONHOOD relations with the instructor's message, as shown in the rhetorical network shown in Figure 57.

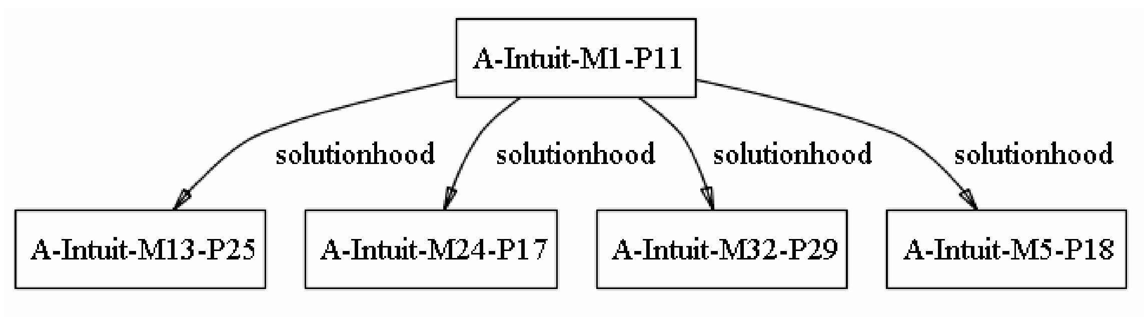

Figure 57. Intertextual Rhetorical Network

The rhetorical network shown in Figure 57 consists of a single nucleus with a set of satellites branching out from it. The nucleus message posed two challenges:

> …We need to DEFINE intuitiveness and discuss how we can MEASURE intuitiveness in terms of usability and design.
>
> (A-Intuit-M1-P11)

This pattern also occurred in the WebCT Intuitiveness discussion, where the instructor made the same challenge:

> We need to DEFINE intuitiveness and discuss how we can MEASURE intuitiveness in terms of usability and design.

(W-Intuit-M1-P11)

That the instructor would use the same assignment for two different offerings of the same course is in no way remarkable. However, the pattern of the response is of interest. As shown in Figure 58, the rhetorical network of the WebCT thread is similar to the pattern of intertextuality found in Allaire. They both consist of a single nucleus with a set of satellites branching out from it. In both, the SOLUTIONHOOD relation was used. Moreover, the satellites in both make extensive use of the JOINT relation in their internal structures.

In the Allaire rhetorical network, all of the satellites use JOINT. In the WebCT rhetorical network, almost half of the satellites use JOINT in the same fashion. That is, the messages consist of two parts: one part discusses the definition of intuitiveness and the other part addresses the measurement of intuitiveness.

The principal difference between the Allaire and WebCT structures is that in WebCT the users made extensive use of the software's threading features. This gave the discussion greater structural integrity, making it easier to discern the flow of the discussion. Otherwise, it seems that the Allaire discussions were no less interactive. This would suggest that the lower level of threaded interaction in the Allaire group was due not to any disinclination to interact, but that the Allaire conferencing software was less conducive to posting threaded responses rather than singletons.

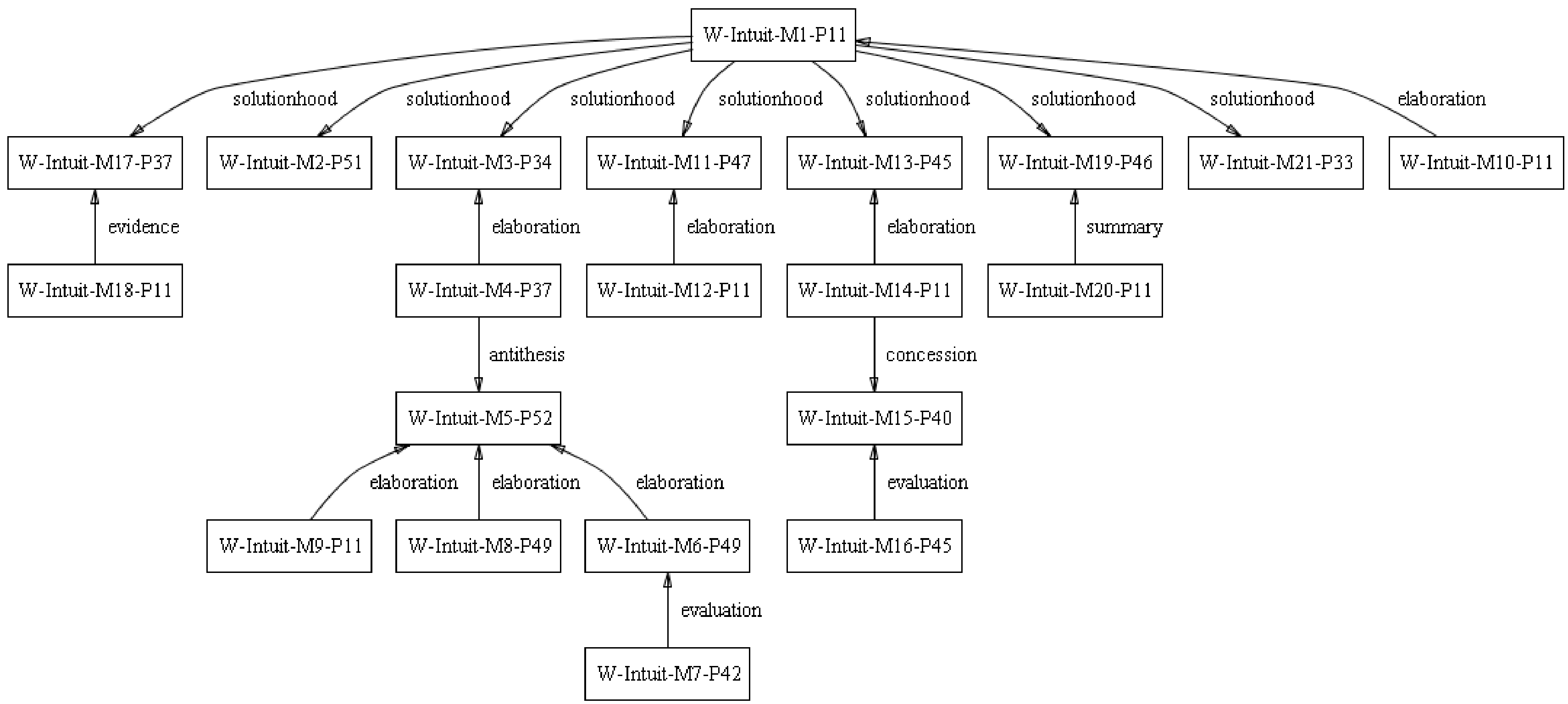

Figure 58. Use of Threading in WebCT

Summary

This study consisted of four interrelated investigations. These included RST analysis, investigation of the use of argumentation, investigation of topic drift, and a comparative study of the Allaire and WebCT discussions. The RST analysis of individual messages found that messages generally followed the structural patterns reported in other studies (e.g. Mann & Thompson, 1988; Stent, 2001; Taboada, 2004a). However, several distinctive patterns were found in the use of the JOINT relation. There were several distinct circumstances that gave rise to the use of JOINT. These were identified as intertextuality, orthogonal elaboration, subtopic escalation, and non sequitur.

The analysis of inter-message RST structures revealed that the discussions were structurally dynamic. These dynamics led to the development of an adaptation of RST called Rhetorical Networks. As defined for this research, rhetorical networks are subject to the RST completeness and connectedness constraints, but not the adjacency and uniqueness constraints. Structures are defined in terms of satellite-nucleus and nucleus-satellite schemas, and a specific set of relations is associated with each schema. These associations are based on the implied temporal considerations of the relations. Using rhetorical networks, it was possible to create structural models of each of the threads in the discussions. These models were used in the analysis of argumentation, topic drift, and comparative features of the discussions.

The investigation of the use of argumentation found that the discussions differed significantly in terms of the extent and type of argumentation used. Argumentation was more prevalent in the STS group than in the Allaire and WebCT groups. The STS group used ANTITHESIS and CONCESSION extensively, suggesting the dominant mode of interaction to be disagreement. EVIDENCE was the preferred inter-message argumentative relation in the Allaire group, while EVIDENCE and CONCESSION were evenly distributed in the WebCT group. In addition, in the STS discussions, arguments were sustained over large numbers of messages and involved many participants. In contrast, disagreements in the Allaire and WebCT discussions involved only a few participants and extended for only a few interactions.

The investigation of topic drift found that parallel association was the most common form of drift. Chained explanation was used occasionally, and metatalk was seldom used. The analysis suggested that topic drift does not occur as a matter of chance. Participants used the devices of topic drift to adapt the discussion to a topic of preference. Participants used several types of parallel association, identified lateral association, subtopic escalation, pedagogical pivot, and redirection. These were used to exploit previous discussion as opportunities for manipulating the tropic.

The Allaire and WebCT comparison showed that the two conferencing environments had many features in common, and the discussions in both systems were similar in terms of rhetorical structures. However, the discussions were quite different in their use of threading. In the Allaire group, less than half of the messages belonged to a thread, with the remainder being posted as singletons. In contrast, most of the messages in the WebCT group were in threads. There was some evidence that the Allaire group compensated for lower levels of threaded interaction by means of informal intertextuality. Further, the Allaire threads were quite short, averaging about three messages in length, with the longest thread containing 10 messages. Many of the threads consisted of a single interaction between two messages.

Chapter 5

Conclusion

Conclusions

Rhetorical structure theory (RST) was used to analyze discussions from two computer conferencing systems and an email debate. The conferencing systems were Allaire Forums and WebCT. The email debate took place on a list devoted to the topic of science, technology, and society (STS). The study included an assessment of the applicability of RST for analysis of asynchronous discussions, an examination of the use of argumentative rhetorical relations in asynchronous discussions, an analysis of topic drift, and a comparative study of interactional coherence in the WebCT and Allaire computer conferencing systems.

RST Analysis

The investigation showed that asynchronous discussions could be described in terms of integrated rhetorical structures. These structures occurred on multiple levels. At the first level, individual messages were analyzed, rendering collections of structural models representing each contribution to the discussion. At the next level of analysis, the discussions were analyzed to describe the structure of complete threads. These models provided insight into how people interact with one another using asynchronous communication systems. These insights provided a better understanding of the nature, extent, and limitations of interactional coherence in asynchronous learning environments.

Application of RST to Individual Messages

Participants showed a clear preference for certain rhetorical relations in composing messages. . The ELABORATION relation was by far the most frequently used. Other frequently used relations included BACKGROUND, ANTITHESIS, and CONCESSION. The extensive use of use of ELABORATION was consistent with other studies (Mann & Thompson, 1988; Marcu, 2000; Stent, 2001; Taboada, 2004a). The study showed that the use of the ELABORATION and BACKGROUND relations was integral to topic development, and that ANTITHESIS and CONCESSION were used to indicate that one idea was being weighed against another, and were often used to indicate disagreement.

The analysis showed that most messages were readily analyzable, leading to structures that conformed to the constraints and definitions of rhetorical structure theory. However, there were significant departures, and these departures indicated a quality of coherence that could not be satisfactorily represented using RST. These situations were identified as intertextuality, orthogonal elaboration, subtopic escalation, and discourse pivot. Intertextuality indicated an implicit relationship of a message with its predecessors. Orthogonal elaboration referred to the use of explicit signaling devices to change topic. Similarly, subtopic escalation was used as a tactical device for initiating topic drift by advancing a subtopic to topic status. One additional category, called non sequitur, was proposed for messages that were, insofar as the investigator was able to discern, incoherent.

Application of RST to Threads

The study found that the structure of the discussion evolved and took shape over the course of the discussion. Although, at the basic level of analysis, any given interaction between two messages could be modeled using RST, this was not the case for complex threads. In an asynchronous environment, any message may respond to any of its predecessors at any time, and it may do so using any rhetorical relation, without regard for any preexistent structural commitments. This dynamic characteristic had important implications for the application of RST. The structural dynamics of a thread could take two forms: convergent and divergent. In a convergent structure, a message responded to multiple predecessors. Because the respondent message could employ any RST relation to any predecessor, including relations using a nucleus-satellite schema, the respondent message could be a satellite to multiple predecessors. In a divergent structure, a message received multiple responses. Here again, the responses could employ any RST relation. When the responses used relations based on satellite-nucleus schema, the original message then became satellite to multiple responses. Since the RST uniqueness constraint permits a satellite to have only one nucleus, such convergent and divergent structures were not conformant to RST. In addition, the analysis found that any message could refer to any previous message, regardless of the presence of other intervening messages. This resulted in the loss of structural adjacency. When combined with non-uniqueness, the discussions could not be represented using conventional RST diagrams. This realization motivated the development of rhetorical networks.

As defined for this study, rhetorical networks are directed graphs. As with RST, the graph edges represent relations and the nodes represent messages. A rhetorical network is subject to the RST constraints of completeness and connectedness, and its structures are limited to two schema: the satellite-nucleus schema and the nucleus-satellite schema, with relations being associated with a specific schema type. Using rhetorical networks, it was possible to create models of each of the threads in the discussions.

Because the Allaire and WebCT messages indicated a high value on matters of agreement, the analysis examined the rhetorical structures of agreement and disagreement. The study found that some rhetorical relations were used for expressing agreement, while others were used for disagreement. Some relations, such as ELABORATION and EVIDENCE, were often used to provide supportive information about their nuclei; other relations, like ANTITHESIS and CONCESSION, were used for expressing disagreement. The EVALUATION relation was used for both agreement and disagreement. That a small subset of relations could be identified as signaling agreement or disagreement is significant because this suggests the possibility of characterizing the agreeableness of discussions based on relation use. A discussion containing a high volume of CONCESSION and ANTITHESIS structures could be predicted to be more disagreeable than one that was predominately BACKGROUND, EVIDENCE, and SUMMARY. This might, in turn, support prediction of the ability of asynchronously communicating groups to reach consensus.

Argumentative Structures

The investigation of the use of argumentation in asynchronous discussions anticipated that argumentative structures would be salient, and that argumentative messages would loosely follow the form of Taboada's (2004b) general argumentative form of asynchronous messages. The research entailed an identification of argumentative structures, an examination of these structures and their dynamics, and comparison of argumentation patterns in the discussion groups.

Argumentative structures were identified at both the individual message and inter-message levels. In individual messages the use of argumentative relations ranged from about 14% in the Allaire Usability discussion to 26% in the STS discussion. No messages were found to meet the full criteria specified by Taboada as a generic message form of argumentation, but many messages met the mandatory criteria.

Inter-message argumentative structures used only ANTITHESIS, CONCESSION, and EVIDENCE argumentative relations. ANTITHESIS and CONCESSION were used extensively in the STS group, suggesting the dominant mode of interaction in the STS discussion is one of disagreement. EVIDENCE was the preferred inter-message argumentative relation in the Allaire group, while EVIDENCE and CONCESSION were evenly distributed in the WebCT group. In the STS discussions, arguments were sustained over large numbers of messages and involved numerous participants. In contrast, arguments in the Allaire and WebCT arguments involved only a few participants and extended for only a few interactions.

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Topic Drift

The investigation of topic drift sought to determine whether the devices of topic drift in asynchronous discussions are similar to those of spoken conversation. The topic drift devices included *parallel association*, *chained explanation*, and *metatalk* as defined by Hobbs (1990). The investigation considered whether the use of these devices would manifest themselves in RST analysis. The investigation also considered whether a select subset of RST relations would be used in implementing topic recovery

The analysis of parallel association suggested that topic drift does not occur as a matter of chance. Participants used the devices of topic drift to adapt the discussion to a topic of preference. Using parallel association, participants leveraged previous discussion as opportunities for posting messages about favorite subjects. The analysis revealed that participants accomplished this using several types of parallel association, including lateral association, subtopic escalation, pedagogical pivot, and redirection.

Similar to parallel association, chained explanations commonly used subtopic escalation. Responses focused on explaining a subtopic within a previous message, and this subtopic would then become subject to a series of chained explanations. There were no instances of metatalk in the Allaire and WebCT discussions. Metatalk was used several times in the STS discussion, usually to voice disagreement with ongoing discussion or to express solidarity with others who were in disagreement.

Topic Recovery was used several times in the STS discussion, but was seldom used in the Allaire and WebCT discussions. The salient relations for topic recovery were ANTITHESIS, CONCESSION, and ELABORATION. When used with ANTITHESIS and CONCESSION, topic recovery expressed dissatisfaction with the current topic.

Examination of the progressive character of topic drift focused exclusively on the STS discussions because the diffuse topographies of the Allaire and WebCT discussions afforded little opportunity for topic drift development. In an in-depth examination of an STS thread, the researcher found that through a combination of chained explanations, metatalk and attempts at recovery, discussion moved relentlessly further from its original topic.

Comparative Study

The comparative study examined the rhetorical structures used by participants in the Allaire and WebCT conferencing environments. RST relation use in the Allaire and WebCT messages was similar. In both forums, ELABORATION was most commonly used. Other frequently used RST relations were CONCESSION, BACKGROUND, and EVIDENCE. The overall use of argumentative structures in individual messages was roughly equivalent between the Allaire and WebCT groups. In both of these groups, the argumentative relations most frequently used were ANTITHESIS, CONCESSION, and EVIDENCE. Although the Allaire group tended to be more argumentative than the WebCT group, the inter-message argumentative relation most frequently used in Allaire was EVIDENCE. In the WebCT group, the use of argumentative relations was roughly evenly distributed between EVIDENCE and CONCESSION.

In the Allaire group, less than half of the messages belonged to a thread, with the remainder being posted as singletons. In contrast, most of the messages in the WebCT group were in threads. Further, the Allaire threads were quite short, averaging about three messages in length, with the longest thread containing 10 messages. Many of the threads consisted of a single interaction between two messages. The WebCT threads were somewhat longer, with an average of five messages per thread.

Although the threads in the Allaire group were relatively short, there were occurrences of topic drift. Over half of these were chained explanations, and one-third were parallel associations. The WebCT group, however, preferred parallel association; only about one-third of its topic drift devices were chained explanations. Both groups made extensive use of subtopic escalation. Pedagogical pivot occurred more frequently in the Allaire group than in the WebCT group. The Allaire group seemed to compensate for lower levels of threaded interaction by means of informal intertextuality.

In the Allaire and WebCT discussions, the depth of reference rarely exceeded more than one message. The only occasions when the depth exceeded this were in messages from the instructor, in which she sought to elaborate, evaluate, or summarize previous discussion.

The study also considered overlapping threads as a possible source of interactional incoherence. Overlapping threads occur when the messages comprising multiple threads are intermixed with one another in their presentation to the user, such that the user is left to distinguish which message responds to which (Herring, 1999b; Pincas, 1999). Because both Allaire and WebCT provide strong thread support, messages are organized as threaded structures. Consequently, there were no instances of overlapping threads in the two conferencing systems.

Implications

Generally, this study has shed light the nature and extent of coherence in asynchronous learning environments. It has provided insight into how people interact with one another in these environments, how they argue with one another, and how they manage topics and technology to achieve their objectives. These insights will be of value to researchers and practitioners as a means for understanding interactional coherence and its limitations in asynchronous learning environments. Other implications include benefits for learning theory, natural language processing, and knowledge representation.

Implications for Learning Theory

If, as Hiltz (1986), Harasim (1990), and others have long held, interaction and collaboration are essential to online learning, then coherence is essential to effectiveness of asynchronous discussion. As Lehtinen (2003) has noted, in these environments written communication is the primary means for making the thinking process visible. If these communications lack coherence, this would raise questions as to the supportability of claims that it is by virtue of interaction that learning occurs. Yet, as argued by Lapadat (2001), there remains a need to describe the nature of this interaction. Studies such as those of Herring (1999b) do not identify the specific elements of interactional coherence or describe how these elements may be structured so as to constitute coherence.

This study has taken steps toward remedying that situation. This study has demonstrated the applicability of several theoretical frameworks to asynchronous discussion. These include rhetorical networks, Azar’s concept of argumentative relations, and Hobbes’ theory of topic drift. By showing the applicability of these theories to asynchronous discussion, this research provides a framework and a terminology for fine-grained analysis of interactional coherence.

Implications for Natural Language Processing

Rhetorical structure theory has proven itself a useful and durable tool within the armamentarium of natural language processing (NLP) resources. Originally conceived as a technology for defining semantic structures in automated text generation applications (Hovy, 1988; Mann, 1984), RST has gone on to support a variety of applications. These include text summarization (Burstein & Marcu, 2000), automated explanation generation (Carenini & Moore, 1993; Cawsey, 1995), information retrieval (Fischer, Maier, & Stein, 1994; Maier & Sitter, 1992), and information extraction (S. W. K. Chan, 2006). Of particular pertinence to the potential benefit of this research for NLP is the role RST has played in automatic essay assessment. Using an automated phrase-based discourse parser, Burstein, Marcu, & Knight (2003) built rhetorical structure trees for a collection of student essays. The parser, developed by Marcu (2000), assigns RST rhetorical relations and structural status to sentences. Using this approach, the researchers were able to identify introductory material, main ideas, supporting ideas, and conclusions in the essay corpus. Burstein and Marcu (2000) showed that this technology could be integrated into e-rater, the automated essay scoring system used for the Graduate Management Admissions Test (GMAT). By extending the reach of RST to include asynchronous discussion, the proposed research provides the basis for future convergence of automatic essay assessment technology with the development of technologies for assessing asynchronous discussions.

Implications for Knowledge Representation

Rhetorical networks as described in this research are directed graphs. The nodes of these graphs represent messages, and the edges represent the interrelationships among the nodes; moreover, it is significant that these messages originate from an arbitrary number of agents, and they represent the competing and interacting views of these agents. In this light, a rhetorical network may be seen as a coherent representation of a multi-agent discussion. In other words, rhetorical networks may offer a key element for a general theory for multi-agent knowledge representation. Malrieu (1999) noted that RST relations may be readily expressed in semantic networks, a well established technology for knowledge representation. The contribution here is that the network represents multiple points of view and it is dynamic. This research has shown rhetorical networks to be capable of representing collaboration, argumentation, and topic drift. This is the case, irrespective of whether the messages originate from humans or from software agents. This has several implications for knowledge representation.

The RST relation set offers a natural ontology for constraining the semantic linkage in knowledge representations. That is, if RST can be used to model the semantic structure of knowledge within naturally occurring discourse, it seems likely that it could be used to advantage for artificially constructed knowledge representations. Further, the theory of rhetorical networks described here may support the representation of complex collaborative knowledge structures generated by multi-agent systems. Research by Hulstijn, Dignum, and Dastani (2004) has shown that, like humans, agents are susceptible to problems with interactional coherence. Hulstijn et al. (2004) proposed a scheme using coherence constraint protocols and centralized coherence enforcement to verify agent coherence. The current protocols are limited to concessive negotiations and information exchange, and the use of an enforcement agent for monitoring compliance may have significant implications for both the multi-agent system architecture and the security of agent communications.

It is possible that a more fully developed set of protocols, based on RST, could lead to a richer environment for inter-agent collaboration. Streeter and Potter (2004) developed a knowledge representation language for distributed reasoning in multi-agent systems. This language, called the Knowledge Agent Mediation Language (KNAML) is a conceptual graph language implemented using XML (Sowa, 2000; Streeter & Potter, 2004). The generic multi-agent infrastructure relies on shared ontological constructs defined in KNAML to coordinate inter-agent collaboration (Potter & Streeter, 2002; Streeter & Potter, 2004; Streeter, Potter, & Flores, 2001). If the ontology were extended to implement a meta-model of interactional coherence, it could be used to enrich the interactive capabilities of software agents. Reitter and Stede (2003) have shown how XML may be used as means for annotating RST structures in newspaper texts. By extending RST to encompass multi-party discourse among knowledge-based agents, potential applications would include the provision of transparent agents to support enriched interaction in asynchronous learning environments and other computer supported collaborative applications.

Recommendations for Future Research

The recommendations identified here follow the same pattern as the research implications. They are grouped as recommendations for learning theory, NLP, and knowledge representation.

Recommendations for Learning Theory

One of the findings of this research is that participants use topic drift in order to adapt the discussion to a topic of preference. In other words, topics do not drift so much as they are pushed and pulled. An effect of this process is that threads often begin with a strong research-based opening message, but quickly descend to anecdotes and personal commentary. Another matter for concern is the weakness of argumentation and prevalence of singleton messages. In the STS discussions, arguments were sustained over large numbers of messages and involved many participants. In contrast, argumentation in the Allaire and WebCT discussions involved only a few participants and extended for only a few interactions. This would suggest that future research is needed in the theory and practice of discussion strategy. An approach based on the devices of lateral association, subtopic escalation, pedagogical pivot, and redirection could lead to nuts-and-bolts guidelines that could be of immediate practical value.

This study also found that a small set of relations used to signal agreement and disagreement in asynchronous discussion. From this it was conjectured that a discussion containing a high volume of CONCESSION and ANTITHESIS structures could be predicted to be more disagreeable than one predominated by BACKGROUND, EVIDENCE, and

SUMMARY. The possibility of predicting the ability of asynchronously communicating groups to reach consensus needs more research.

Recommendations for NLP Research

Another area for potential development is in discussion assessment. If the technology developed by Marcu and others for essay assessment could be extended to asynchronous discussions, instructors could use the resulting products as an aid to evaluating student online participation. The application of RST to asynchronous discussions is a step toward realizing this capability. Further steps need to be taken.

Recommendations for Knowledge Representation

Numerous researchers have explored the notion that argumentation theory could be used to motivate the development of technologies for intelligent human-computer and computer-computer collaboration. Among these, Ye (1995) and Ye and Johnson (1995) investigated expert system interaction with human users. They found that a system capable of presenting arguments persuasively is more likely to be regarded as a credible resource for resolving complex issues. Moulin, Irandoust, Bélanger, and Desbordes (2002) maintained that argumentative reasoning strategies could be used to make agents more persuasive and proposed that Perelman and Olbrechts-Tyteca's (1969) analysis of argumentation could be used in this endeavor. Along similar lines Grasso (2002) used rhetorical schemas for modeling argumentative dialogues, with the objective of providing participants with a familiar behavioral model. Wærn and Ramberg (2004) proposed a system that would use Mann and Thompson's (1988) rhetorical structure theory to construct explanation networks and Toulmin's (1958) model to find paths through these networks, resulting in a dual level knowledge system that would support both inferencing and explanation derivation.

Clearly, if the human propensity for argumentation could be imparted to computers, computers could, in turn, be used to engage humans in argumentation and in the complex problem-solving processes enacted through argumentation. What has not emerged from previous studies is a general theory of reasoning for use in human-computer collaboration. For humans and computers to collaborate, they must reason together, and in order to reason together, they must share common ground in rhetoric and argumentation. Having shown how RST can be applied to discussions, it is now time to refine RST as a knowledge representation technology for use by collaborative multi-agent systems. Further research in rhetorical networks as a knowledge representation technology is therefore needed.

Summary

Numerous studies have affirmed the value of asynchronous online communication as a learning resource (e.g. Blanchette, 2001; Harasim, 1990; Hiltz & Wellman, 1997; Meyer, 2003; Reasons et al., 2005; Rovai, 2002). Several investigations, however, have indicated that discussions in asynchronous environments are often neither interactive nor coherent (e.g. Henri, 1992, 1995; Herring, 1999a). This research sought to develop an enhanced understanding of interactional coherence in asynchronous learning environments. The study used Rhetorical Structure Theory (RST) (Mann & Thompson, 1988) to analyze and assess the coherence of a several asynchronous discussions.

The goal of this research was to develop a theoretical understanding of the nature, extent, and limitations of interactional coherence in asynchronous learning environments. Rhetorical structure theory (RST) was used to analyze discussions from two computer conferencing systems and an email debate. The conferencing systems were Allaire Forums and WebCT. The email debate took place on a list devoted to the topic of science, technology, and society (STS). The research included an assessment of the applicability of RST for analysis of asynchronous discussions, an examination of the use of argumentative rhetorical relations in asynchronous discussions, an analysis of topic drift, and a comparative study of interactional coherence in the WebCT and Allaire computer conferencing systems.

The RST analysis showed that asynchronous discussions could be modeled as integrated rhetorical structures. These structures occur on multiple levels. At the first level, individual messages may be analyzed using rhetorical structure theory, rendering collections of structural models, with each representing a contribution to the discussion. At the next level of analysis, structures representing complete threads were produced.

The RST analysis of individual messages showed that most messages readily conformed to the constraints and definitions of rhetorical structure theory; however, there were significant departures, and these departures indicated a quality of coherence that could not be satisfactorily represented using RST. Three such situations were identified. These were identified as *intertextuality*, *subtopic escalation*, and *discourse pivot*. *Intertextuality* refers to the implicit relationships of a message with its predecessors, with the implication that this relationship affects how the text is understood. In the context of this study, this means that the coherence of a message cannot be assessed through analysis of the message alone, but must take into account the context of previous messages in the discussion.

Orthogonal elaboration refers to the use of explicit signaling devices to depart from the focus of the current topic to introduce another aspect of the same topic. In such cases, the elements of a message might be interpreted as ELABORATION satellites of some unmentioned nucleus. *Subtopic escalation* is a tactical device for initiating topic drift by means of advancing some subtopic of the discussion. Finally, one additional category was proposed for messages that are, insofar as the investigator was able to discern, incoherent. This category was called *non sequitur*. Only a few messages fell into this category.

The application of RST to threads showed that discussions evolve and take shape on multiple levels. At the basic level of analysis, any given interaction between two messages can be modeled using RST, and under some circumstances extended threads, consisting of a series of interactions, may conform to the constraints of rhetorical structure theory. However, at a more complex level the thread structures presented significant challenges. Principally, this is because, for any given interaction, the incipient structure is at the discretion of the respondent, without regard for any preexistent structural commitments, and, moreover, any given message may be linked to any other message, provided the two messages were not composed concurrently. A message may at anytime be coerced into becoming a satellite to some new message.

Thread convergence introduced additional complexity into the structure of discussion. Thread convergence occurs when the various elements of a discussion are brought together into a single comprehensive perspective (Ceruzzi, 1991; Hewitt, 2001). In the discussions studied, convergences fell into two categories: *direct* and *general*.

Direct convergence links to its predecessors using rhetorical relations to produce a convergent topical perspective. General convergence provides a broad perspective, but without specifically identifying the messages converged. Direct and general convergences were used with about equal frequency. Further, the study showed that by adding a convergent message to a thread, the structure of the thread could be dramatically altered.

The dynamic character of discussions has important implications for the application of RST. A single instance of coercion, where one message is coerced by another into becoming a satellite, is well within the RST constraints of completeness, connectedness, uniqueness, and adjacency. However, a problem arises when multiple messages coerce some other message into becoming a satellite. In this case, the coerced message becomes satellite to multiple nuclei. This violates the principle of uniqueness. Consequently, for the inter-message analysis it was necessary to relax the uniqueness requirement. In addition, any message may refer to any previous message, regardless of the presence of other intervening messages. A result of this is a loss of structural adjacency. When combined with non-uniqueness, the discussions cannot be represented using conventional RST diagrams. This realization motivated the development of a variant of RST called *rhetorical networks*.

Rhetorical networks are directed graphs. The graph edges are directional, leading from satellite to nucleus. The vertices, or nodes, of the graph represent messages or other semantic units and the edges identify relations between the nodes. A rhetorical network is subject to the constraints of completeness and connectedness. The completeness constraint requires that all nodes be included in the structure. Connectedness requires that all nodes be related, either directly or through some other node. Rhetorical network structures are defined in terms of satellite-nucleus and nucleus-satellite schemas. Relations are associated with specific schema types. These associations are based in part on the implied temporal considerations of the relation and in part on experience in analyzing the asynchronous discussions. Using rhetorical networks, it was possible to create models of each of the threads in the discussions.

Because the Allaire and WebCT messages indicated a high value on matters of agreement, the analysis also examined the rhetorical structures of agreement and disagreement. Some rhetorical relations are useful for expressing agreement, others for disagreement. Relations like ELABORATION or EVIDENCE, which are used to provide additional information about their nuclei, are, by definition, supportive; relations like ANTITHESIS and CONCESSION that indicate a preference for the nucleus over the satellite are used for expressing disagreement. The EVALUATION relation can be used for either agreement or disagreement. That a small subset of relations could be identified as signaling agreement or disagreement is significant because it suggests the possibility of characterizing the agreeableness of discussions based on relation use. A discussion containing a high volume of CONCESSION and ANTITHESIS structures could be predicted to be more disagreeable than one predominated by BACKGROUND, EVIDENCE, and SUMMARY. This might, in turn, support prediction of the ability of asynchronously communicating groups to reach consensus.

The investigation of argumentation included an identification of argumentative structures, an examination of these structures and their dynamics, and comparison of argumentation patterns in the discussion groups. Argumentative structures were identified at both the individual message and inter-message levels. The use of argumentative relations ranged from about 14% in the Allaire Usability discussion to 26% in the STS discussion. Inter-message argumentative structures used only ANTITHESIS, CONCESSION, and EVIDENCE argumentative relations. ANTITHESIS and CONCESSION was used extensively in the STS group, suggesting the dominant mode of interaction in the STS discussion is one of disagreement. EVIDENCE was the preferred inter-message argumentative relation in the Allaire group, while EVIDENCE and CONCESSION were evenly distributed in the WebCT group. In the STS discussions, arguments were sustained over large numbers of messages and involved numerous participants. Disagreements in the Allaire and WebCT arguments involved only a few participants and extended for only a few interactions.

The investigation of topic drift sought to determine whether the devices of topic drift in asynchronous discussions are similar to those of spoken conversation. The topic drift devices included *parallel association*, *chained explanation*, and *metatalk* as defined by Hobbs (1990). The investigation considered whether the use of these devices would manifest themselves in RST analysis. The investigation also considered whether a select subset of RST relations would be used in implementing topic recovery.

Parallel association was used frequently in the discussions. ANTITHESIS and CONCESSION accounted for almost half of the relations used in parallel association. The analysis suggested that there are several types of parallel associations, consisting of *lateral association*, *subtopic escalation*, *pedagogical pivot*, and *redirection*. Lateral association is an association between the main topic of a message and its response. In subtopic escalation, mentioned earlier, the respondent responds to a subtopic within the previous message. Pedagogical pivot entails a deliberate intervention by the instructor to shift the topic into alignment with learning objectives. In topic redirection, the respondent dismisses the previous message and proposes a new approach. Redirection is similar to pedagogical pivot, except that the writer carrying it out is not the course instructor. Redirection was seen only in the STS discussion.

The analysis of parallel association suggested that topic drift does not occur as a matter of chance. Participants used the devices of topic drift to adapt the discussion to a topic of preference. Using parallel association, participants leverage previous discussion as opportunities for posting messages about favorite subjects.

Similar to parallel association, chained explanations commonly used subtopic escalation. Responses focus on explaining a subtopic within a previous message, and this subtopic would then become subject to a series of chained explanations. ELABORATION accounted for almost half of RST relations used in chained explanation. ANTITHESIS, CONCESSION, and EVALUATION were also frequently used.

There were no instances of metatalk in the Allaire and WebCT discussions. Metatalk was used several times in the STS discussion. EVALUATION accounted for one-third of the metatalk relations, and ANTITHESIS accounted for one-third. Other relations used included CONCESSION and ELABORATION. ANTITHESIS and CONCESSION were used to take exception to previous discussion, and ELABORATION was used to continue metatalk from a previous message.

Topic Recovery was used several times in the STS discussion, but not in the Allaire and WebCT discussions. The salient relations for topic recovery were ANTITHESIS, CONCESSION, and ELABORATION. When used with ANTITHESIS and CONCESSION, topic recovery expressed dissatisfaction with the current topic.

Examination of the progressive character of topic drift focused exclusively on the STS discussions because the Allaire and WebCT discussions were not well suited for this portion of the investigations. Their response patterns were typically diffuse, resulting in response patterns that are more wide than deep. These diffuse topographies afforded little opportunity for topic drift development. In an in-depth examination of an STS thread the research found that through a combination of chained explanations, metatalk and attempts at recovery, discussions move relentlessly further from their original topics. An attempted recovery may provide the opportunity for further discourse pivots away from the topic.

The comparative study examined the rhetorical structures used by participants in the Allaire and WebCT environments in an effort to discover how differences in these systems lead to differences in interactional coherence. RST relation use in the Allaire and WebCT messages was similar. The overall use of argumentative structures in individual messages was also roughly equivalent. In both of these groups, the argumentative relations most frequently used were ANTITHESIS, CONCESSION, and EVIDENCE. Although the Allaire group tended to be more argumentative than the WebCT group, the inter-message argumentative relation most frequently used in Allaire was EVIDENCE, indicating that the argumentation tended to be supportive rather than disputative. In the WebCT group, the use of argumentative relations was roughly evenly distributed between EVIDENCE and CONCESSION.

In the Allaire group, less than half of the messages belonged to a thread, with remainder being posted as singletons. In contrast, almost 80% of the messages in the

WebCT group were in threads. Further, the Allaire threads were quite short, averaging about three messages in length, with the longest thread containing 10 messages. Many of the threads consisted of a single interaction between two messages. The WebCT threads were somewhat longer, with an average of five messages per thread.

Although the threads in the Allaire group were relatively short, there were occurrences of topic drift devices. Over half of these were chained explanations, and one-third were parallel associations. The WebCT group however preferred parallel association; a little over one-third of its topic drift devices were chained explanations. Both groups made extensive use of subtopic escalation. Pedagogical pivot occurred more frequently in the Allaire group than in the WebCT group. The Allaire group seemed to compensate for lower levels of threaded interaction by means of informal intertextuality.

In the Allaire and WebCT discussions, the depth of reference rarely exceeded more than one message. The only occasions when the depth exceeded this were in messages from the instructor, in which she sought to elaborate, evaluate, or summarize previous discussion.

Overlapping threads occur when the messages comprising multiple threads are intermixed with one another in their delivery to the user, such that the user is left to distinguish which message responds to which (Herring, 1999b; Pincas, 1999). Because both Allaire and WebCT provide strong thread support, messages are organized as threaded structures. Consequently there were no instances of overlapping threads in the two conferencing systems.

This research has yielded important implications for learning theory, natural language processing, and knowledge representation. By demonstrating the applicability of RST, argumentative analysis, and topic drift analysis to asynchronous discussion, this research provides a framework and a terminology for fine-grained analysis of interactional coherence. By showing the applicability of RST to asynchronous discussion, this study has offered evidence that essay assessment technology could be developed for evaluating the quality of online discussions. The development of rhetorical networks as a graph theory for representing the semantics of asynchronous interaction could lead to a richer knowledge representation technology for inter-agent collaboration.

These implications have, in turn, identified new directions for future research. The insights in intertextuality, argumentation, topic drift, and the structural dynamics of asynchronous discussion indicate that additional research is needed in the theory and practice of asynchronous discussion strategy. In NLP, further research is necessary to develop the ability to apply essay assessment technology to asynchronous discussions. Additional research is needed to refine RST as a knowledge representation technology for use by collaborative multi-agent systems. Thus, while this research has generated useful results, it has also opened the door on a number of additional research problems.

Appendix A

RST Relations

Binary Relations

ANTITHESIS *(Mann & Thompson, 1988, p. 253)*

Relation Name	ANTITHESIS
Constraints on Nucleus	Writer has positive regard for the situation presented in Nucleus
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	The situations presented in Nucleus and Satellite are in contrast; because of an incompatibility that arises from the contrast, one cannot have positive regard for both the situations presented in Nucleus and Satellite; comprehending Satellite and the incompatibility between the situations increases Reader's positive regard for the situation presented in Nucleus
The Effect	Reader's positive regard for Nucleus is increased
Locus of Effect	Nucleus

Appendix A (Continued)

BACKGROUND (Mann & Thompson, 1988, p. 273)

Relation Name	BACKGROUND
Constraints on Nucleus	Reader won't comprehend Nucleus sufficiently before reading text of Satellite
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite increases the ability of Reader to comprehend an element in Nucleus
The Effect	Reader's ability to comprehend Nucleus increases
Locus of Effect	Nucleus

Appendix A (Continued)

CIRCUMSTANCE (Mann & Thompson, 1988, p. 272)

Relation Name	CIRCUMSTANCE
Constraints on Nucleus	Satellite presents a situation (not unrealized)
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite sets a framework in the subject matter within which Reader is intended to interpret the situation presented in Nucleus
The Effect	Reader recognizes that the situation presented in Satellite provides the framework for interpreting Nucleus
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

CONCESSION (Mann & Thompson, 1988, p. 254)

Relation Name	CONCESSION
Constraints on Nucleus	Writer has positive regard for the situation presented in Nucleus
Constraints on Satellite	Writer is not claiming that the situation presented in Satellite does not hold
Constraints on the Nucleus + Satellite Combination	Writer acknowledges a potential or apparent incompatibility between the situations presented in Nucleus and Satellite; Writer regards the situations presented in Nucleus and Satellite as compatible; recognizing that the compatibility between the situations in Nucleus and Satellite increases reader's positive regard for the situation presented in Nucleus
The Effect	Reader's positive regard for the situation presented in Nucleus is increased
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

CONDITION (Mann & Thompson, 1988, p.276)

Relation Name	CONDITION
Constraints on Nucleus	None
Constraints on Satellite	Satellite presents a hypothetical, future, or otherwise unrealized situation (relative to the situational context of Satellite)
Constraints on the Nucleus + Satellite Combination	Realization of the situation presented in Nucleus depends on realization of that presented in Satellite
The Effect	Reader recognizes how the realization of the situation presented in Nucleus depends on the realization of the situation presented in Satellite
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

ELABORATION (Mann & Thompson, 1988, p. 273)

Relation Name	ELABORATION
Constraints on Nucleus	None
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite presents additional detail about the situation or some element of subject matter, which is presented in Nucleus or inferentially accessible in Nucleus in one or more of the ways listed below. In the list, if Nucleus presents the first member of any pair, the S includes the second: 1. set : member 4. process : step 2. abstract : instance 5. object : attribute 3. whole : part 6. generalization : specific
The Effect	Reader recognizes the situation presented in Satellite as providing additional detail for Nucleus. Reader identifies the element of subject matter for which detail is provided
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

ENABLEMENT (Mann & Thompson, 1988, p. 274)

Relation Name	ENABLEMENT
Constraints on Nucleus	Presents Reader action (including accepting an offer), unrealized with respect to the context of Nucleus
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Reader comprehending Satellite increases Reader's potential ability to perform the action presented in Nucleus
The Effect	R's potential ability to perform the action presented in N increases
Locus of Effect	Nucleus

Appendix A (Continued)

EVALUATION *(Mann & Thompson, 1988, p. 277)*

Relation Name	EVALUATION
Constraints on Nucleus	None
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite relates the situation in Nucleus to degree of Writer's positive regard toward the situation presented in Nucleus
The Effect	Reader recognizes that the situation presented in Satellite assesses the situation presented in Nucleus and recognizes the value it assigns
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

Evidence (Mann & Thompson, 1988, p. 251)

Relation Name	Evidence
Constraints on Nucleus	Reader might not believe Nucleus to a degree satisfactory to Writer
Constraints on Satellite	Reader believes Satellite or will find it credible
Constraints on the Nucleus + Satellite Combination	Reader's comprehending of Satellite increases Reader's belief of Nucleus
The Effect	Reader's belief of Nucleus is increased
Locus of Effect	Nucleus

Appendix A (Continued)

INTERPRETATION (Mann & Thompson, 1988, p. 277)

Relation Name	INTERPRETATION
Constraints on Nucleus	None
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite relates the situation presented in Nucleus to a framework of ideas not involved in Nucleus itself and not concerned with Writer's positive regard
The Effect	Reader recognizes that Satellite relates the situation presented in Nucleus to a framework of ideas not involved in the knowledge presented in Nucleus itself
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

JUSTIFY (Mann & Thompson, 1988, p. 252)

Relation Name	JUSTIFY
Constraints on Nucleus	None
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Reader's comprehending satellite increases Reader's readiness to accept Writer's right to present Nucleus
The Effect	Reader's readiness to accept Writer's right to present Nucleus is increased
Locus of Effect	Nucleus

Appendix A (Continued)

MEANS (Mann & Taboada, 2006)

Relation Name	MEANS
Constraints on Nucleus	An Activity
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite presents a method or instrument which tends to make realization of Nucleus more likely
The Effect	Reader recognizes that the method or instrument in S tends to make realization of Nucleus more likely
Locus of Effect	Nucleus

Appendix A (Continued)

MOTIVATION (Mann & Thompson, 1988, p. 274)

Relation Name	MOTIVATION
Constraints on Nucleus	Presents an action in which Reader is the actor (including accepting an offer), unrealized with respect to the context of Nucleus
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Comprehending Satellite increases Reader's desire to perform action presented in Nucleus
The Effect	Reader 's desire to perform action presented in Nucleus is increased
Locus of Effect	Nucleus

Appendix A (Continued)

NONVOLITIONAL-CAUSE (Mann & Taboada, 2006; Mann & Thompson, 1988, p. 275)

Relation Name	NONVOLITIONAL-CAUSE
Constraints on Nucleus	Presents a situation that is not a volitional action
Constraints on Satellite	A situation which causes Nucleus, but not anyone's deliberate action
Constraints on the Nucleus + Satellite Combination	Satellite presents a situation that, by means other than motivating a volitional action caused the situation presented in Nucleus; without the presentation of Satellite, Reader might not know the particular cause of the situation; a presentation of Nucleus is more central than Satellite to Writer's purposes in putting forth the Nucleus-Satellite combination.
The Effect	Reader recognizes the situation presented in Satellite as a cause of the situation presented in Nucleus
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

NONVOLITIONAL-RESULT (Mann & Thompson, 1988, pp. 275-276)

Relation Name	NONVOLITIONAL-RESULT
Constraints on Nucleus	None
Constraints on Satellite	Presents a situation that is not a volitional action
Constraints on the Nucleus + Satellite Combination	Nucleus presents a situation that caused the situation presented in Satellite; presentation of Nucleus is more central to Writer's purpose in putting forth the Nucleus-Satellite combination than is the presentation of Satellite.
The Effect	Reader recognizes that the situation presented in Nucleus could have caused the situation presented in Satellite
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

OTHERWISE (Mann & Thompson, 1988, pp. 276-277)

Relation Name	OTHERWISE
Constraints on Nucleus	Presents an unrealized situation
Constraints on Satellite	Presents an unrealized situation
Constraints on the Nucleus + Satellite Combination	Realization of the situation presented in Nucleus prevents realization of the situation presented in Satellite
The Effect	Reader recognizes the dependency relation of prevention between the realization of the situation presented in N and the realization of the situation presented in Satellite. Satellite may be an action or situation whose occurrence results from the lack of occurrence of the conditioning situation.
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

Preparation (Mann & Taboada, 2006)

Relation Name	Preparation
Constraints on Nucleus	None
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite precedes Nucleus in the text; Satellite tends to make Reader more ready, interested or oriented for reading Nucleus
The Effect	R is more ready, interested or oriented for reading N
Locus of Effect	Nucleus

Appendix A (Continued)

PURPOSE (Mann & Thompson, 1988, p. 276)

Relation Name	PURPOSE
Constraints on Nucleus	Presents an activity
Constraints on Satellite	Presents a situation that is unrealized
Constraints on the Nucleus + Satellite Combination	Satellite presents a situation to be realized through the activity in Nucleus. In other words, Satellite is the purpose of Nucleus.
The Effect	Reader recognizes that the activity in Nucleus is initiated in order to realize Satellite
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

RESTATEMENT (Mann & Thompson, 1988, p. 277)

Relation Name	RESTATEMENT
Constraints on Nucleus	None
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite restates Nucleus, where Satellite and Nucleus are of comparable bulk
The Effect	Reader recognizes Satellite as a restatement of Nucleus
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

SOLUTIONHOOD (Mann & Thompson, 1988, pp. 272-273)

Relation Name	SOLUTIONHOOD
Constraints on Nucleus	None
Constraints on Satellite	Satellite presents a problem. The problem may be a question, request, problem, or other expressed need.
Constraints on the Nucleus + Satellite Combination	The situation presented in Nucleus is a solution to the problem stated in Satellite
The Effect	Reader recognizes the situation presented in Nucleus as a solution to the problem presented in Satellite
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

SUMMARY (Mann & Thompson, 1988, pp. 277-278)

Relation Name	SUMMARY
Constraints on Nucleus	Nucleus must be more than one unit
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite presents a restatement of the content of Nucleus that is shorter in bulk
The Effect	Reader recognizes Satellite as a shorter restatement of Nucleus
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

UNCONDITIONAL (Mann & Taboada, 2006)

Relation Name	UNCONDITIONAL
Constraints on Nucleus	None
Constraints on Satellite	Satellite conceivably could affect the realization of Nucleus
Constraints on the Nucleus + Satellite Combination	Nucleus does not depend on Satellite
The Effect	Reader recognizes that Nucleus does not depend on Satellite
Locus of Effect	Nucleus

Appendix A (Continued)

UNLESS (Mann & Taboada, 2006)

Relation Name	UNLESS
Constraints on Nucleus	None
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite affects the realization of Nucleus; Nucleus is realized provided that S is not realized
The Effect	Reader recognizes that Nucleus is realized provided that Satellite is not realized
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

Volitional-cause (Mann & Thompson, 1988, pp. 274-275)

Relation Name	Volitional-cause
Constraints on Nucleus	Presents a volitional action or else a situation that could have arisen from a volitional action
Constraints on Satellite	None
Constraints on the Nucleus + Satellite Combination	Satellite presents a situation that could have caused the agent of the volitional action in Nucleus to perform that action; without the presentation of Satellite, Reader might not regard the action as motivated or know the particular motivation; Nucleus is more central to Writer's purposes in putting forth the Nucleus-Satellite than Satellite is.
The Effect	Reader recognizes the situation presented in Satellite as a cause for the volitional action presented in Nucleus
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

VOLITIONAL-RESULT (Mann & Taboada, 2006; Mann & Thompson, 1988, p. 275)

Relation Name	VOLITIONAL-RESULT
Constraints on Nucleus	None
Constraints on Satellite	Presents a volitional action or a situation that could have arisen from a volitional action.
Constraints on the Nucleus + Satellite Combination	Nucleus presents a situation that could have caused the situation presented in Satellite; the situation presented is more central to Writer's purposes than is presented in Satellite
The Effect	Reader recognizes that the situation presented in Nucleus could be a cause for the action or situation presented in Satellite
Locus of Effect	Nucleus and Satellite

Appendix A (Continued)

Multi-Nuclear Relations

CONJUNCTION *(Mann & Taboada, 2006)*

Relation Name	CONJUNCTION
Constraints on Nucleus	Multi-nuclear
Constraints on Combination of Nuclei	The items are conjoined to form a unit in which each item plays a comparable role
The Effect	Reader recognizes that the linked items are conjoined
Locus of Effect	Multiple nuclei

Appendix A (Continued)

CONTRAST (Mann & Taboada, 2006; Mann & Thompson, 1988, p. 278)

Relation Name	CONTRAST
Constraints on Nucleus	Multi-nuclear
Constraints on Combination of Nuclei	No more than two nuclei; the situations in these two nuclei are (a) comprehended as the same in many respects (b) comprehended as differing in a few respects and (c) compared with respect to one or more of these differences
The Effect	Reader recognizes the comparability and the difference(s) yielded by the comparison is being made
Locus of Effect	Multiple nuclei

Appendix A (Continued)

Disjunction (Mann & Taboada, 2006)

Relation Name	DISJUNCTION
Constraints on Nucleus	Multi-nuclear
Constraints on Combination of Nuclei	Writer claims that at least one of the nuclei are true
The Effect	Reader recognizes that the writer claims at least one of the nuclei are true
Locus of Effect	Multiple nuclei

JOINT (Mann & Taboada, 2006; Mann & Thompson, 1988, pp. 278-279)

Relation Name	JOINT
Constraints on Nucleus	Multi-Nuclear
Constraints on Combination of Nuclei	None
The Effect	JOINT represents the lack of a rhetorical relation between the nuclei
Locus of Effect	Multiple nuclei

Appendix A (Continued)

LIST (Mann & Taboada, 2006)

Relation Name	LIST
Constraints on Nucleus	Multi-Nuclear
Constraints on Combination of Nuclei	An item comparable to others linked to it by the List relation
The Effect	R recognizes the comparability of linked items
Locus of Effect	Multiple nuclei

Multi-nuclear RESTATEMENT (Mann & Taboada, 2006)

Relation Name	RESTATEMENT-MN (Multi-Nuclear)
Constraints on Nucleus	Multi-Nuclear
Constraints on Combination of Nuclei	An item is primarily a re-expression of one linked to it; the items are of comparable importance to the purposes of Writer
The Effect	R recognizes the re-expression by the linked items
Locus of Effect	Multiple nuclei

SEQUENCE (Mann & Taboada, 2006; Mann & Thompson, 1988, p. 278)

Relation Name	SEQUENCE
Constraints on Nucleus	multi-nuclear
Constraints on Combination of Nuclei	A succession relationship between the situations is presented in the nuclei
The Effect	Reader recognizes the succession relationships among the nuclei
Locus of Effect	Multiple nuclei

Appendix B

IRB Approval

NSU

MEMORANDUM

To: Andrew Potter

From: James Cannady, Ph.D.
Institutional Review Board

Signature

Date: November 15, 2005

Re: *An Investigation of Interactional Coherence in Asynchronous Learning Environments*

IRB Approval Number: cannady11150502

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1) CONSENT: If recruitment procedures include consent forms these must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE REACTIONS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and 954-262-2085 respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Protocol File
Office of Grants and Contracts (if study is funded)

3301 College Avenue • Fort Lauderdale, FL 33314-7796 • (954) 262-5369
Fax: (954) 262-3977 • Email: *inga@nsu.nova.edu* • Web site: www.nova.edu/cwis/ogc

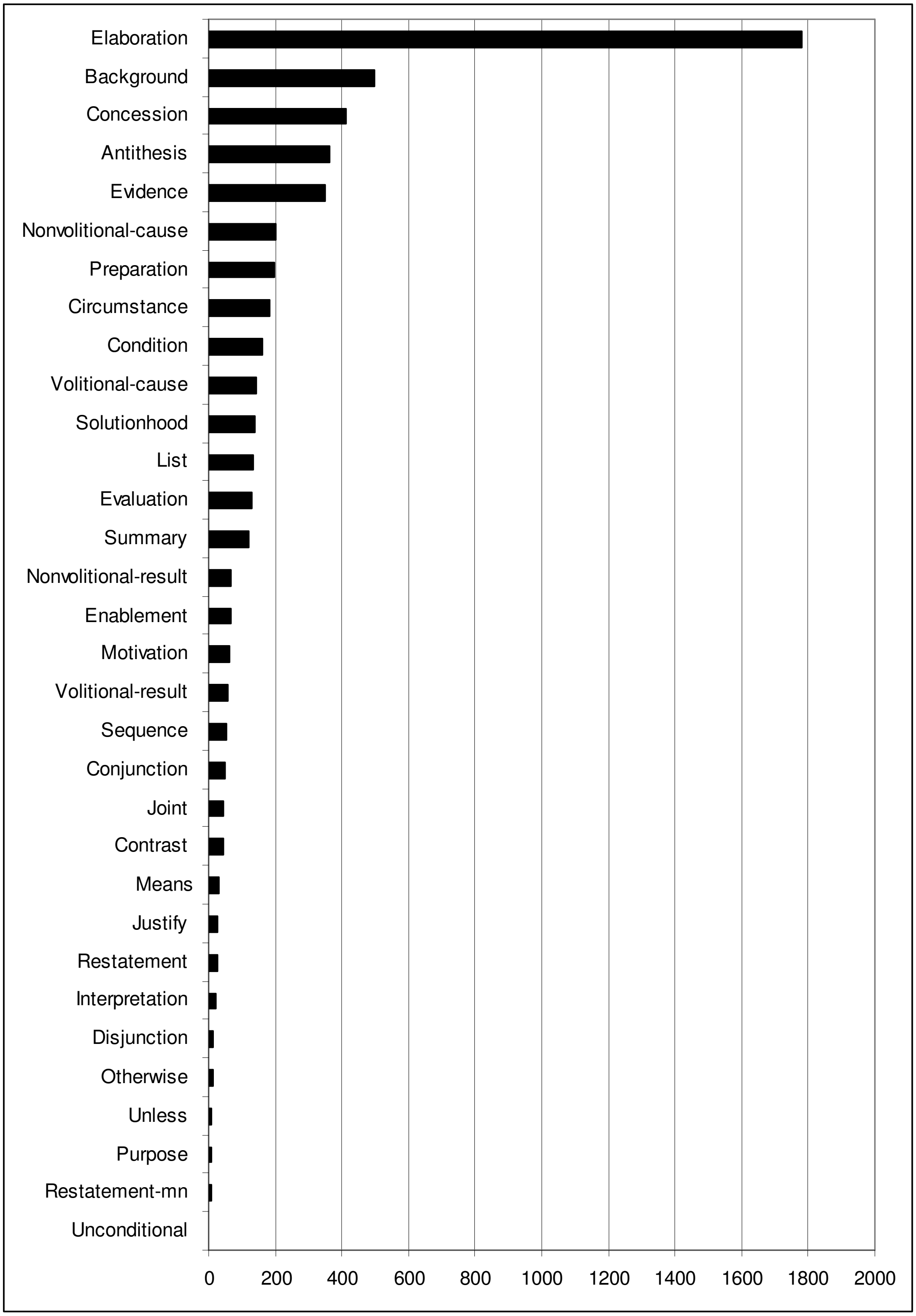
Appendix C

Message Segmentation Parameters

Group	Discussion	Messages	Segments	Average	Min	Max
Allaire	Intuitiveness	35	365	10.4	2	26
	Usability Concepts	53	513	9.7	2	37
	HCI and the Web	39	341	8.7	1	51
WebCT	Intuitiveness	61	588	9.6	1	30
	Usability Concepts	73	630	8.6	1	28
	HCI and the Web	62	564	9.1	1	30
STS	STS Under Attack	152	3130	20.9	1	85
Total		475	6131	12.9	1	85

Appendix D

Relative Frequency of RST Relation Use in Individual Messages



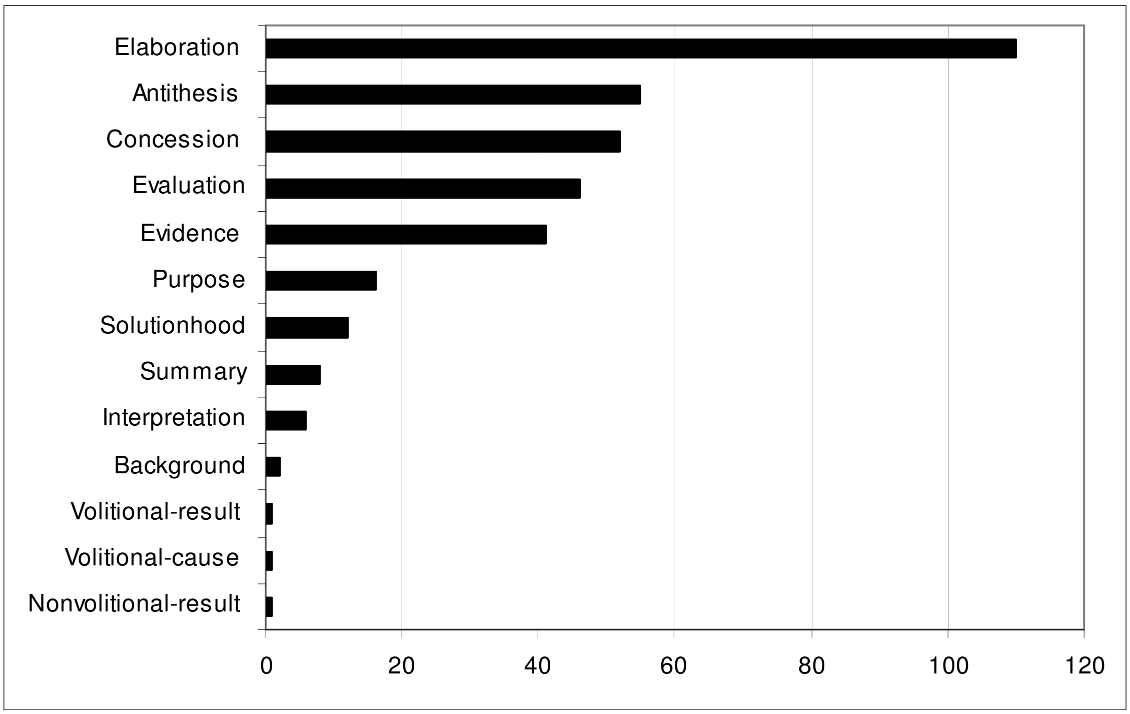
Appendix E

Joint Typology Usage in all Discussions

JOINT Type	Messages	Percentage
Intertextuality	29	61.7%
Orthogonal Elaboration	12	25.5%
Subtopic Escalation	2	4.3%
Non Sequitur	4	8.5%
Total	47	100.0%

Appendix F

Inter-Message Relation Use



Appendix G

Direct and General Convergences

Group	Direct	General	Total	Percent
Allaire	1	1	2	1.6
WebCT	4	3	7	3.6
STS	16	14	30	19.7
Total	21	18	39	8.2

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