

# The Effects of Response Time on Student Interactions and Online Discussions

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## Introduction

Computer-mediated communication (CMC) is widely used to support distance learning (Harasim 1993; Berge 1997) in ways that apply principles of constructivist learning (Muilenburg & Berge 2000), emphasizing social interaction and learning processes (Driscoll 2000). One of the most commonly accepted assumptions and an often-touted advantage of asynchronous online discussions is that participation is *time* independent (Harasim, 1993) because distance learners are able to read, reflect, compose and post responses at their own time and convenience. Given that students are free to choose *when* to post to a discussion, what needs to be determined is whether or not this freedom imposes any unanticipated constraints on students' ability to sustain and constructively contribute to the growth of discussion threads, and more specifically, constraints on *what* types of messages students can post or should be encouraged to post to maintain active and meaningful discussion threads.

Hewitt and Teplovs (1999) found that discussion threads were most likely to remain active when replies were posted to the thread within a day of the most recent posting. Responses posted to a thread within a 24-hour period resulted in a .26 to .63 probability of remaining active, depending on the number of existing messages in the current thread. After one day of inactivity, the odds of maintaining an active thread dropped to .18 to .41. After two days of inactivity, the odds dropped further to .12 to .31. As a result, threads were more likely to die with increasing number of days of inactivity. One explanation for this finding is that students also initiate new discussion threads with each passing day, and as a result, messages in earlier threads are less likely to receive the responses that are needed to keep the threads alive (Hewitt, 2003). Although Hewitt demonstrated that the death of a thread can be unintentional and brought on by the asynchronous nature of online threaded discussions, Hewitt acknowledged that other factors can also affect the life of a discussion thread. For example, the life of a thread can be affected by the content of the discussions and its ability to capture the interest of its readers, and the extent to which its questions and issues have been explored, challenged and resolved.

The purpose of this study was to measure the effects of response time in relationship to the effects of message content in asynchronous online discussion threads. The content of messages was examined in terms of cognitive events prescribed in models of critical thinking (Gunawardena, 1997; Garrison, 1992) and argumentation (Cerbin, 1988). To measure how response time and message content affected response rates, the method of event sequence analysis (Bakeman & Quera, 1995; Bakeman & Gottman, 1997) was used

to examine response rates and response time in relationship to types of message content such as arguments, supporting evidence, criticisms, elaboration, evaluation and other process comments. Using this method, the following questions were addressed in this study:

1. *Response Rates* - What is the average *response rate* for each particular type of message? For example, is a critical response or disagreement more likely to elicit a response than a simple agreement or elaboration?
2. *Wait Time* - Does the content of a message affect the amount of time it takes to elicit a response? For example, is the wait time for a response to an argument shorter than the wait time for a response to a criticism?
3. *Response Time* - Does the amount of time one takes to post a particular type of message affect the message's ability to elicit a follow-up response? In other words, does the response rate of a specific type of message vary with the amount of time one takes to post the message?

## **Method**

***Participants.*** The participants were 19 graduate students from a major university in the Southeast region of the U.S., consisting of 8 females and 11 males, ranging in ages from 24 to 49. The students were enrolled in an online course on theories of learning and cognition.

***Topics of the Online Debates.*** The topics were related to the assumptions of a particular learning theory for any given week and were based on reading assignments, lectures and support materials for the course. Examples of discussion topics were "Knowledge cannot be instructed (transmitted) by a teacher - it can only be constructed by the learner." Or "Schema theory is more of a constructivist theory than a cognitive theory".

***Online Debate Procedures.*** Each week students were randomly assigned to one of 2 mixed-gender debate teams. In the random assignments to teams, students were balanced by gender and the level of weekly participation in discussions earlier in the course. Each team was then assigned to take the position of either being *for* a given topic/statement (Supporting Team) or *against* the topic/statement (Opposing Team). Students were instructed to support only their team position with arguments, evidence, critiques and evaluation of opposing arguments, and to critique the messages posted by the opposing team. Students were required to post a minimum of four messages to support their team position in order to receive full credit for each weekly debate. Twenty-five percent of the course grade was rewarded for participation in the weekly discussions and debates.

Students were also required to identify their messages by event category by inserting designated labels into the message subject headings when posting to the threaded discussions. The labels consisted of nine possible event categories which included

position statements, arguments to support their assigned position, evidence to support stated arguments, criticisms of opposing arguments, elaboration, asking questions, and judgments for drawing conclusions, and evaluation. The Other category was used for comments not related to any of the above categories. Each label had to be followed by an additional tag, *o* = opposing team or *p* = supporting team, to identify team membership (see figure 1). The student labeling procedure was implemented in order to assure that each message addressed one and only one category at a time in order to establish a clear unit of analysis. This self-labeling procedure also was intended to facilitate the collection and coding of large data sets needed to generate sufficient cell sizes required in conducting event sequence analysis.

### **Data Sources & Analysis**

***Messages & Event Codings.*** The discussions were drawn from five online debates completed midway into the semester. The five debates generated a total of 565 messages for analysis. Because the students' message labels were used to identify the content of each message, inter-rater reliability was examined by comparing the student's self-codings with the codings of the experimenter. The inter-rater reliability was found to be fairly reliable at Cohen's Kappa 0.68.

***Data Analyses.*** Two computer programs, *Forum Manager* and *Discussion Analysis Tool*, were developed to automatically download the threaded discussions directly into Microsoft Excel, format and compile event and response time data, identify the events and event sequences within the threaded discussions, compute the frequencies of events and paired events, the event sequence probabilities and response times, and Z-scores to determine which sequences occurred at rates significantly higher or lower the expected probability (Bakeman and Gottman, 1997). See example screen shot in Figure 2. See <http://bbproject.tripod.com> to download a prototype of ForumManager.

To reduce the number of possible event sequences ( $18 \times 18 = 324$ ) to a more manageable size, the number of response categories was collapsed to 12 in order to ensure sufficient cell frequencies for conducting the event sequence analysis. The event category Position Statements was collapsed with the Arguments category because position statements were almost always presented with supporting arguments. The category Questions was collapsed into Elaboration because most questions were raised to request additional elaborative information. Finally, Judgment was collapsed with Evaluation given that Judgments were rarely stated and were very difficult to separate from evaluation statements. To further simplify the analysis, the labels identifying team membership were removed to collapse the coded messages between opposing teams, leaving a total of six event categories for the final analysis.

***Theoretical Framework.*** The theoretical basis for examining group interactions in terms of event sequences and response times are drawn from the assumptions and theory of dialogism (Bakhtin, 1981; Koschmann, 1999). The assumption is that language is to be viewed as part of a larger whole or social context in which all possible meanings of a word interact, possibly conflict, and affect future meanings. Meaning is produced not by examining an utterance by itself, but by examining the relationship between utterances. Meaning is therefore renegotiated and reconstructed as a result of *conflict* in social

interactions, which drives inquiry, reflection, articulation of individual viewpoints and underlying assumptions.

Under these assumptions, this study focused not on the analysis of messages in isolation (as one does in content analysis), but instead, this study focused on the relationship and transitions between threaded messages in online discussions with respect to message content and response times. As a result, *interaction* was operationally defined as a two-event sequence composed of given messages and a subsequent target response. The types of interactions that were of most interest were centered on cognitive conflict, which was believed to be essential in driving discussion threads.

## Results

**Response Rates.** The event sequence analysis produced the transitional probabilities between messages and responses across event categories displayed in Table 1. The table shows for example that an argument elicited a total of 145 responses. Of these responses, 26% were additional arguments, 19% were supporting evidence, 28% were criticisms, and only 9% were evaluations of the arguments. Of the 150 arguments observed in the discussions, 49 of them did not receive a response, or conversely, 67% of the posted arguments were successful in eliciting a response.

The messages that generated the highest response rates were criticism (.72) and arguments (.67). The messages that were least likely to elicit a response were ‘other’ comments (.40), evidence (.54), and evaluative responses (.54). The response rates were .67 for arguments, .54 for evidence, .72 for criticisms, .65 for elaborations, .54 for evaluations, and .40 for other process comments. The high response rate to criticism is consistent with the theoretical assumption that conflict in message-response exchanges drives the processes of inquiry and critical discourse.

The overall response rate in the online debates was .59, given that there was a total of 226 messages that received no replies out of the total of 565 posted messages. This overall response rate was a high response rate relative to Hewitt’s (1999) finding that threads had only a .26 to .63 probability of remaining active when responses are received within a day’s time, with substantially lower probabilities with longer wait times. One possible explanation for the high response rates was that the discussions were structured within a debate format where opposing teams were expected to respond, critique and post rebuttals.

**The Effects of Wait Time.** Table 1 also displays the average wait times for each response category. The overall average wait time (the time one must wait for a response to a given type of message) across all response categories was .82 days (st.dev. = 1.04). The average wait time for a response was .99 days for posted arguments, .96 days for evidence, 1.04 days for criticisms, .68 days for elaborations, .74 days for evaluations, and .50 days for other and process comments.

The longest wait time was observed when waiting for responses to criticisms (1.04 days), which is counter intuitive given that criticism was also found to generate the

highest response rates (.72). This finding contradicts Hewitt's finding that longer response times results in lower response rates. A possible explanation for this contradictory finding is that students in the debates were expected if not highly motivated to rebuke criticisms posed by the opposing team. At the same time, it is also possible that students required more time to reflect and carefully compose their rebuttals. This particular finding suggests that there are times when the content of messages rather than response time can have a greater impact on response rates.

A graph of the messages and threads charted across time (see Figure 3) indicate that by and large discussion threads were sustained by responses that were posted in relatively short wait time – particularly where there were sudden spurts of discussion and activity. For example, the message in the first thread did not receive a reply until four days later. As a result of this long wait time, no responses were posted after day four to sustain the discussion thread. On the other hand, the graph also reveals particular instances where threads were able to remain active despite the presence of one or more substantially long wait times. For example, message #5 initiated a thread that ultimately generated a total of 12 responses. In this thread, there was a 2.5 days wait time before a response was posted to the opening message. There was also another 2.5 day wait time for a response to the third message in the thread. But after the fifth day, there was a rapid increase in activity in the discussion thread. A close examination of the text indicated that the first three messages were able to sustain the thread, despite the long wait times, because the opposing teams were exchanging counter-arguments (ARGo → ARGs → ARGo). This series of challenges set the stage for further discussion and illustrates the significant impact of content, particularly content that generates conflict, in keeping a thread active.

The wait times for responses to criticisms were compared and tested against the wait times for responses to the other five response categories. The wait time for a response to a posted criticism was not significantly different from the wait time following the posting of arguments, evidence and evaluation. A possible explanation for the similarity in wait times following arguments and evidence is that these two particular types of messages were more susceptible to criticisms than elaborative and other process messages. The z-scores in Table 2 indicate that critical responses to arguments (Z-score = 3.10, alpha = .05 n = 40) and evidence (Z-score = 2.12, alpha = .05, n = 18) were significantly higher than the expected frequency. In essence, arguments, evidence and criticisms appear to be the main interactions found in students' critical discourse and argumentation.

In contrast, the wait time of .68 days for responses to elaborative messages was significantly shorter than the wait time of 1.04 days for responses to criticisms (T-test = 0.038, alpha = .05). In addition, the wait time of .50 days for Other comments concerning process was also significantly shorter than the wait time following criticisms (T-test = .005, alpha = .05). One possible explanation for the significantly shorter wait times for elaboration and other comments is that these types of responses did not require as much detail, effort and carefully formulated responses as required to post arguments, supporting evidence and criticism.

**Effects of Response Time.** The overall mean response time (the time it takes to reply with a given type of response) across all categories was .88 days. The mean amount of time used to respond to a previous message was .94 days when responding with arguments, .98 days with evidence, .96 days with criticisms, .96 days with elaboration, .74 days with evaluations, and .67 days when responding with other comments.

In order to determine if response time had different effects on response rates for each response category, the response rates were computed for each response category within fixed time intervals (see Table 3). For example, .68 of the forty arguments posted as a response within the first 12 hours (between 0.0 and 0.5 days) were able to elicit a responding message. The response rates to posted arguments fell rapidly as the response times for posting the arguments increased, starting from .68 and dropping steadily to .50, .29 and .43. Criticism received a response rate of .84 when posted and responding to a previous message within 0.5 days. Its response rates also dropped steadily with increasing response times, from .84 to .71, .56, and .56.

The results from Table 3 were converted into a graphical representation (see Figure 4). The response rates of messages posted after 1.5 days were not included in the graph given that the cell frequencies were less than five for most of the responses posted with response times greater than 1.5 days. Bakeman & Gottman (1995) recommend that cell with frequencies of less than five should be excluded from analysis when examining interaction data in order to avoid instability in the observed interaction patterns. Figure 4 shows that the impact of response time did not change as a result of the message content. In other words, none of the response categories were able to sustain a steady response rate regardless of response time. However, the graph does show that Criticism and Elaborative responses were generally able to generate high response rates. As a result, their response rates did not theoretically approach zero percent until 2.0 to 2.5 days in response time when projecting the graphs ahead into longer response times. As a result, criticisms and elaborations are essential to helping groups sustain a discussion thread when longer response times are anticipated.

## **Discussion**

The purpose of this study was to re-examine how response time affects students' ability to engage in active discussion threads, and to determine to what extent online discussions are truly asynchronous and free from the constraints of time. Hewitt and Teplovs' (1999) findings indicate that the odds of eliciting responses in a discussion thread decreases as response time and wait time increase, therefore implying that online discussions are not as asynchronous as we believe them to be. The aim of this study was to determine the relationship between the effects of response time and the effects of message content on response rates in order to test and re-examine some of Hewitt's findings. Using event sequence analysis and the technique of student-labeled messages, this study was able to successfully test the effects of response time across different response categories. The results of the tests produced some evidence to contradict Hewitt's claim that response rates increase with shorter wait and response times. The

results of this study indicate that criticism and other confrontational interactions tended to elicit higher rates of responses and that their response rates were less dependent or less affected by the amount of time it took to post them. The findings in this study demonstrate that particular types of interactions and discussion structures can contribute significantly to making online discussions more asynchronous and time independent.

A number of reasons explain why some of the results in this study contradict Hewitt's findings – some of which will carry instructional implications. The discussions examined in this study were generated in the context of five debates between two opposing teams. This context set the stage for encouraging adversarial interactions than other types of discussion formats. In other formats, the goal of discussions might be to negotiate and converge towards consensus, or the goal might simply be to brainstorm ideas and share information while withholding criticism. A second reason for the differences in findings might be attributed to the use of student-labeled messages. The example discussion in Figure 2 illustrates how the labels allowed students to easily and quickly locate where the issues, challenges and disagreements lie within and between discussion threads. The ability to quickly scan and search for criticisms (e.g. CRITo or CRITs) posted by the opposition and the ability to locate multiple counter-exchanges between opposing teams (e.g. ARGo → CRITs → CRITo → EVIDs) can also bring a thread back to the attention of students and help to keep the thread active. At this time, the author is conducting an experimental study to test the effects of message labeling (versus no message labeling) on group interaction and the growth of discussion threads.

To continue exploring the effects of response time, further research is needed to substantiate and test some of the findings and claims reported in this study. Larger data sets will be needed to generate sufficient cell frequencies to examine the impact of longer response times. In figure 4, the response rates could only be examined across responses posted between 0.0 and 1.5 days. Examining the response rates at 1.5 days and longer will make it possible to determine where response rates bottom out, and whether or not it is possible to increase the base response rate. The software tools created in this study, ForumManager and DAT, combined with the techniques of student-labeled messages will enable researchers to collect and analyze ever larger data sets to generate more rigorous and empirical-based findings.

Furthermore, the effects of both response time for posting the responding message *and* the average wait time for a response to the initial message must also be examined in order to fully understand which message-response exchanges are most likely to sustain a discussion thread – particularly exchanges where the relationship between the message and response are more adversarial or less adversarial. For example, Table 1 shows that the average wait time for a response to a criticism was 1.04 days. If the response to the criticism is an elaborative message which take only .76 days to post as a response, what must be determined is the actual wait time in a criticism-elaboration exchange and the ability of this exchange to elicit further discussion. To determine the response times for specific message-response exchanges and how likely they are to elicit yet another response, a transitional probability matrix for three-event sequences must be computed (see Table 4). In order to generate this matrix, however, larger data sets are needed once

again in order to generate sufficient cell frequencies for the exponentially growing number of possible event pairings.

Some other questions and issues that require further investigation might include the following:

- 1) What is the effect of content on response rates when message labels are used versus when they are not used?
- 2) When labels are used, how does the ability to see the relationships between messages (and not just the content of a single message or response) or the “multiple counter-exchanges between the opposition” captivate the attention of students and engage them in developing a discussion threads?
- 3) How do response rates and message content change across other discussion formats or models beside the debate formats and critical thinking model used in this study?
- 4) For each discussion format, what specific types of messages should be encouraged to maximize student interaction and growth in discussion threads?
- 5) How do these factors ultimately affect learning outcomes or the quality of discussion threads?
- 6) Using the methods outlined in this study to measure and *discriminate* the effects of response time and message content, what are the differences in group interaction in asynchronous versus synchronous versus face-to-face discussions given that the available time for delivering a response is one of the fundamental differences between these three modes of communication?

The findings in this study illustrates some of the potential limitations of examining features of group interaction in isolation, such as response time, simple message counts, and frequency counts for response categories as required in content analysis. Despite the emphasis on *interaction* and *process* in distance learning, researchers in CMC are continuing to search for a theoretical framework, a methodology, and the tools to implement the methodology that can adequately and operationally define, measure and study student interaction and learning processes in online group discussions (Collins & Berge, 2001). Existing theories, methods and tools have not been successful in producing measures that provide clear and quantifiable descriptions of the complex processes observed in online discussions. New and more sophisticated methods are needed to advance the research in CMC (Koschmann, 1999; Fahy, Crawford & Ally, 2001). Due to the lack of a rigorous and theory-based methodology, the large body of research on online group interaction has been severely limited in explanatory power, and has not generated the evidence needed to empirically test the many assumptions and practices applied to the design and implementation of online discussions.

This study demonstrates one application of event sequence analysis, and provides useful findings to suggest that CMC researchers should begin to apply this method to examine group *processes* and to measure the complex relationships between messages and responses in online interactions. This study provides one illustration of how event sequence analysis might be used to examine the complex nature of group interaction in terms of *what* students say and *when* they say it. This method will likely prove to be also

useful for examining interactions in terms of individual characteristics of participants (*who*), the motivations and conditions for participation (*why*), and the language, style and mode of communication (*how*) in computer-mediated communication.

**Figure 1**  
**Example Excerpt from Discussion Thread with Student-Labeled Messages.**

- 1 **ARGo**: To say that ‘knowledge cannot be instructed or transmitted by a teacher, but can only be constructed by the learner’ is an overgeneralization. It would make teachers obsolete.
2. **ARGo**: Excellent argument. It is the symbiotic relationship between teacher and student that enables learning to take place. The teacher must provide guidance to the learner.
- 3 . . . **JUDGs**: This is a well-reasoned commentary. I agree with these contentions, but I believe that what has not been explained is how a learner constructs new ideas stemming from new theories or perspectives. Although I side with the opposition, I believe there must be a middle ground that recognizes that learners can construct knowledge.
- 4 . . . . . **ELABo**: A self-taught person can only construct new ideas until they have learned the pre-requisite information and skills needed to construct the new knowledge.
- 5 . . . . . **OTHo**: Very well stated about the conditions of self-taught individuals. I thought that was a good comeback.
- 6 **CRITs**: What teachers transmit is not knowledge, but accumulated *information*. We use this information as tools to construct new knowledge. By analogy, we need access to tools and materials to construct a house. The transmission and access to tools and information simply facilitates the construction of a house.
- 7 . . . **CRITo**: But I would argue that teachers can and do transmit knowledge or information. What you are saying instead is that *NEW* knowledge (or building an architecturally unique house) cannot be instructed by a teacher and must be constructed by the learner. And that is an entirely different argument.
- 8 . . . . . **CRITs**: But not all learned knowledge is instructed. I learned how to build houses by mainly watching my father build houses and learned through practice. I never received any formal instruction.
- 9 . . . . . **EVALs**: From what has been said thus far, some learning result from instruction and some do not. From an epistemological standpoint, this is consistent with Constructivists’ acceptance and synthesis of cognitive learning theories and principles.
- 10 . . . **ARGo**: Although there is truth to what you say, most of the skills and tools used to build a house is passed down from one generation to the next through and are not re-constructed. In other words, we generally try to avoid the mistake of always trying to “re-create the wheel”.
- 11 . . . . . **EVIDo**: Your ideas are consistent with what Driscoll states in Chapter 3 of the textbook. Teacher input is important and so is their assessment of the learner’s performance in order to ensure performance is to established standards.

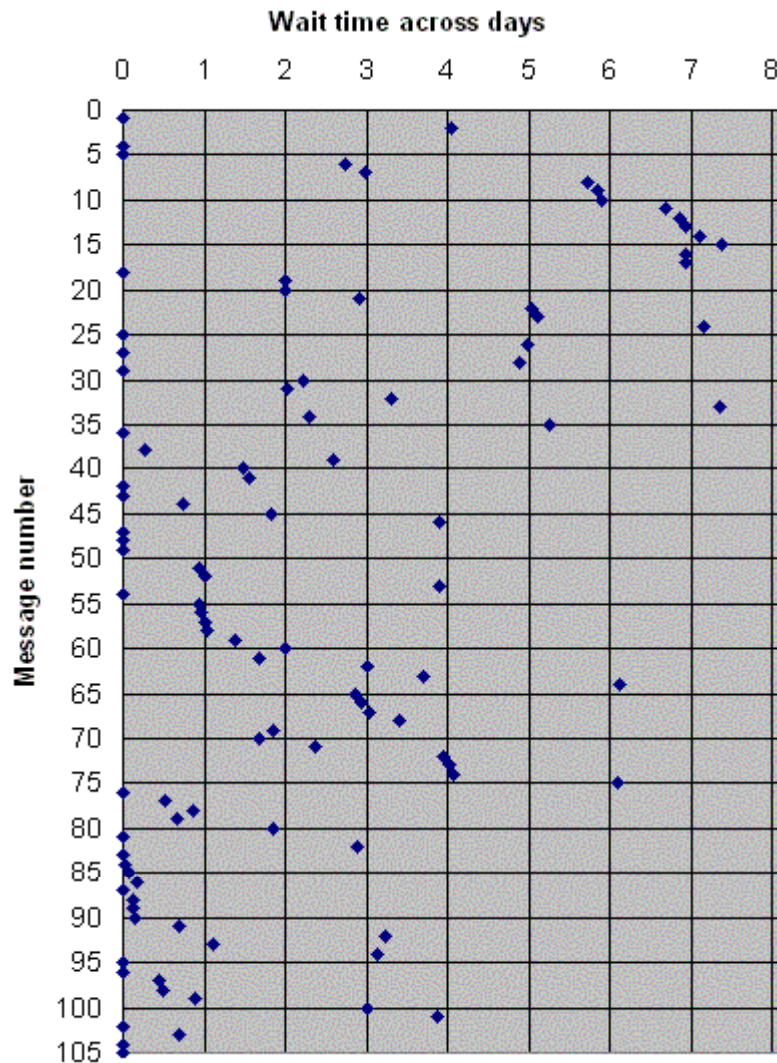
The texts in the example have been modified and abbreviated for illustrative purposes.

**Figure 2**  
**Sample Discussion Downloaded and Compiled in Excel for Data Analysis**

	A	B	C	D	H	K
1	A1	<b>Instructions (read carefully)</b>	Instructor	Tue Feb 5 2002 8:10 am	0.0000	
2	A2	. POSo	Student1	Wed Feb 6 2002 9:03 pm	0.0000	ARG
3	A3	. . CRITs The internal process...	Student2	Thu Feb 7 2002 6:51 pm	0.9083	CRIT
4	A4	. . . EVALs The internal process...	Student1	Sun Feb 10 2002 10:18 am	3.5521	EVAL
5	A5	. POSs	Student3	Wed Feb 6 2002 11:37 pm	0.0000	ARG
6	A6	. . CRITo Even the mechanic is external	Student4	Thu Feb 7 2002 10:23 am	0.4486	CRIT
7	A7	. . . EVIDs	Student3	Thu Feb 7 2002 4:31 pm	0.7042	EVID
8	A8	. . . . OTHs External Observation of internal workings	Student5	Fri Feb 8 2002 6:56 pm	1.8049	OTH
9	A9	. . . POSs Even the mechanic	Student6	Fri Feb 8 2002 7:29 am	1.3278	ARG
10	A10	. POSs	Student6	Thu Feb 7 2002 6:35 am	0.0000	ARG
11	A11	. POSs The box matters...	Student2	Thu Feb 7 2002 7:35 pm	0.0000	ARG
12	A12	. . ARGo Importance of the Box	Student4	Thu Feb 7 2002 11:12 pm	0.1506	ARG
13	A13	. . . POSo Purpose for Class	Student7	Fri Feb 8 2002 8:26 am	0.5354	ARG
14	A14	. . . . ARGs ...not teaching computers	Student4	Fri Feb 8 2002 4:47 pm	0.8833	ARG
15	A15	. . . . POSoMind vs Brain	Student8	Fri Feb 8 2002 11:07 pm	1.1472	ARG
16	A16	. . . . QUESs Do we really have control	Student5	Fri Feb 8 2002 7:04 pm	0.9785	ELAB
17	A17	. . . . ELABo I have control	Student4	Sat Feb 9 2002 9:25 am	1.5764	ELAB
18	A18	. POSo Nature vs. Nurture	Student9	Thu Feb 7 2002 9:49 pm	0.0000	ARG
19	A19	. . ARGo Nature vs. Nurture	Student6	Fri Feb 8 2002 7:45 am	0.4139	ARG
20	A20	. . . CRITo Fears aren't innate	Student9	Fri Feb 8 2002 4:35 pm	0.7819	CRIT
21	A21	. . . . EVIDo Re: CRITo Fears aren't innate	Student10	Sat Feb 9 2002 4:34 pm	1.7813	EVID
22	A22	. . . CRITo Nature vs. Nurture	Student1	Sun Feb 10 2002 5:43 pm	2.8292	CRIT
23	A23	. . . . POSs Nature vs. Nurture	Student6	Sun Feb 10 2002 7:33 pm	2.9056	ARG
24	A24	. . . . ARGs Treatable	Student11	Mon Feb 11 2002 8:22 am	3.4396	ARG
25	A25	. . CRITs ...No blank slate	Student2	Fri Feb 8 2002 5:17 pm	0.8111	CRIT
26	A26	. . . CRITo Genetic Foundation	Student9	Sun Feb 10 2002 7:39 pm	2.9097	CRIT
27	A27	. . . . QUESs Environment	Student11	Mon Feb 11 2002 8:41 am	3.4528	ELAB
28	A28	. . . . ARGs Brain Chemistry	Student9	Mon Feb 11 2002 8:55 am	3.4625	ARG
29	A29	. . . OTHs No blank slate	Student11	Mon Feb 11 2002 8:35 am	3.4486	OTH
30	A30	. . CRITs	Student5	Fri Feb 8 2002 7:17 pm	0.8944	CRIT

Column B displays the message subject headings with students' self-labels; Column C identifies the message author; Column D records the time of posting; Column H contains the time of posting converted into numerical format scaled by day; Column K contains the new labels after collapsing labels across various categories and across debate teams.

**Figure 3**  
**Graph of Messages and Message Threads Charted Across Time**



Each individual thread is marked by a message posted at 0 days. Overlapping messages indicate multiple sub-threads within a given thread. For example, the first thread consists of message #1 and 2. The second thread consists of only message 4. The third thread consists of messages 5 through 17, spanning over a seven day period.

**Table 1**  
**Transitional Probabilities between Message-Response Interactions**

	ARG	EMD	CRIT	ELAB	EVAL	OTH	Replies	No Replies	Givens	Reply Rate	Wait Time	Response Time
ARG	<b>.26</b>	<b>.19</b>	<b>.28</b>	<b>.12</b>	<b>.09</b>	<b>.06</b>	145	49	150	.67	.99	.94
EVID	.13	.13	<b>.29</b>	.13	.16	.16	62	35	76	.54	.96	.98
CRIT	.19	.17	.23	.15	.14	.13	88	25	89	.72	1.04	.96
ELAB	<b>.10</b>	.08	<b>.10</b>	<b>.35</b>	.21	.17	78	30	85	.65	.68	.96
EVAL	.16	<b>.05</b>	<b>.02</b>	.20	<b>.29</b>	<b>.29</b>	56	39	85	.54	.74	.74
OTH	.14	<b>.00</b>	<b>.06</b>	<b>.06</b>	.20	<b>.54</b>	35	48	80	.40	.50	.67
	84	60	89	79	74	78	464	226	565	.59	.82	.88

**Table 2**  
**Z-Scores to Identify Transitional Probabilities that Deviate from Expected Frequencies**

	ARG	EMD	CRIT	ELAB	EVAL	OTH	
ARG	<b>2.80</b>	<b>2.76</b>	<b>3.10</b>	<b>-1.78</b>	<b>-2.77</b>	<b>-4.12</b>	145
EVID	-1.14	-0.01	<b>2.12</b>	-0.93	0.04	-0.15	62
CRIT	0.33	1.28	0.94	-0.62	-0.66	-1.20	88
ELAB	<b>-1.97</b>	-1.51	<b>-2.19</b>	<b>4.53</b>	1.21	-0.04	78
EVAL	-0.42	<b>-1.80</b>	<b>-3.53</b>	0.56	<b>2.75</b>	<b>2.51</b>	56
OTH	-0.61	<b>-2.37</b>	<b>-2.10</b>	<b>-1.85</b>	0.68	<b>6.17</b>	35
	84	60	89	79	74	78	464

The Z-scores in bold indicate the transitional probabilities that were significantly higher than the expected frequency by chance alone. Z-scores which are bolded and underlined indicate transitional probabilities that were significantly lower than the expected frequency.

**Table 3**  
**Response Rates Table for Response Time Intervals & Response Categories**

		Response Category													
		ARG		EVID		CRIT		ELAB		EVAL		OTH		Total	
Response Time (in days)	0.0	.68	40	.66	29	.84	38	.74	38	.59	41	.47	47	.65	233
	0.5	.50	18	.50	6	.71	21	.75	16	.59	17	.46	13	.60	91
	1.0	.29	7	.40	10	.50	10	.57	7	.50	4	.00	7	.38	45
	1.5	.43	7	.00	5	.56	9	.71	7	.40	5	.33	3	.44	36
	2.0	1.00	3	.40	5	.75	4	--	0	--	0	.00	3	.53	15
	2.5	.33	3	.50	2	.50	2	.17	6	.67	3	.00	2	.33	18
	3.0	.67	3	--	0	.00	1	.00	2	.00	2	1.00	1	.33	9
	3.5	--	0	.00	2	1.00	3	--	0	.00	1	.00	1	.43	7
	4.0	--	0	--	0	--	0	.00	1	.00	1	--	0	.00	2
	4.5	.00	3	.00	1	.00	1	.00	1	--	0	.00	1	.00	7
	5.0	--	0	--	0	--	0	.00	1	--	0	--	0	.00	1
5.5	--	0	--	0	--	0	--	0	--	0	--	0	--	0	
r*		-0.76	72	-0.95	55	-0.89	82	-0.39	74	-0.94	67	-0.51	67	-0.85	464

r\* is the Pearson correlation computed only with cells frequencies greater than 4.

**Figure 4**  
**Graph of Response Rates for Each Response Category Across Response Time**

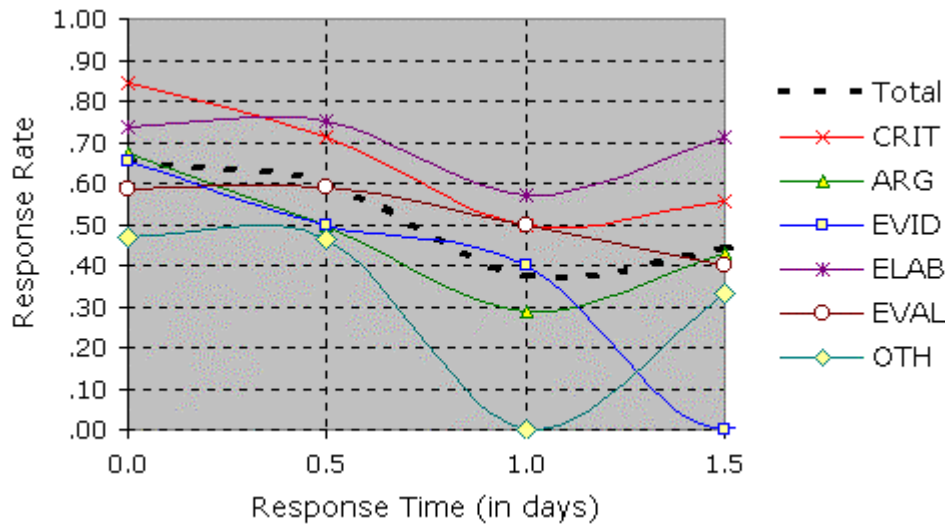


Table 4

**Matrix of Transitional Probabilities for Three-Event Sequences**

<b>EVENTS</b>	<b>ARG</b>	<b>EVID</b>	<b>CRIT</b>	<b>ELAB</b>	<b>EVAL</b>	<b>OTH</b>	<b>Replies</b>	<b>Givens</b>	<b>NoReplies</b>	<b>Total RT</b>	<b>Ave RT</b>	<b>Reply Rate</b>	<b>Reply Ratio</b>
OTH ELAB	.00	.00	.00	.00	.00	.00	0	2	2	1.74	-	0.00	0.00
EVAL CRIT	.00	.00	.00	.00	.00	.00	0	1	1	0.10	-	0.00	0.00
EVID OTH	.00	.00	.50	.00	.25	.25	4	10	6	15.64	3.91	0.40	0.40
ELAB ARG	.00	.00	.50	.00	.50	.00	2	8	6	7.03	3.51	0.25	0.25
EVAL OTH	.40	.00	.00	.00	.40	.20	5	16	11	12.01	2.40	0.31	0.31
CRIT ARG	.38	.13	.25	.25	.00	.00	8	17	9	19.06	2.38	0.47	0.47
CRIT EVAL	.00	.00	.00	.50	.33	.17	6	12	8	12.58	2.10	0.33	0.50
CRIT OTH	.00	.00	.00	.00	.00	1.00	4	11	7	8.21	2.05	0.36	0.36
CRIT EVID	.00	.25	.13	.00	.38	.25	8	15	8	15.44	1.93	0.47	0.53
CRIT ELAB	.18	.00	.18	.55	.09	.00	11	13	4	19.95	1.81	0.69	0.85

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