Weaving multiple coordinated discourse threads in a distributed learning activity

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Draft version
February 8, 2011

Abstract

New educational media allow for new kinds of instructional interaction. This paper presents several kinds of analyses of online interaction that occurred as part of graduate education courses, interactions that occurred through multiple threads of discourse (Black, Levin, Mehan, & Quinn, 1983). These analyses support the concept of a "global shape" of an interaction, with "width" that is the number of multiple simultaneous topic threads, and "mean thread length" measured by the average number of turns involved in the topic threads. These analyses also support a measure of "interactional influence" of a participant, which is the percentage of total interactional turns that are contained in topic threads that the participant started. The "wide" parts of the interaction are more likely to be marked by "trouble talk", explicit expressions by the participants of difficulties with following the interaction.

The analyses presented here show some of the upper limits of interactivity in online education. If an interaction is too interactive, then it can overwhelm the processing capabilities of at least some of the participants. While highly interactive learning environments are valuable for supporting learning, they also come with a cost. The analyses here suggest that interactivity be carefully chosen as a tool for promoting learning, and that the design of learning environments take into account both the benefits and the costs of interactivity.

The research reported in this paper provides a deeper understanding of the role of interactivity in education, both online and more generally, describing the ways that multiple coordinated threads of discourse can be woven together to create productive environments for learning. It also points to the critical role of mediators in coordinating the distributed nature of learning across both space and time and across people and media.

Introduction

There is an ongoing debate about the benefits and cost of interactivity in online education [needs refs]. Some online education programs provide minimal interaction. For example one program at the University of Illinois videotapes existing on-campus lectures, streams these videos over the Internet, and then provides online access to teaching assistants to allow students to ask questions. When challenged about the paucity of interaction in this online program, an instructor in this program countered with "Well, it is at least as interactive as our on-campus program".

I have been involved in an online masters program at the University of Illinois called "CTER OnLine" that strives to be highly interactive. In creating highly interactive courses, we have become aware of the costs involved in creating highly interactive educational programs. In this paper I present an in-depth analysis of a specific highly interactive part of an online course, to illustrate some of the benefits and costs of interactivity.

On June 20, 2002, Linda Polin, a faculty member at Pepperdine University, made an online "guest appearance" in an online course that I taught at the University of Illinois, Urbana-Champaign. This paper presents analyses of this guest appearance text chat session from a number of different perspectives, in order to explore online education and in particular synchronous online interactions, from the perspectives of the benefits these interactions provide for learning and the costs that they extract.

A Distributed Activity Perspective

Many theories of learning have focused on the individual as the unit of analysis, including the behaviorist perspective that dominated much of the first half of the twentieth century and the cognitive/constructivist perspectives that have dominated the second half. Another perspective, with its roots in the earliest theories of learning but which has been flourishing recently, takes into account the physical and social contexts of the individual learner. With the rapid growth of new communication and computational media, the multiple ways that learning is distributed across multiple people, artifacts, time, and other dimensions has become increasingly salient. Described below is an effort to reconceptualize learning by focusing on this distribution, a "distributed learning" perspective that explores the variety of ways that learning is distributed and then examines the kinds of mediation needed to span the distributions to allow for successful learning.

Distributed learning is not a particular kind of learning, but instead a specific perspective on all learning. There are two aspects of learning that this perspective focuses on, distribution and mediation.

Distribution

Interaction in general, as well as the interactions that lead to the changes we call learning, is distributed in many different ways. Cole & Engeström (1993) describe how cognition is distributed in space along a dimension of spatial scale, varying from distribution "'in' the person" within a particular person's body and brain, to distribution "'in' the medium culture" among a small number of people and artifacts to distribution across whole societies and cultures. They also point to distribution in time, varying along a dimension of temporal scale, with microgenetic time scales of "moment to moment lived experience", ontogeny time scales of "the life of the individual", cultural-historical time scales of "the history of human beings on earth", phylogeny time scales of "the history of life on earth, and finally the physical time scale of "the history of the physical universe."

The notion of distribution across different scales of analysis is central to one potential power of the distributed activity perspective, the possibility that the nature of distribution of learning and how it functions at any one scale level may be similar to how it functions at other levels. This provides a large number of "boundary-crossing" cases that can provide for potentially powerful new approaches to challenges at any given level. For example, when faced with a challenge in understanding how learning is organized among a small group of people and artifacts, concepts or techniques that are useful at the organizational learning level might be useful. Or conversely, a problem in data collection or analysis in organizational learning might be addressed in

a productive way by those used at more micro levels. Many advances in research of all sorts are due to this kind of boundary crossing -- the distributed activity perspective may allow this to happen in a more systematic and widespread way.

Mediation

Once we focus on the full range of distribution that faces learning activity, the question arises about how does learning occur at all, given the variety of distributions to cross. Learning occurs because of a variety of mediators that span the distributions. A distributed activity perspective focuses on the different kinds of mediators that are involved in learning, and the dynamic nature of their involvement in learning. As with distribution, mediation can be view at a range of spatial and temporal scales. There are mediators at the neuron level, mediators at the person or artifact level, mediators at the organizational or societal level. In distributed learning activity, there are often multiple mediators operating at the same time that need to be coordinated. Multiple mediators are sequenced in time over the course of the learning, and that sequencing needs to be coordinated.

One advantage of the distributed learning activity perspective is that it helps us focus systematically on mediation in its multiple forms, and the ways in which the multiple mediators are coordinated (or not). Multiple mediators can be coordinated (interacting in ways that benefit the functioning of each mediator), uncoordinated (not interacting with each other at all), or discoordinated (interaction in a way that mutually interferes with each others' functions), or a mixture of these possibilities. Problems with distributed learning can occur when mediators are missing altogether, or when they are present but discoordinated. Mediators may be present during the timecourse of learning but not at the times that they are needed for the distributed learning to occur. These are the kinds of things we will look at in our analyses of the case study of online teaching and learning described below.

The context of this study

The interaction analyzed in this paper occurred during an online course taught by the author. This course "Computer Use in Education", is the first course taken by students in the Curriculum, Technology, & Education Reform" online master of education program in the Department of Educational Psychology in the College of Education at the University of Illinois, Urbana-Champaign. Most of the students in the interaction studied here were elementary school and high school teachers (20 out of 21).

The interaction

One assignment required students to read a paper by Dr. Linda Polin from Pepperdine University about the importance of virtual contexts for shaping online educational interaction (Polin, 2000). They then attended a synchronous text chat "guest appearance" by Professor Polin on June 20, 2002 which occurred in a professional development online environment called Tapped In (Schlager, Fusco, & Schank, 1998, 2002). This interaction lasted for 75 minutes, and the transcript (with names "pseudo-ized") appears in Appendix A. This transcript is automatically generated by Tapped In and emailed to each participant. This transcript consisted of 904 turns.

Simple analyses

Turn analysis: A simple measure of "influence"

Much of face-to-face classroom interaction is characterized by the IRE (Initiation-Reply-Evaluation) pattern identified by Mehan (1979). That is, a teacher initiates a topic, a student replies, and the teacher evaluates that reply. If a classroom interaction is dominated by this pattern (T:I -> S:R -> T:E,I -> S:R -> T:E,I -> …), then the teacher would have generated 50% of the conversational turns. Do we find this teacher dominance in online interactions? In the interaction being analyzed here, the situation is complicated because of the presence of two people in an authority role, the teacher of the class (T1) and the guest speaker (T2). One simple measure of "influence" on the interaction by a participant is the percentage of total turns that that participant generates. We will explore more sophisticated measures of "influence" later in this paper, but Table 1 shows the number and percentage of turns taken by each of the participants.

Participants	Number of turns	Percent of turns
T1	105	11.6%
T2	182	20.1%
S1	60	6.6%
S2	40	4.4%
S3	55	6.1%
S4	36	4.0%
S5	17	1.9%
S6	25	2.8%
S7	72	8.0%
S8	25	2.8%
S9	22	2.4%
S10	14	1.5%
S11	73	8.1%
S12	46	5.1%
S13	35	3.9%
S14	29	3.2%
S15	10	1.1%
S16	27	3.0%
S17	23	2.5%
PS1	7	0.8%
O1	1	0.1%

O2	0	0.0%
Total	904	100.0%

Table 1: Number and percentages of turns taken in the interaction

The teacher (T1) generated 11.6% of the turns; the guest speaker (T2) generated 20.1%, for a total of 31.7% of the turns generated by the two instructional leaders. While the leaders each generated more turns than any student, the total number of student turns constituted about two-thirds of the turns in the interaction. So this online conversation, at least, is not quite so dominated by teacher turns as the prototypical teacher-dominated IRE instructional interaction. We will see a more sophisticated analysis of "conversational influence" later in this paper, which supports this same position but not quite so strongly.

Simple measures of conversational intensity

Some conversations proceed at a fairly leisurely pace; others are tightly packed with many different topics. There are at least two simple measures of conversational intensity, and then a more sophisticated one that will be described further on in this paper.

Turns per minute. This interaction took place over 75 minutes and there were 904 different turns. So a simple measure of intensity is that there were 12.05 turns per minute, or approximately one turn every 5 seconds. That's a pretty fast-paced interaction.

Topics per minute. Another measure of conversational intensity goes beyond just a simple turn count, and involves determining the number of topics introduced per unit time. To do that, a rater needs to go through the interaction, and identify the number of different topics involved. In this interaction, I identified 67 topics, so there were 0.89 new topics introduced per minute. Having almost one new topic every minute is again a fairly fast-paced interaction.

A multiple topic thread analysis: The "shape" of an online interaction

A spreadsheet as a topic thread analysis tool

People have been doing topic thread analyses for many years, including thread analyses of online interaction (Black, Levin, Mehan, & Quinn, 1983; Grimes, 1975; Harasim, 1995; Levin, Kim, & Riel, 1990; Quinn, Mehan, Levin, & Black, 1983). Just displaying the threads, usually done in a computer-based "drawing" program, however, has been labor-intensive.

A human rater (JAL) read through the transcript, and determined for each turn if it was a response to some ongoing topic or the start of a new topic. A turn that was not

judged to be a response to a previous topic was classified as the starter turn of a new topic thread.

The author was not excited about the prospect of representing a 904 turn long interaction with a computer-based drawing tool. However, the author had the happy thought of using a spreadsheet program, Microsoft Excel, for this purpose, which certainly could represent all the turns in this interaction with a row for each turn, and all of the topic threads identified in this conversation with each topic in a separate column.

While I started the analysis of this interaction by typing in the turn number and speaker into each cell, Sandy Levin suggested just importing the transcript into the spreadsheet and copying each turn into the column representing the topic thread it was judged by the human rater to belong to. So while the spreadsheet is not doing any sophisticated analysis of the transcript, it certainly makes it much easier mechanically to represent multiple topic threads.

So, the procedure for coding the multiple turns of an interaction using a spreadsheet consists of the following steps:

1. Import the text file of the transcript into a spreadsheet (Microsoft Excel, in this case). This puts each turn into a separate cell in Column A.
2. Copy the first turn cell to the same row in column B, as a new thread.
3. For each additional turn, decide whether it belongs to an existing thread or starts a new thread. If it belongs to an existing thread, copy it to the same row in the column for that thread. If it starts a new thread, copy it to the same row in the next empty column.
4. For each thread, add a thread header, with a short title, the thread length, and the conversational width (how many other threads were ongoing when this thread started).
5. After all turns have been coded, for each column, select the thread title in that thread through the last turn and specify a gray background color.

Table 2 is the transcript for the first 15 turns of the interaction. Real names are replaced by pseudonyms, with T1 & T2 being the two leaders and S1 through S17 being the seventeen CTER students who participated. There were also three other participants, a graduate student of Linda's from Pepperdine (PS1) and two visitors (O1 and O2).

Connected to TAPPED IN on Thu Jun 20 16:46:02 2002 PDT.

S1 has arrived
T1 says, "Hi S1."
S1 says, "Hi T1"
S2 has connected.
T1 asks, "Ready to ask T2 some interesting questions?"
T1 says, "Hi S2 - welcome."
S1 says, "that hot tub will feel good tonight--I hope so...the questions"
S2 says, "Hi"
S1 says, "Hi S2"

T1 says, "We'll meet T2 in the Hottub room - I see somebody is already there."
S2 has disconnected.
S2 has connected.
S1 exclaims, "okay...I'm going downstairs for a minute. see ya soon!"
T1 says, "okay - later."
S1 goes out.
T1 says, "welcome back S2"
S4 has arrived.
S3 finds her way in.
T1 asks, "Hi S3 - how is the hottub?"
S2 says, "I was reading the tour log and saw that I should click on the detach button"
S4 says, "hi S2"
S4 leaves for the HT.
S5 has connected.
T1 says, "Yes, that gives you lots more scroll space."
S3 exclaims, "hello- I was waiting for you guys in the hot tub!"

Table 2: Transcript of the first fifteen turns.

Here are the four topic threads that occurred in these first fifteen turns, as represented in an Excel spreadsheet.

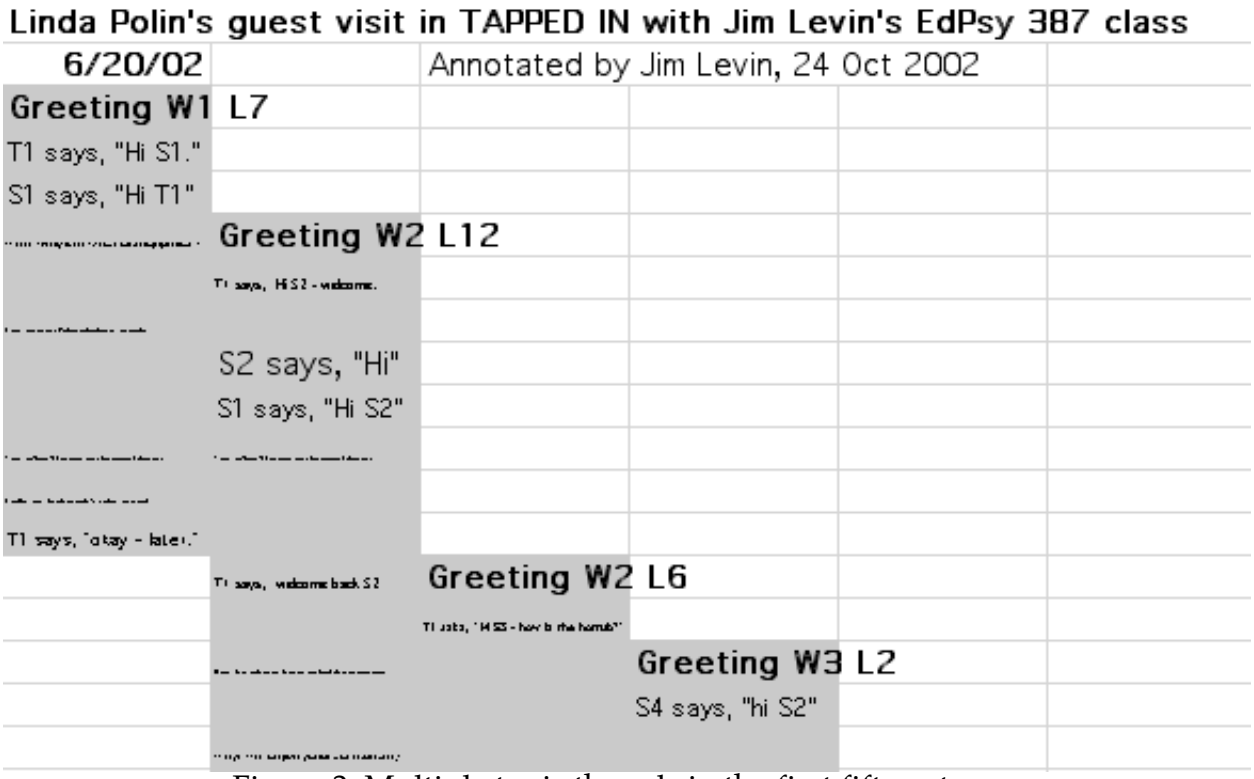

Figure 2: Multiple topic threads in the first fifteen turns.

Now, one of the features of a spreadsheet program is that you can view the spreadsheet at different percentages of reduction in size, so that you can view a large spreadsheet all at once, even though the contents of each cell are very small. Figure 3 shows a "macro"

view of the entire 904 turn interaction. Each short black line is a turn, and each grey rectangle delimits a particular topic thread. The first four topic threads shown in Figure 2 appear as the four short rectangles in the upper left corner of figure 3.

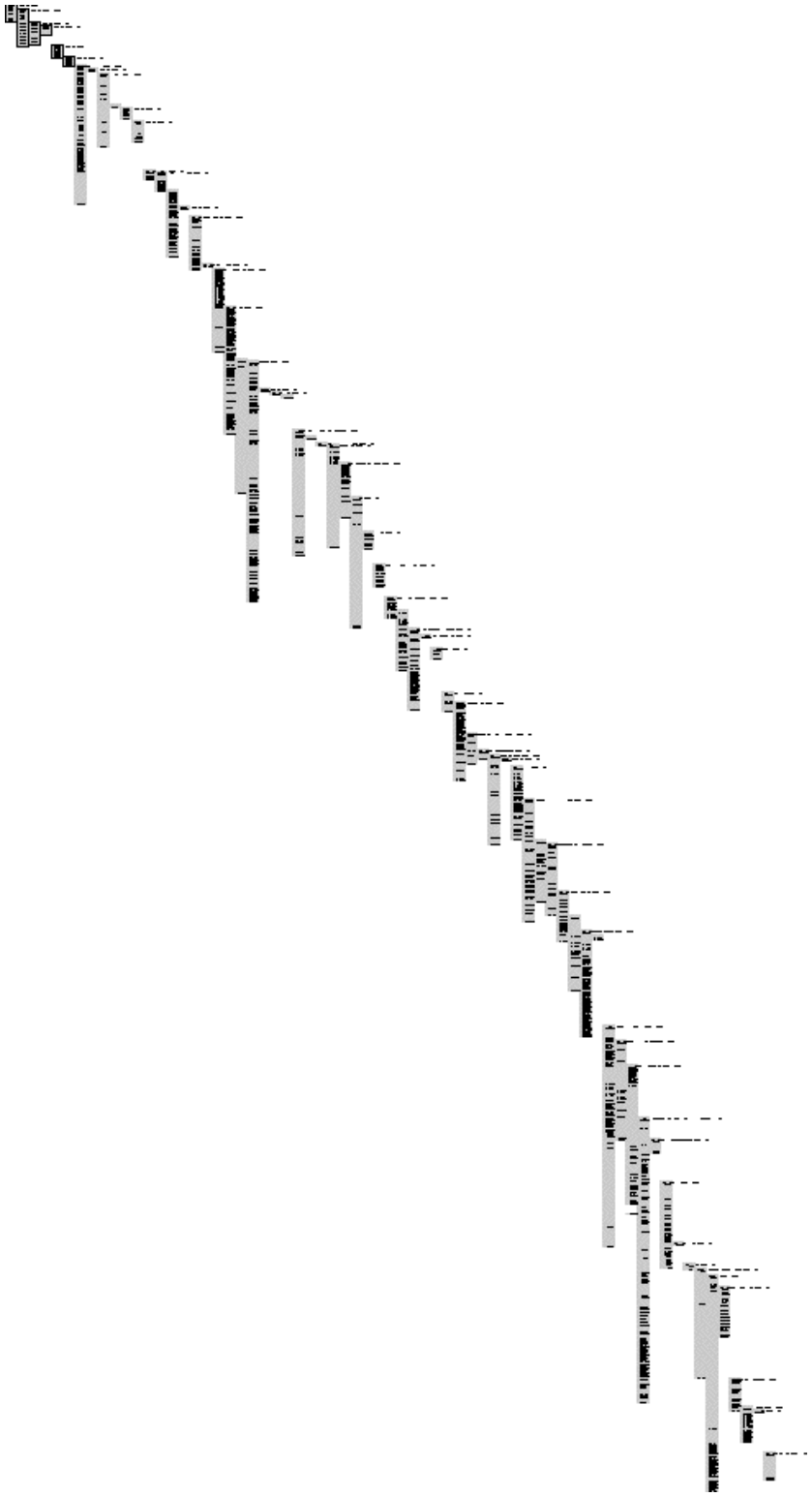

Figure 3: Macro view of the multiple topic threads in the chat session (time proceeds from top to bottom; each column is a different topic thread)

This view of the interaction allows us to ask questions about the "shape" of the interaction, including questions about changes in the "width" of the conversation (how many multiple topic threads are ongoing at each time) and the length of threads. [reference Hollan et al. Dynapad http://hci.ucsd.edu/dynapad/]

Conversational influence as measured by a topic thread analysis

A simple measure of conversation influence was presented previously in this paper – the percentage of total turns created by a given participant. However, it is clear that some turns have more influence on an interaction than others. In an extreme case, a participant who is very active but none of whose turns are responded to would be counted as influential by the "turn analysis", but would be seen as non-influential (or even as a nuisance participant) by the other participants. The topic thread analysis allows us to look at the "length" dimension of the interactional shape described above.

A person whose turns start extended threads has more influence on the interaction than someone whose turns start short threads or whose turns do not start any threads at all. We can define a measure called "interactional influence", which is the percentage of turns that belong to topic threads that a person starts. Participants who initiate topic threads that overall contain a higher percentage of the turns of the interaction are, by this measure, more influential. Table 3 shows the number of topic threads that each participant started, the percent of total threads that each started, the average number of turns in the topic threads, and the "interactional influence" of each participants, measured by the percentage of total turns that fall within the topic threads that each participant started.

Participant	Topic threads started	% of total threads	Average thread length	Interactional Influence
T1	13	19.7%	9.0	12.9%
T2	16	24.2%	19.2	34.0%
S1	2	3.0%	2.0	0.4%
S2	0	0.0%	0.0	0.0%
S3	7	10.6%	12.0	9.3%
S4	2	3.0%	3.0	0.7%
S5	0	0.0%	0.0	0.0%
S6	3	4.5%	6.7	2.2%
S7	1	1.5%	5.0	0.6%
S8	0	0.0%	0.0	0.0%
S9	1	1.5%	11.0	1.2%
S10	1	1.5%	2.0	0.2%
S11	4	6.1%	30.5	13.5%
S12	3	4.5%	13.0	4.3%
S13	4	6.1%	3.5	1.5%

S14	0	0.0%	0.0	0.0%
S15	0	0.0%	0.0	0.0%
S16	5	7.6%	30.4	16.8%
S17	3	4.5%	4.7	1.5%
PS1	0	0.0%	0.0	0.0%
O1	1	1.5%	2.0	0.2%
O2	0	0.0%	0.0	0.0%
Total	66			

Table 3: Number and percentage of topic threads started, average thread length, and interactional influence (% of turns contained in topic threads started) for each participant in the interaction.

Note that with this measure of "interactional influence", the guest speaker (T2) dominated the interaction to a greater extent (34% of the total turns were in topic threads that she started) than in the simple turn count measure (20.1% of the turns were her turns). This measure is closer to the overall impression that both the guest speaker and the course instructor had about their influence on the interaction than is indicated by the simple turn count. Together, these two participants started threads that accounted for almost half of the total turns in the interaction (46.9%), even though they contributed only less than a third (31.7%) of the turns.

Also note that with this measure, two students (S11=13.5%; S16=16.8%) each had a greater "influence" on the interaction than the course instructor (T1=12.9%). Even through they had fewer turns (T1=105 turns; S11=73 turns; S16=27 turns), these two students started longer topic threads on average (S11=30.5 turns per thread; S16=30.4 turns per thread) than the course instructor (T1=9.0 turns per thread). In this interaction, the instructor played more of a role as the facilitator of the interaction, deferring most topic initiation to the guest (T2) and by deferring, opened the door to more influential roles by some of the students.

Width of the interaction: Evidence from the "trouble talk"

Trouble talk: Explicit markers of being overwhelmed. During 23 turns in this interaction, members expressed concern about being overwhelmed by the pace of the interaction. This "trouble talk" occurred during three different points in the interaction. Those three topic threads are shown in Appendix B.

Nine of the students (of the 17 students participating) expressed at least one concern about following the interaction at various times, but the trouble talk consisted of only 23 turns (out of the 904 total turns). Is there a relation between the "width" of the conversation (the number of concurrent topic threads) at a specific time and the occurrence of "trouble talk"? For each of these three "trouble talk threads", there were three other topic threads ongoing at the same time (in other words, the interactional "width" was 4). How does that compare to the width of the other 63 topic threads? The mean "width" of the others is 2.88. The width of the interaction at the point of each

topic thread start turn is shown in Figure 4. The square markers are the trouble talk thread start turns.

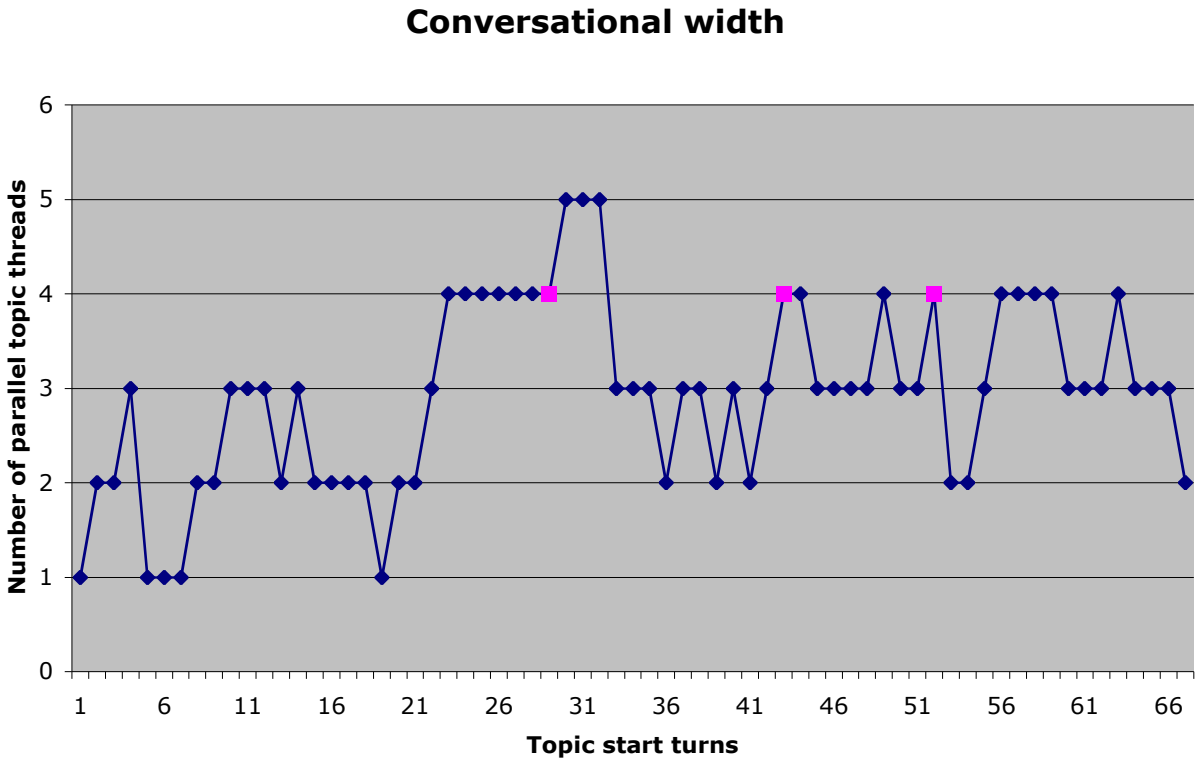

Figure 4: The "width" of the interaction at each topic thread start turn. The square markers are the three trouble talk thread start turns.

Now it is certainly not the case that people are inherently limited to participating in or even in following 4 parallel topic threads. In fact, in this interaction, there were three places where five topic threads were operating in parallel. (All three of the places where there were five parallel topic threads overlapped the first "trouble talk thread, but started later.) However this analysis of the "trouble talk" provides at least some evidence that a large number of parallel topic threads (a "wide" interaction) can overload at least some of the participants in an interaction.

There is a substantial "practice effect" through which people gain expertise at participating in these kind of multiple thread interactions. In fact, in this very interaction, one of Linda's Pepperdine online students showed up, and when asked how she handles this kind of interaction, she said: "hmmmmmmm it is hard in the beginning but you will get used to it." A participant in an interaction often only has to follow the turns of some participants and can ignore others. But the evidence presented here still supports the notion that the "wider" the conversation, the more cognitive load is generally required of the participants and the more likely that some of the participants will have trouble participating in (or even following) the interaction.

Discussion

One of the implications of this study is to confirm systematically something that is obvious to anyone who has participated in a group "text chat" or "instant message" session: that multiple threads of discourse often evolve in these communication media. An earlier study of text-based messaging, which compared it to face-to-face communication (Black, Levin, Mehan, & Quinn, 1983), concluded that it was the asynchronous nature of email that allowed multiple threads to thrive. That paper compared email-based multi-participant interactions to multi-participant face-to-face interactions and to two person chat interactions. The analysis in this paper contradicts that Black et al. conclusion, finding that instead it is the multiple participant nature of the interaction combined with the text-based nature, rather than the "non-real time" aspect, that supports multiple threads of discourse. That previous paper focused on "unraveling multiple threads of discourse". This paper focuses on ways that people weave together multiple threads of discourse.

That same earlier study pointed to the implications of text-based electronic communication media for education (Quinn, Mehan, Levin, & Black, 1983). The study reported in this paper continues that line of research, exploring the ways in which features of these new communication media have implications for uses in educational settings. Attempts by teachers and students to use new media in the same ways that they use existing media are likely to lead to dissatisfaction and discontent. However, once we are aware of the nature of the new media, we can develop new interactional frameworks and mediational strategies that take advantage of the strengths of the new media while avoiding the weaknesses.

For example, research in cognitive science has shown that expertise in a domain can be characterized at least in part by the expert having multiple coordinated representations of the domain of expertise (Levin, Stuve, & Jacobson, 1999; Chi, Feltovich, & Glazer, 1981; Larkin, McDermott, Simon & Simon, 1980). This study raises the possibility that expert mediation of an interaction is expressed by the coordination of the multiple threads of discourse that emerge, while non-expert mediation either leaves the multiple threads uncoordinated or worse discoordinated (interfering with each other). Further research is needed into the mediational roles that evolve in these kinds of media and the ways in which those mediational roles can make the interactions more productive by weaving together in coordinated ways the multiple threads of discourse.

One further possibility raised by this analysis relates to the value of visualizations. A visual presentation of an interaction allows us to see relationships that would be difficult to see otherwise. When these message maps are constructed manually (as described in this paper), they provide only retrospective insight into a conversation that has already taken place. Hursh (2003) has suggested that automated text analysis techniques similar to those used to rank web pages by search engines could be used to create at least a simplified message map in real time to be viewed by the interaction participants while the interaction is in progress. What would be the impact of seeing such a visualization of the multiple threads as they evolve and how could that insight help in the mediation of the interaction? Could it help the participants to weave the

multiple threats of discourse into a whole cloth of meaning? These are important questions to address in research on interaction in these new media and the development of new mechanisms for supporting these interactions.

Summary

I introduce here the concept of an "interactional shape", with a "width" that is the number of multiple simultaneous topic threads at each time, and with a "length", which is the number of turns involved in each topic thread. I propose a measure of "interactional influence" of a participant, which is the percentage of total interactional turns that are contained in topic threads that a participant has started. I also show that the "wide" parts of the interaction are those that are more likely to be marked by "trouble talk", explicit expressions by the participants of difficulties with following the interaction.

The analyses presented here of a particular synchronous text chat interaction show some of the limits of interactivity in online education. If an interaction is too interactive, then it can overwhelm the processing capabilities of at least some participants. I am not arguing that interaction is not valuable – much of my own and others' previous research has shown the value of highly interactive learning environments. But the analyses presented here show that interactivity comes at a cost, that interactivity should be used as a carefully chosen tool for promoting learning, and that the design of learning environments should take into account both the benefits and the costs of interactivity. These analyses are useful for a deeper understanding of the role of interactivity in education, both online and more generally.

More importantly, these analyses provide some initial descriptions of the ways that multiple coordinated threads of discourse can be woven together to create productive environments for learning. Multiple discourse threads can become tangled, leading to confusion, especially for novices, but they can also contribute to the acquisition of multiple coordinated representations that characterize expertise in a domain (Levin, Stuve, & Jacobson, 1999). In the case in which these multiple threads are coordinated by expert mediators, they can contribute to the weaving of the whole cloth of meaning out of multiple individual threads of discourse.

These analyses also point to the critical role of mediators in coordinating the distributed nature of learning, across both space and time. There are multiple mediator roles, and the roles that are important for sustaining meaningful discourse vary across different stages in the life-cycle of an interaction. As we better understand these mediator roles, we can develop and support these mediators and help to coordinate their interactions to provide for powerful distributed learning environments.

Acknowledgments

I would like to thank Linda Polin and the students of CTER OnLine who participated in the interactions analyzed in this paper. I would also like to thank Linda Polin and Mark Schlager for useful feedback on earlier drafts of this paper.

Appendix A
Transcript of the 904 turn chat interaction.

See http://edsserver.ucsd.edu/~jlevin/transcript-20jun02.html .

Appendix B
Transcripts of the three "trouble talk" threads

First "trouble talk" thread:

S16 says, "there are a lot of people talking about a lot of different things... I forgot what I read three lines ago..I am so confused..:{"

S13 says, "Me , too"

S12 says, "It is hard to keep up with the reading snce it moves so fast."

S10 says, "I have the same problem S16"

T1 says, "I'll post the whole transcript so if anyone misses something you can read it later."

S3 says, "thanks"

S11 asks, "what are we talking about?"

Second "trouble talk" thread:

S16 says, "its hard for me to keep up with this conversation :) Younger kids would not benefit from something like this.."

S5 says, "I agree S16"

T1 says, "Well, it would move slower with younger kids."

S8 says, "Also slower with less people"

S3 says, "I can't keep up either"

T1 says, "Yes, that too, S8. We're pushing the upper limit here."

S16 says, "good, Im not the only one struggling to read and type? IM is one thing, chat rooms are quite another.."

S8 says, "I can't keep up either"

T2 [to S16]: "there's way too many of us aat once right now."

S17 says, "there are a lot of people talking at once, but the loud people always get the floor in classrooms--not so here"

S11 says, "but the fast people do here"

S17 says, "true"

S10 says, "I agreee that the faster have an advantage"

S13 says, "I am struggling to keep up with you fast typists."

Third "trouble talk" thread:

S3 asks, "what are we talking about?"

S13 says, "You have lossed me"

References

Black, S. D., Levin, J. A., Mehan, H., & Quinn, C. N. (1983). Real and non-real time interaction: Unraveling multiple threads of discourse. *Discourse Processes, 6*, 59-75.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5*, 121-152.

Grimes, J. E. (1975). The thread of discourse. The Hague: Mouton.

Harasim, L. M. (1995). *Learning networks: A field guide to teaching and learning online*. Cambridge, MA: MIT Press.

Hewitt, J. (2003). How habitual online practices affect the development of asynchronous discussion threads. *Journal of Educational Computing Research, 28*(1), 31-45.

Hursh, A. (2003). Personal communication.

Larkin, J. H., McDermott, J., Simon, D. P., & Simon, H. A. (1980). Expert and novice performance in solving physics problems. *Science, 208,* 1335-1342.

Levin, J. A., & Cole, M. (2007). Simulations as mediators for distributed research activity. Paper presented at the American Education Research Association, Chicago, IL.

Levin, J. A., Stuve, M. J., & Jacobson, M. J. (1999). Teachers' conceptions of the Internet and the World Wide Web: A representational toolkit as a model of expertise. *Journal of Educational Computing Research, 21*(1), 1-23.

Levin, J. A., Kim, H., & Riel, M. M. (1990). Analyzing instructional interactions on electronic message networks. In L. Harasim (Ed.), *Online education: Perspectives on a new environment* (pp. 185-213). New York: Praeger.

Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Cambridge, MA:

Harvard University Press.
Polin, L. (2000). *Affordances of a VR world as a place for learning: Discourse patterns and contextualization cues framing learning experiences for adults in a real-time, text-based, virtual reality setting.* Paper presented at the American Educational Research Association Meeting, New Orleans LA.
Quinn, C. N., Mehan, H., Levin, J. A., & Black, S. D. (1983). Real education in non-real time: The use of electronic message systems for instruction. *Instructional Science, 11*, 313-327.
Schlager, M. S., Fusco, J., & Schank, P. (1998). Cornerstones for an on-line community of education professionals. *IEEE Technology and Society, 17*(4), 15-21,40.
Schlager, M. S., Fusco, J., & Schank, P. (2002). Evolution of an online education community of practice. In K. A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace* (pp. 129-158). New York: Cambridge University Press.