Handbook of Research on Computer Mediated Communication

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Chapter XXXIV
Discourse and Network Analyses of Learning Conversations

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ABSTRACT

Analytical frameworks for examining educational computer mediated discourse have been mainly designed for asynchronous discussions; hence the classification schemes are typically more sensitive when applied to longer postings than the shorter, more condensed exchanges present in online synchronous discourse. This chapter introduces the exchange structure analysis framework for examining online synchronous interaction at levels of structural organization and pragmatic intention. The further application of social network analysis as a method and visualization tool for the coded exchanges are explained and illustrated. Examples are provided from transcript data of moderated collaborative group discussions during virtual tutorials in a case study. With the integration of discourse and social network analytical methods, a richer interpretation is gained on the processes of articulation and negotiation of meaning during online learning conversations.

INTRODUCTION

Analytical frameworks for examining educational computer mediated discourse have been mainly designed for asynchronous discussions. Such classification schemes are typically more sensitive when applied to longer postings than the shorter, condensed and more intense exchanges present in online synchronous (chat) discourse. Nevertheless, there have been recent frameworks developed for analyzing educational chat discourse. This chapter describes a new methodological design which integrates discourse analysis (DA) and social network analysis (SNA) for examining educational chat interaction during collaborative group learning. A refined exchange structure analysis framework and coding scheme, based on Cox, Carr, and Hall (2004) and Kneser, Pilkington, and Treasure-Jones (2001), for examining educational chat exchanges are introduced. The

addition of SNA as a method and visualization tool for the coded exchanges are explained and illustrated with examples from transcript data of moderated group discussions in a case study (Lim, 2006). The chapter concludes with future research areas with the integrated method for studying online collaborative learning processes.

BACKGROUND

Interaction is considered crucial to learning experiences from a sociocultural constructivist perspective (Vygotsky, 1962) which assumes that participation in discursive practices of the community supports knowledge construction. In online educational contexts, within the zone of proximal development (ZPD) (Vygotsky, 1962) interpreted as encompassing the student, tutor, and virtual learning environment (Duffy & Cunningham, 1996), the learner's potential capacity for intellectual growth is enhanced by the presence of scaffolding (guidance) in the form of tutor/peer support through interaction. The mediation means of CMC technology and the language of computer mediated discourse enable the formation of learning conversations from which learners appropriate (Rogoff, 1990), for their own use, the resulting shared understandings. Essentially, individual and group knowledge construction processes are held to be supported by interaction in online instructional events such as virtual lectures/tutorials. Such knowledge construction processes are assumed to be empirically observable through examining the dialogic interactions between learning parties.

Characteristics of Computer Mediated Interaction and Discourse

Online interactions between learning parties are largely facilitated by asynchronous and/or synchronous CMC media that offer different capabilities and constraints (Ngwenya, Annand, & Wang, 2004). The asynchronous CMC mode supports delayed-time dialogue through applications such as e-mail and discussion forums. The interactions are usually text-based contributions which could be composed, sent and accessed without time or proximity constraints.

In contrast, the synchronous CMC mode requires communicating parties to be 'present' at the same time for the dialogue to occur through services and applications such as voice over IP, desktop video conferencing, and Internet relay chat. Online synchronous (chat) interactions are mainly text-based messages, composed and sent by parties who are simultaneously logged in chat rooms. Rather than having the facility to order messages in topical or temporal order, as in the case of asynchronous discussion threads, chat messages appear chronologically on-screen with preceding exchanges scrolling up and then off each party's computer screen at a speed corresponding to the pace of the conversation (Werry, 1996), offering a potentially permanent record of the proceedings, which is generally not retrievable unless deliberately saved by the user.

The emergence of such text-based electronic language (Collet & Belmore, 1996) from online interactions prompted research in computer mediated discourse (CMD) which is "distinguished by its focus on *language and language* use in computer networked environments, and by its use of methods of discourse analysis to address that focus" (Herring, 2003, p.1-emphasis in original). The type of CMD relevant here is chat discourse which challenges conventional understandings of the differences between speech and text with its text-based orality (December, 1993). While chat discourse displays the spontaneity of speech in its rhythm (given its synchronicity), it presents at the same time, the textual and structural forms of written language.

Studies that compared chat discourse characteristics to speech (Kortti, 1999; Murphy & Collins, 1999; Werry, 1996) identified linguistic features similar to face-to-face conversation such

as the presence of turn-taking, observer selection, and self-repair. Features considered unique to chat discourse include the presence of paralinguistic communication conventions, server messages, and informal language structure. Additionally, Werry (1996) noted that in chat conversational sequences, "[e]ach utterance is simply displayed in the chronological order in which it is received by the IRC system" (p.51). With this linear organization of conversational sequence, chat discourse is also distinctive from text and talk for its interweaving text-based conversational threads containing different speech acts and topics.

Research on Quality of Online Educational Interaction

Since the mere generation of computer mediated dialogue may not necessarily lead to educationally productive collaboration and quality learning (Palloff & Pratt, 2003), further research is needed on the quality of online interaction. The quality of online asynchronous interaction in higher education has been extensively examined from a constructivist view for indications of "sustained reflection" associated with knowledge building in the discourse (Garrison, Anderson, & Archer, 2001, p.11). A number of studies utilized the methodological approach of content analysis for analyzing electronic text generated from asynchronous discussions for the presence of cognitive and/or social-emotional dimensions considered necessary for developing student critical thinking and collaborative skills (Booth & Hulten, 2004; De Laat & Lally, 2004; Garrison, 2003; Garrison et al., 2001; Hara, Bonk, & Angeli, 2000; McLoughlin & Luca, 1999).

In contrast, there is relatively less research on the quality of online synchronous interaction in higher education. Researchers have observed that the synchronous CMC medium has only recently been utilized for instructional purposes (Murphy & Collins, 1997) even though it offers possibly the closest technological approximation to face-to-face communication in classroom settings, hence facilitating the transfer of formal patterns of behavior acquired in physical to virtual classrooms (Crook & Light, 2002). Additionally, the sense of immediacy afforded by real-time interaction could reduce transactional distance (Moore & Kearsley, 1996) and motivate participation, hence providing intellectual and emotional support to distant learners (Haythornthwaite, Kazmer, Robins, & Shoemaker, 2000).

Studies on synchronous CMC interaction have largely focused on its effectiveness in enhancing social-emotional aspects of collaborative learning and work group processes (Chou, 2002; Duemer, Fontenot, Gumfory, & Kallus, 2002; Mercer, 2003; Schwier & Balbar, 2002; Sudweeks & Simoff, 2000), while its role in supporting knowledge construction remains unclear. Moreover, most analytical frameworks for educational CMD (Garrison et al., 2001; Gunawardena, Lowe, & Anderson, 1997; Henri, 1992) are designed for asynchronous discussions which typically contain complete thoughts, extended reflection and reasoning, and therefore may not be suitable for the shorter, more condensed exchanges in chat discourse.

With greater experimentation by educators with both CMC modes for extending the range of interaction in distance learning (Bonk, Hansen, Grabner-Hagen et al., 1998; Chou, 2002) and given the constructivist view that knowledge is constituted in dialogic interaction, such a situation highlights the need for analytical frameworks, appropriate for examining educational chat discourse, to further current understanding of the knowledge construction processes facilitated by chat interaction.

Analytical Frameworks for Educational Chat Discourse

Several analytical frameworks have been developed recently for educational chat discourse based on the methodological tradition of discourse

analysis (Berzenyi, 1999; Cox et al., 2004; Kneser et al., 2001; Pilkington & Walker, 2004). The method of DA is a procedure of textual analysis distinctive for its focus on interaction patterns of language in situated use (Taylor, 2001) and speech act functions realized by text or talk (Van Dijk, 1997). Since chat discourse displays the spontaneity of speech and structural forms of text, the DA approach is particularly suitable for analyzing interactional patterns of education chat.

Of particular relevance here is the exchange structure analysis (ESA) framework developed by Kneser et al. (2001) for "capturing the grammar of turns between dialogue participants with the aim of gaining insights into their relative contributions and roles" (p.67) during educational chat interaction. Application of the framework's coding scheme to chat transcripts using exchange structure categories alone produces counts of turn frequency and type contributed during discussions. A more informative analysis could be obtained by examining speech acts (Austin, 1962; Searle, 1969) or the pragmatic intention of turns using move categories, and further associating turns already coded at exchange structure and move levels, with anticipated argument and exchange structure roles. Kneser et al. (2001) applied the framework to examining chat discourse characteristics and evaluating online tutor effectiveness in transferring discussion skills to postgraduate students in an online course from a constructivist perspective. Transcripts from chat seminars were analyzed with ESA to identify exchange patterns of tutors and students that indicate the degree of inclusiveness of participation by both parties in an online learning environment.

Extending Kneser et al.'s (2001) framework, Cox et al. (2004) modified the ESA coding scheme and presented formal definitions of coding categories to guide analysis of educational chat exchanges. The study examined the impact of course design, group dynamics, and facilitation styles in supporting effective online synchronous discussions in two university courses. Transcripts from chat discussions were analyzed to identify participant roles and inclusiveness of participation during learning conversations.

Although such analyses of educational chat discourse could be illuminative, the results, mainly as quantitative counts of turns, form a static representation of interaction during learning. However, the integration of social network analysis (SNA) with ESA could offer an interpretation of educational chat interaction that more closely represents the intuitive understanding of the dynamic to-and-fro patterns of turn-taking in exchanges.

In this context, SNA is defined as a qualitative method enabling "the disciplined inquiry into the patterning of relations among social actors, as well as the patterning of relationships among actors at different levels of analysis (such as persons and groups)" (Breiger, 2004, p. 505). SNA has been used to describe and model relations ranging from corporate interlocking (Levine, 1972), information diffusion (Granovetter, 1974; Lee, 1969), language change and variation (Labov, 1972; Milroy, 2000), terrorist networks (Krebs, 2002; Tsvetovat & Carley, 2005), and recently, computer mediated communication (Garton, Haythornthwaite, & Wellman, 1997; Paolillo, 1999). Also, two recent studies examined CMC-supported learning networks, in which student asynchronous discussion postings were analyzed using SNA and content analysis methods to investigate participation patterns, learner network structures, and quality of knowledge construction processes (Aviv, Erlich, Ravid, & Geva, 2003; Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2001).

In contrast, the analytical suite presented here incorporates SNA and discourse analysis methods in examining the impact of online synchronous interaction on the collaborative learning processes. In brief, when integrated with the refined ESA framework described in the next section, SNA is applied to textual data comprising turns/ties by actors (pre-coded with the ESA coding scheme) engaged in dialogic interaction within an online

learning context. The significance of results is interpreted from the sociocultural constructivist perspective and the following SNA assumptions are held (Wasserman & Faust, 1994, p.4):

- Actors and their actions are viewed as interdependent rather than independent, autonomous units.
- Relational ties (linkages) between actors are channels for transfer or 'flow' of resources (either material or nonmaterial).
- Network models focusing on individuals view the network structural environment as providing opportunities for or constraints on individual action.
- Network models conceptualize structure (social, economic, political, and so forth) as lasting patterns of relations among actors.

More specifically, relational ties in this context are considered properties of learning groups rather than individual actors. The ties are means for the exchange of information, social and emotional support between group members, and subject to interactional opportunities and constraints present in the settings. The next section presents the refined ESA framework and coding scheme based on Kneser et al. (2001) and Cox et al. (2004), explains and illustrates the integrated method of ESA and SNA in examining educational chat exchanges during online tutorial discussions.

THE INTEGRATED METHOD

The analytical suite of ESA and SNA was first applied in Lim (2006) to analyze educational chat discourse, from two online tutorial groups, for patterns of engagement and interaction, to further understand the knowledge construction processes facilitated by chat interaction. The transcript data used reflect dialogic participation involving critical discussions on set-readings, which were facilitated by a tutor and moderated by student presenters in WebCT chat tutorial rooms. Extracts from the transcripts are used here as examples and pseudonyms are used except for the authors.

This section introduces two main constructs in the refined ESA framework: a virtual classroom interaction model reflecting interaction specific to the online tutorial context, and an educational chat exchange system representing interactions at the levels of exchange, turn, and move. The section also explains areas of integration between ESA and SNA in conceptualizing the chat exchange structure, discusses key SNA concepts, and illustrates the application of the integrated method for examining, specifically, the presence of topic development phases as indicators of knowledge construction and the extent of participant involvement in collaborative group learning.

The ESA Framework: Representation of Virtual Classroom Interaction

Sinclair and Coulthard (1992) conceptualized conventional classroom interaction as a hierarchy with a lesson as the highest unit of classroom discourse, comprising a series of transactions. Transaction boundaries are indicated by sets of preliminary and final exchanges which frame medial exchanges. Exchanges consist "minimally of contributions by two participants" (Coulthard & Brazil, 1992, p.64) that are moves with speech act functions.

Drawing from this concept, the virtual classroom interaction model (Figure 1) represents interactions specific to the chat tutorial context at levels higher than the exchange. In each 1-hour weekly chat tutorial, there are two ½-hour discussion slots and within each slot, a presenter moderates discussions based on issues in set reading(s). The model frames such interactions as sessions, episodes, and social spaces. A session, like a lesson, is the highest unit of classroom discourse. It refers to the entire (1 hour) chat tutorial period and constitutes episodes and social spaces. Social spaces comprise utterances on non-task related

topics, marked by their location in the transitional area between episode boundaries and at the start/end of a session. Such utterances, usually reflecting social content, are excluded from analysis. Episodes comprise turns on task related topics in discussion slots, within a session (Figure 2).

Since knowledge construction processes rather than social-emotional aspects of collaborative learning are of interest, turns within episode boundaries are the focus of analysis. Such turns are labeled (e.g., tu01.2.1) and numbered sequentially with the labels reflecting the origins of turns by session, episode and turn number. The turns are further categorized as contributions for establishing social/teaching presences (Garrison, Anderson, & Archer, 2000) or contribu-

Figure 1. Virtual classroom interaction model: Session, episode and social spaces

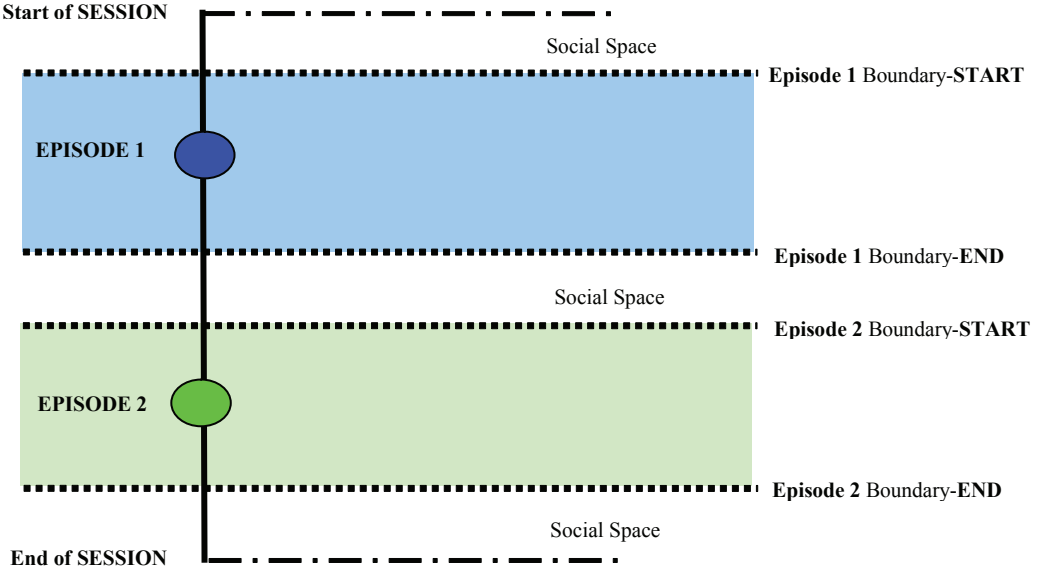


Figure 2. Turns in an episode adjacent to a social space

TURNS				
	($_{tu}$03.1.214)	Participant M>>	its the same as the dictator question before, if you put a bunch of people to decide what video to rent they don't get anywhere	
	($_{tu}$03.1.216)	Participant M>>	in the end someone has to come along and take the recommendations and get the job done.	
	($_{tu}$03.1.217)	Participant J>>	agreed	Episode 1 Boundary-End
		Participant F>>	reminds me of travelling with a bus load of ppl	Social Space
		Participant A>>	I believe I should go onto next topic now if everyone finished	
		Participant R>>	lol	
		Participant F>>	And trying to decide where to eat	

Figure 3. Sorting turns in episode into an exchange

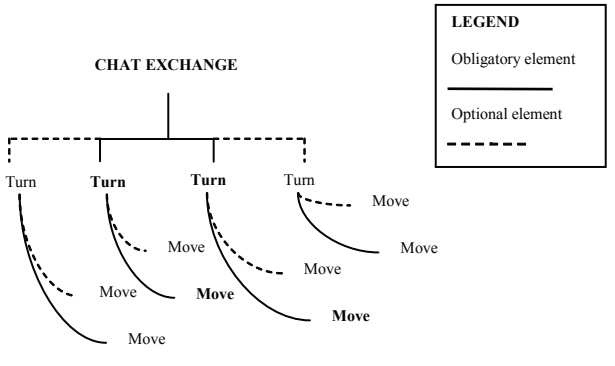
TURNS IN EPISODE		
No.	Participant	Turn
1	Eric>>	How do you get a hundred strangers to agree: Computer mediated communication and collaboration
2	Bill>>	subwayyy :D
3	Eric>>	This article is basically about a research project dubbed ?PROJECTH?. What it basically looks at is how we behave using an online text computer mediated communication. It looks at how to get 100 strangers to communicate to each other and how to get each of them to agree on some topic.
4	Eric>>	This Qu is from Robin which contains I believe elements of both topics
5	Eric>>	What is your take on Janis?s theory of ?group think? And do you think it occurs in Computer Meditated Communication (CMC)?
6	Eric>>	Would you like to or anyone else like to add to this?
7	Pete>>	I think its easier to maintain inviduality because this is more anonymous- no face to face pressure
8	Robin>>	wouldn't thought so too... its much more easier to be yourself in cmc then ftf at times
9	Jack>>	I agree with Pete. CMC removes a certain fear most people have when faced with speaking their mind.
10	Jack>>	(in a group or team situation)_
11	Eric>>	but would it be better if ftf to have your views explained to others in more detailed and see other peoples expression
12	Mike>>	yeah but cmc familiarity stops people from being polite, and wouldn't think it reduces productivity. But it does help with participation.
13	Eric>>	I agree
14	Lim>>	how does it help participation Mike?
15	Jack>>	you need to have a facilitator just the same as mentioned before, but they would act in a different way
16	Mike>>	if we were in a room right now sitting behind desks, we wouldn't be talking like we are now.
TURNS IN EXCHANGE		
No.	Participant	Turn EXG-4-g4S3-E1
1	Eric>>	How do you get a hundred strangers to agree: Computer mediated communication and collaboration
3	Eric>>	This article is basically about a research project dubbed ?PROJECTH?. What it basically looks at is how we behave using an online text computer mediated communication. It looks at how to get 100 strangers to communicate to each other and how to get each of them to agree on some topic.
4	Eric>>	This Qu is from Robin which contains I believe elements of both topics
5	Eric>>	What is your take on Janis?s theory of ?group think? and do you think it occurs in Computer Meditated Communication (CMC)?
6	Eric>>	Would you like to or anyone else like to add to this?
7	Pete>>	I think its easier to maintain inviduality because this is more anonymous - no face to face pressure
8	Robin>>	i thought so too... its much more easier to be yourself in cmc then ftf at times
9	Jack>>	I agree with Pete. CMC removes a certain fear most people have when faced with speaking their mind.
10	Jack>>	(in a group or team situation)_
15	Jack>>	you need to have a facilitator just the same as mentioned before, but they would act in a different way
12	Mike>>	yeah but cmc familiarity stops people from being polite, and i think it reduces productivity. but it does help with participation.
13	Eric>>	I agree
14	Lim>>	how does it help participation Mike?
16	Mike>>	if we were in a room right now sitting behind desks, we wouldnt be talking like we are now.

tions that reflect content directly relevant to the learning activities (task-oriented turns). Then exchanges within episodes (Figure 3) are built comprising task-oriented turns interpreted as threads relevant to the issue(s) under discussion and as structural elements of an educational chat exchange described in the following. The names of participants are pseudonyms except for Lim and Fay (authors).

The ESA Framework: Representation of Educational Chat Exchange System

At exchange level, an educational chat exchange system represents interaction as a hierarchical organization of exchanges, turns and moves (Figure 4). Synthesizing the exchange structure concepts in Coulthard and Brazil (1992) and Kneser et al. (2001), a well-formed chat exchange consists of at least an initiating and a responding turn, performed by a minimum of two participants. While in conventional spoken discourse, a turn is delimited by the start and end of a participant speaking, in chat discourse, "a carriage return effectively sends a message and automatically delimits a turn" (Kneser et al., 2001, p.67). A turn consists of at least one move indicating its pragmatic intention at the speech act level.

Figure 4. Educational chat exchange system: Exchange, turn and move



Chat Exchange Structure: Integration of ESA and SNA Perspectives

Regarding the sequence of turns that forms an exchange, exchange structure theory holds that the organization of pedagogical exchanges are distinctive for their three-part structure of Initiate, Response and Feedback [I-R-<F>] or Initiate, Response and Evaluation [I-R-<E>] (Mehan, 1985; Sinclair & Coulthard, 1992) where the optional third element, <F> or <E>, constitutes an evaluative element in the sequence of turns. For instance, the following classroom exchange (Example 1) could be characterized as consisting of "an *initiation* by the teacher, followed by a *response* from the pupil, followed by [an optional] *feedback*, to the pupil's response from the teacher" (Sinclair & Coulthard, 1992, p.3-emphasis in original) that closes the exchange.

A possible variation in turn sequence (Example 2) could take the form of [I-<RI>-R] where an optional element Reinitiate <RI> "functions as

Example 1. Pedagogical exchange: [I-R-<F>] structure (adapted from Sinclair & Coulthard, 1992, p.33)

Teacher>>	Where does he live?	**I**		
Student>>	Rome.		**R**	
Teacher>>	Rome, yes.			**F**

Example 2. Variation of pedagogical exchange: [I-<RI>-R] structure

Teacher>>	Can anyone tell me what this chart means?	**I**		
Student>>	Where is the chart?		**RI**	
Teacher>>	Look at page two.			**R**

Example 3. Pedagogical chat exchange: [I-<RI>-R-<RC>] structure

Participant A>>	did you do ICT108? you should know why the internet was first developed	**I**			
Participant B>>	hmm wasn't the internet made for the army or something...		**RI**		
Participant C>>	arpa			**R**	
Participant A>>	military, yes				**RC**

a response with respect to the preceding element and as an initiation with respect to the following one" (Coulthard & Brazil, 1992, p.71).

Kneser et al. (2001) proposed that the structure of pedagogical chat exchange (Example 3) comprised at least two elements: Initiate (I), and Respond (R), and up to four when inclusive of the elements Reinitiate (RI) and Response-Complement (RC) that is, [I-R] or [I-<RI>-R-<RC>]. The term Response-Complement is used, instead of feedback or evaluation as practiced by Sinclair and Coulthard (1992), to avoid the implication that evaluation is mandatory in a pedagogical chat exchange since the (RC) element may serve to communicate either acknowledgment or evaluative content.

Example 4. (RC) positions in pedagogical chat exchanges: [I-RC], [I-<RI>-RC] and [I-R-<RC>]

Participant A>>	does everyone understand what i have said	**I**		
Participant B>>	yes, understood		**RC**	
Participant A>>	internet drags you away from culture	**I**		
Participant B>>	how can the internet drag you away from culture, the internet is a culture		**RI**	
Participant C>>	ah			**RC**
Participant A>>	Antecedents are the contributing factors of Self-efficacy and are incorporated in the investigation of one?s degree of self-efficacy. What are some antecedents you can think of?	**I**		
Participant B>>	er... previous experience		**R**	
Participant C>>	yes - Remote working experience & training			**RC**

The refined ESA framework, presented here, holds that since (RC) is not exclusively an evaluative element and may convey acknowledgment, further variations of turn sequence in pedagogical chat exchanges are possible with a (RC) turn occupying the responding turn position after initiating turns (I) or (RI) that is, [I-RC] and [I-<RI>-RC], which is originally reserved for a (R) according to Sinclair and Coulthard (1992). Additionally, a (RC) turn could be structurally located in the responding turn position after a (R) that is, [I-R-<RC>]. Hence, well-formed pedagogical chat exchanges may also display the structures of [I-RC], [I-<RI>-RC], and [I-R-<RC>] (Example 4).

Regarding the pragmatic intentions of turns identified by moves in the educational chat exchange system, speech act theory (Austin, 1962; Searle, 1969) assumes that any sentence/turn could be used by the addressor/speaker to simultaneously perform a locutionary, an illocutionary and a perlocutionary act. The 'uptake' (Levinson, 1983) or interpretation (rightly or wrongly) of the turn's pragmatic intention, in a particular context, is held to be explained by a system of turn-taking rules or the concept of adjacency pairs which are two-turn units that "set constraints on what should be done in a next turn" (Sacks, Schegloff, & Jefferson, 1974, p.717).

Additionally, turns may perform more than one move, such as to Clarify {CLA} and Challenge {CHA} (Example 5) because, other than the immediate local context of the turn, the extra-linguistic context (Levinson, 1983), such as participant expectations about the purpose, and management routine of the online tutorial or speech event (Hymes, 1974), could contribute to a multitude of pragmatic intentions.

Example 5. A turn performing two moves

					Move*
Participant A>>	do u think by using CMC small organization will be able to upgrade and increase productivity ?	I			{INQ}
Participant B>>	how small is small anyway, if it's just one office with 20 people or whaever then what's the point?		RI		**{CLA/ CHA}**
Participant C>>	I agree			RC	{FBK}

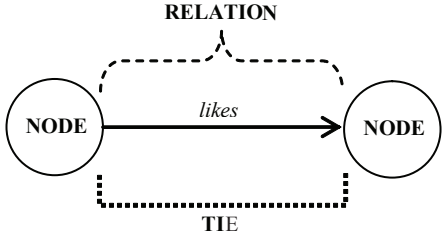
**Moves indicate the pragmatic intentions of turns e.g.s: to Inquire {INQ}, Clarify {CLA}, Challenge {CHA} or Feedback {FBK}*

As stated earlier, a well-formed chat exchange is performed by a minimum of two participants and comprises at least two elements: initiate (I), respond (R), and up to four when inclusive of reinitiate (RI) and response-complement (RC). From a SNA perspective, this concept of well-formed chat exchange remains fundamentally unchanged (Figure 5).

- A node represents a social unit which could be an individual (actor), an entity, group, organization, country, or an abstraction (point).
- A tie represents a connection/link between two nodes which is "inherently a property of the pair" (Wasserman & Faust, 1994, p.18). A connection exists between a pair of nodes which has ties incident to and/or from each other, for example, i -> j, i <- j or i <-> j.
- A relation refers to the type of tie that exists between a pair of nodes and could be extended to refer to the "collection of ties of a given kind measured on pairs of actors from a specific actor set" (Wasserman & Faust, 1994, p.20).

Therefore, a chat exchange would basically comprise nodes, ties, and relations. Since nodes could be individuals or abstract entities, both actor and turn networks could be conceived from an exchange (Example 6). In actor networks, the nodes are participants (n1, n2); ties are turns ($_{tu}$01.2.1, $_{tu}$01.2.2) that link participants; and relations are the type of turns (I, R) present between the participants (Figure 6). In turn networks, nodes are turns ($_{tu}$01.2.1, $_{tu}$01.2.2); ties are the links between turns; and relations are the types of turns (I, R) exchanged in the interaction (Figure 7).

Figure 5. Node, tie and likes relation



Example 6. Chat exchange: [I-R] structure

Turn No.	Participant	Turn		
($_{tu}$01.2.1)	n1>>	Do you think that Virtual Organisations should be based on High Reliability Organisations?	I	
($_{tu}$01.2.2)	n2>>	not really, they are a special case		R

Figure 6. Nodes as actors in chat exchange

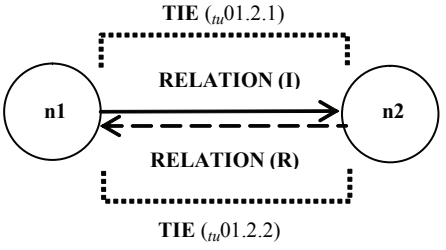


Figure 7. Nodes as turns in chat exchange

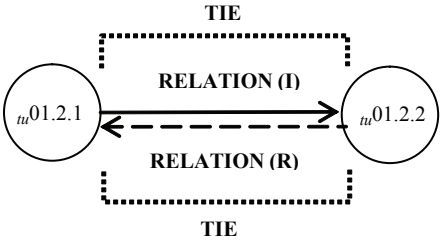
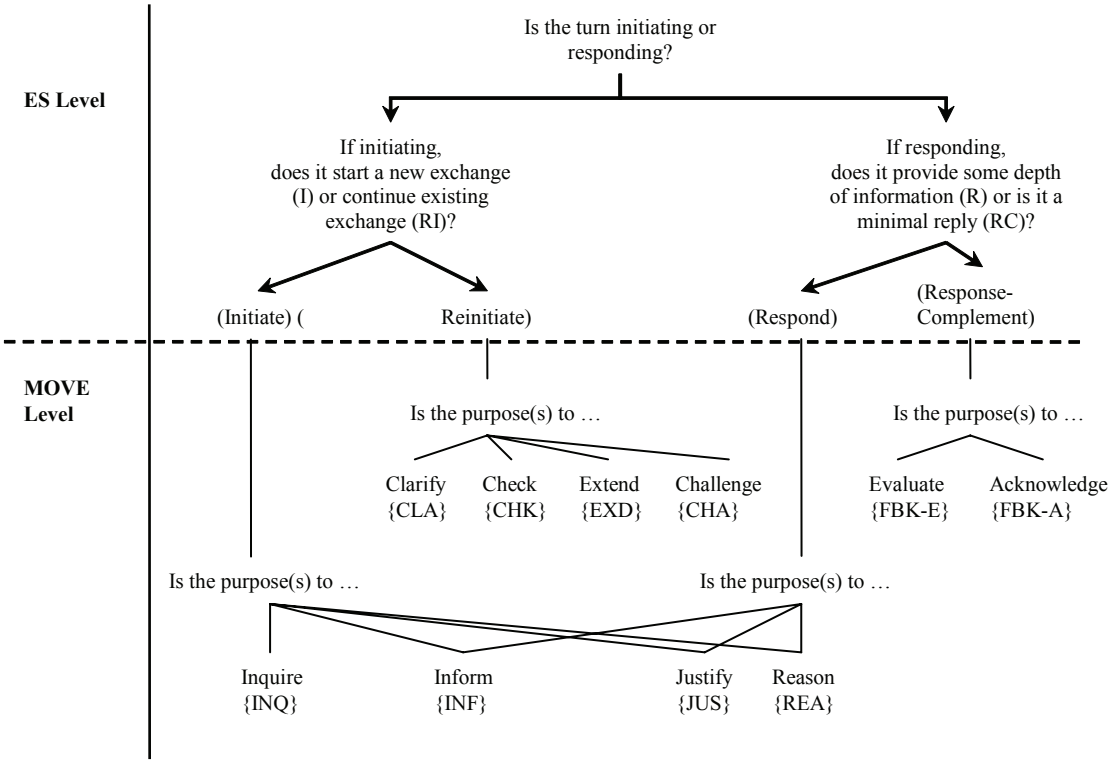


Figure 8. ESA coding scheme: Coding at ES and Move levels



In summary, the constructs of the virtual classroom interaction model, the educational chat exchange system and the chat exchange structure form the theoretical framework for the application of the integrated method of ESA and SNA described in the next section.

The Integrated Method: The ESA Coding Scheme

Reflecting the hierarchical educational chat exchange system, the refined ESA coding scheme presented here analyzes chat exchanges in tutorial discussions at Exchange Structure (ES) and move levels. Turns in episodes are first coded at the ES level according to four structural categories: Initiate (I), Reinitiate (RI), Respond (R), or Response-Complement (RC) to derive exchanges. A top-down analysis (Figure 8) starting at the ES level could reveal the structural organization of an exchange such as [I-RI-R-RC]. At the move level, coded turns are further classified according to their associated moves. For instance, a (RI) turn could be coded at the move level as having the pragmatic intention to Check {CHK}, Clarify {CLA}, Extend {EXD}, or Challenge {CHA}.

Example 7. ES and Move level analyses of a pedagogical chat exchange

		ES Level				Move Level
Participant A>>	What do you think of barber's paper-did you find it depressing? enlightening?	I				{INQ}
Participant B>>	which one? or both?		RI			{CHK}
Participant A>>	either			R		{INF}
Participant B>>	ah				RC	{FBK-A}

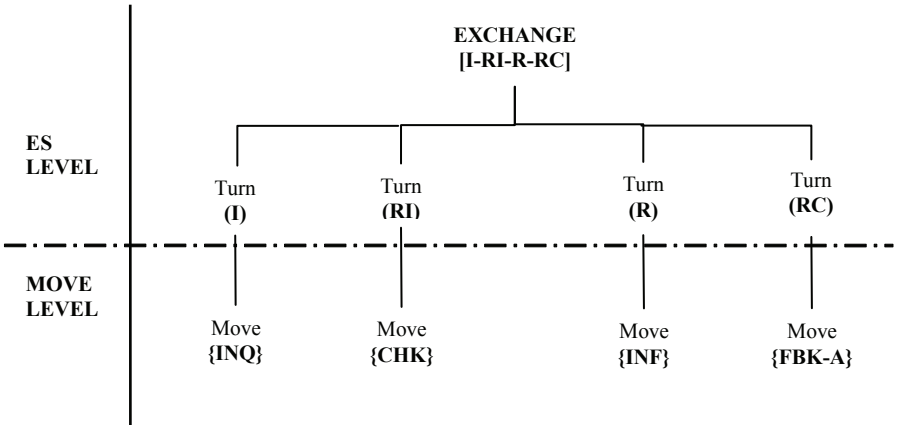
While ES level analysis reveals the structural organization of the pedagogical chat exchange, Move level analysis indicates the communicative intentions underlying the turns constituting the exchange that could offer a more informative analysis of exchange (Example 7, Figure 9). It should be noted that coding of structural positions and pragmatic functions of turns are largely guided by interpretations of their relevance to discussion context and content than the correctness of content in the turns. At this stage, the analyses of exchanges could produce results as counts of turn frequency and types which offer a static representation of interaction during the learning process. The integration of SNA with ESA provides a more dynamic interpretation of interaction which could indicate extent of topic development and participant involvement in discussions.

The Integrated Method: Network Visualization and Analysis of Chat Exchanges

From the coded chat exchanges, adjacency matrices of actor and turn networks could be built. Turns in exchanges are transformed into relational ties in adjacency matrices representing actor networks with nodes as participants (Figure 10) and turn networks with nodes as turns (Figure 11). Following the construction of adjacency matrices of actor/turn networks, visualization of data as sociograms (Figure 12a/b) is carried out with NetMiner II version 2.4.0 (Cyram, 2004) which is a commercial SNA program.

Chat exchanges can be visualized as actor and turn network sociograms. The actor network sociogram (Figure 12a) is a graphical representation of the chat exchange in Figure 10. With nodes as actors/participants, the sociogram illustrates the extent of directional symmetry of information flow in the exchange. The sociogram shows that n9 (Robin) occupies a central position in the network as the initiator of the exchange; with many ties

Figure 9. ES and Move level analyses of a pedagogical chat exchange



sent to adjacent actors. Similarly, actors n3, n10 and n11 are prominently located as recipients of more ties than others in the network. Additionally, as all actors are connected by ties, this suggests that all participants in the network are included in the exchange.

The same chat exchange can be visualized as a turn network sociogram (Figure 12b) based on the adjacency matrix in Figure 11. With nodes as turns, the sociogram illustrates a main conversational thread and the development of divergent discussion strands in the exchange. The sociogram shows that the exchange opens with a turn (tu45) and closes with tu92. Even though tu45 starts the exchange, it is clear that tu73 plays a key role in extending the direction of discussion. Furthermore, the presence of an extended turn sequence, comprising multiple short turns (tu78+84+86) posted by the same participant that sends a complete message, signals the quantity of information exchanged which could indicate development of some depth in the discussion.

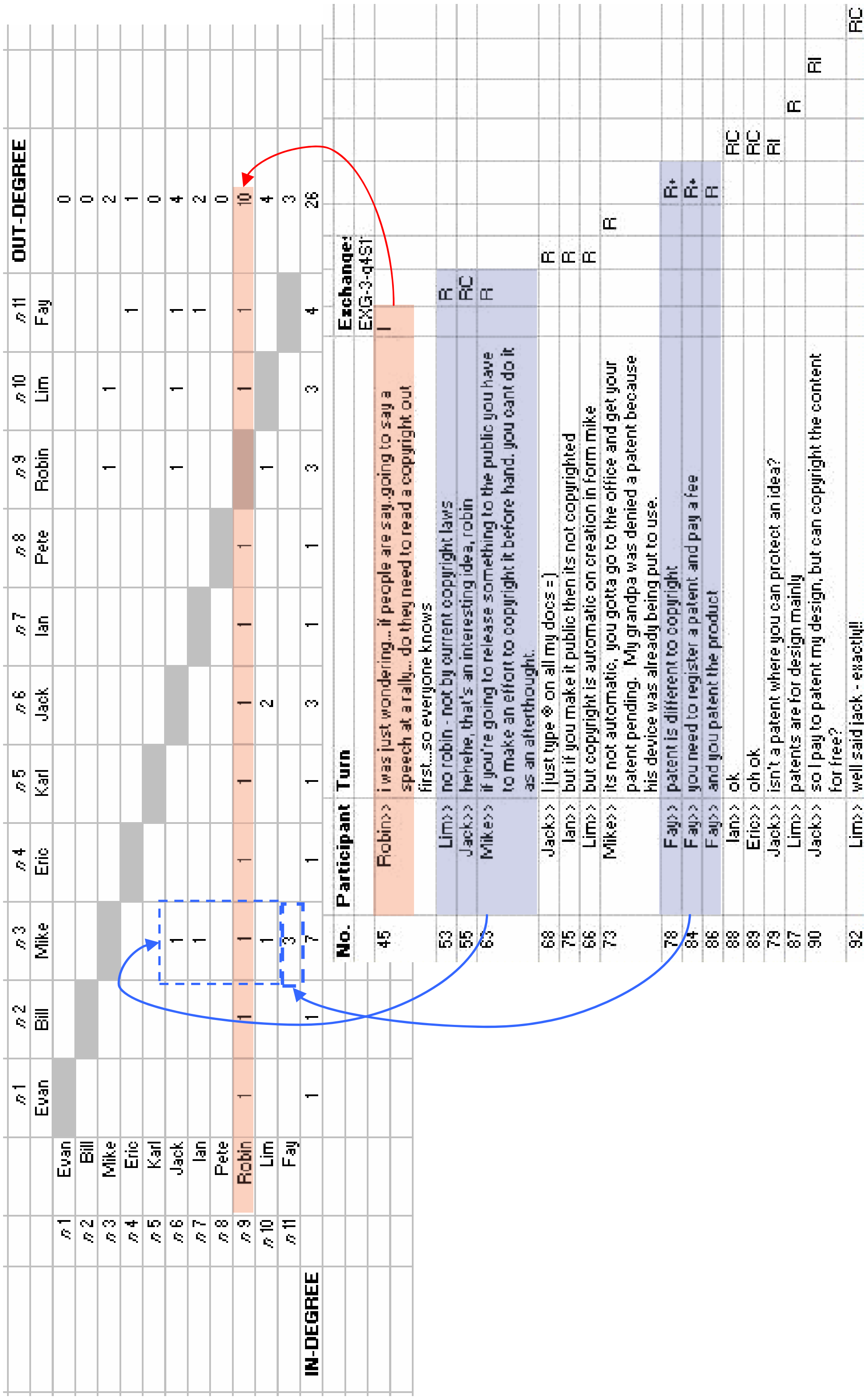
In Lim (2006), network analysis with measures of degree, inclusiveness, node type and reciprocity were also carried out with NetMiner II. However, this chapter focuses on actor-node type analysis and the SNA concepts of degree and actor type fundamental to the analysis are explained below.

Degree: The relations examined are behavioral interaction involving 'talking' and initiating/responding in exchanges which are characterized by the transfer (one-way) or exchange (two-way) of nonmaterial resources (information). Given the nature of such relations, ties (as links or turns) are directed and valued (Figure 12a) indicating respectively, the communicative direction of the information exchange as out-ties (ties sent) or in-ties (ties received), and the frequency of the interaction as degree of connection between a node to other nodes adjacent to it.

Actor-node type: Actors are a finite set of participants in two tutorial groups functioning as distributors and/or recipients of information during discussions. Drawing from the concept of degree as the frequency of ties/turns sent (outdegree) or received (indegree) between actor-nodes, the extent of directional symmetry in the flow of information between actors could be examined through the concept of actor-node types.

Based on overall tendencies to send and/or receive ties, actors could be analyzed as four node types (Wasserman & Faust, 1994) (Figure 13) with the proportion of actor-node types present indicating the extent of participant involvement in the information sharing process.

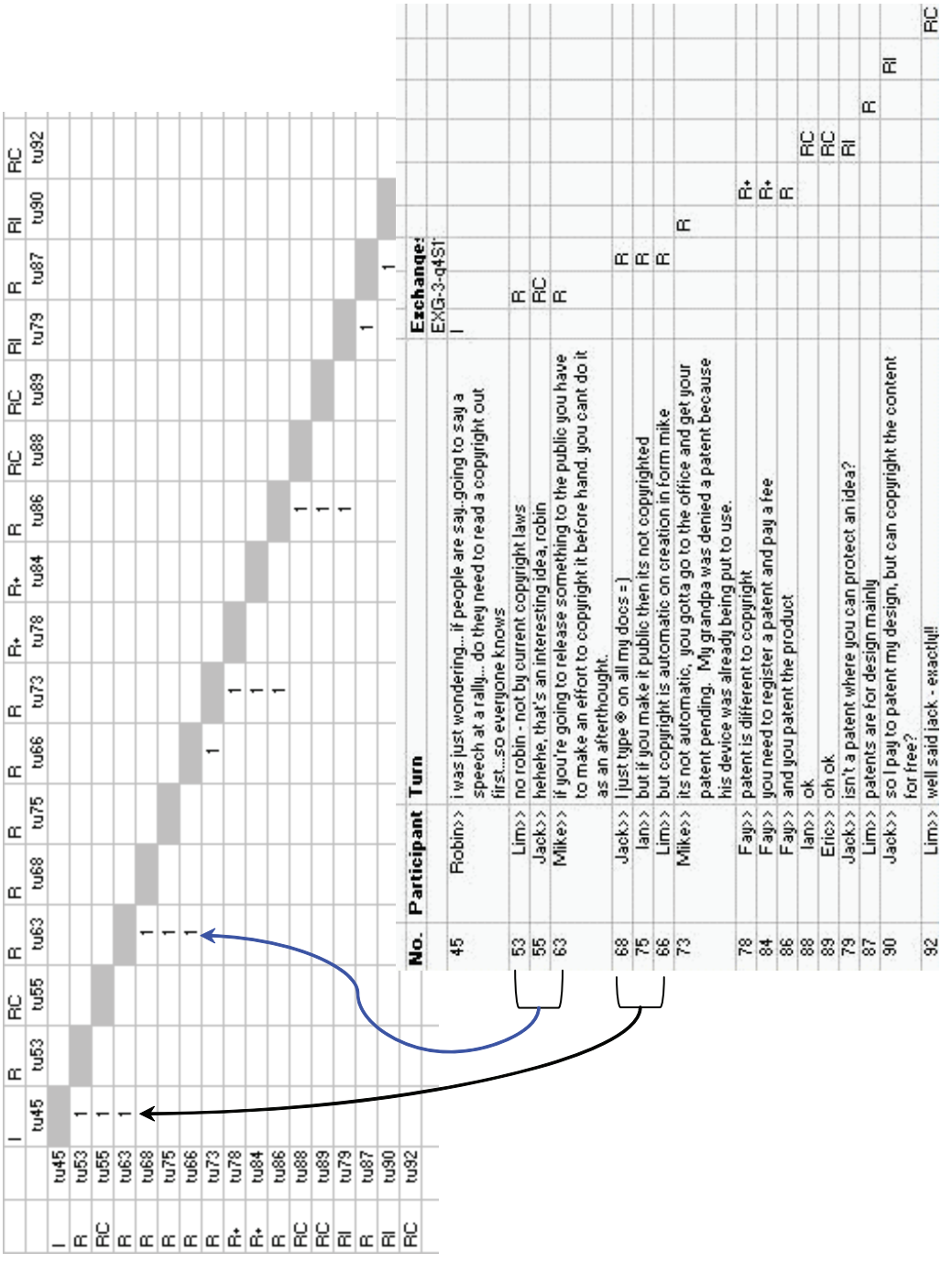
Figure 10. Chat exchange: Actor network adjacency matrix



		♬1 Evan	♬2 Bill	♬3 Mike	♬4 Eric	♬5 Karl	♬6 Jack	♬7 Ian	♬8 Pete	♬9 Robin	♬10 Lim	♬11 Fay	OUT-DEGREE
♬1	Evan												0
♬2	Bill												0
♬3	Mike									1	1		2
♬4	Eric											1	1
♬5	Karl												0
♬6	Jack			1						1	1	1	4
♬7	Ian			1								1	2
♬8	Pete												0
♬9	Robin	1	1	1	1	1	1	1	1		1	1	10
♬10	Lim			1			2			1			4
♬11	Fay			3									3
IN-DEGREE		1	1	7	1	1	3	1	1	3	3	4	26

No.	Participant	Turn	Exchange: EXG-3-q4S1								
45	Robin>>	i was just wondering... if people are say..going to say a speech at a rally... do they need to read a copyright out first...so everyone knows	I								
53	Lim>>	no robin - not by current copyright laws		R							
55	Jack>>	hehehe, that's an interesting idea, robin		RC							
63	Mike>>	if you're going to release something to the public you have to make an effort to copyright it before hand. you cant do it as an afterthought.		R							
68	Jack>>	I just type ® on all my docs =)			R						
75	Ian>>	but if you make it public then its not copyrighted			R						
66	Lim>>	but copyright is automatic on creation in form mike			R						
73	Mike>>	its not automatic, you gotta go to the office and get your patent pending. My grandpa was denied a patent because his device was already being put to use.				R					
78	Fay>>	patent is different to copyright					R+				
84	Fay>>	you need to register a patent and pay a fee					R+				
86	Fay>>	and you patent the product					R				
88	Ian>>	ok						RC			
89	Eric>>	oh ok						RC			
79	Jack>>	isn't a patent where you can protect an idea?						RI			
87	Lim>>	patents are for design mainly							R		
90	Jack>>	so I pay to patent my design, but can copyright the content for free?								RI	
92	Lim>>	well said jack - exactly!!									RC

Figure 11. Chat exchange: Turn network adjacency matrix



		I	R	RC	R	R	R	R	R+	R+	R	RC	RC	RI	R	RI	RC
		tu45	tu53	tu55	tu63	tu68	tu75	tu66	tu73	tu78	tu84	tu86	tu88	tu89	tu79	tu87	tu90	tu92
I	tu45																	
R	tu53	1																
RC	tu55	1																
R	tu63	1																
R	tu68				1													
R	tu75				1													
R	tu66				1													
R	tu73							1										
R+	tu78								1									
R+	tu84								1									
R	tu86								1									
RC	tu88											1						
RC	tu89											1						
RI	tu79											1						
R	tu87														1			
RI	tu90															1		
RC	tu92																	

No.	Participant	Turn	Exchange: EXG-3-q4S1
45	Robin>>	i was just wondering... if people are say..going to say a speech at a rally... do they need to read a copyright out first...so everyone knows	I
53	Lim>>	no robin - not by current copyright laws	R
55	Jack>>	hehehe, that's an interesting idea, robin	RC
63	Mike>>	if you're going to release something to the public you have to make an effort to copyright it before hand. you cant do it as an afterthought.	R
68	Jack>>	I just type ☻ on all my docs =)	R
75	Ian>>	but if you make it public then its not copyrighted	R
66	Lim>>	but copyright is automatic on creation in form mike	R
73	Mike>>	its not automatic, you gotta go to the office and get your patent pending. My grandpa was denied a patent because his device was already being put to use.	R
78	Fay>>	patent is different to copyright	R+
84	Fay>>	you need to register a patent and pay a fee	R+
86	Fay>>	and you patent the product	R
88	Ian>>	ok	RC
89	Eric>>	oh ok	RC
79	Jack>>	isn't a patent where you can protect an idea?	RI
87	Lim>>	patents are for design mainly	R
90	Jack>>	so I pay to patent my design, but can copyright the content for free?	RI
92	Lim>>	well said jack - exactly!!	RC

Figure 12a. Chat exchange: Actor network sociogram

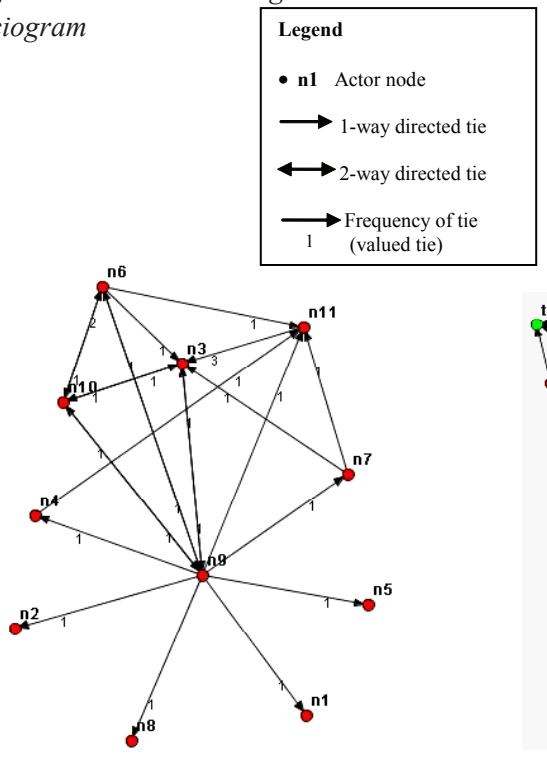
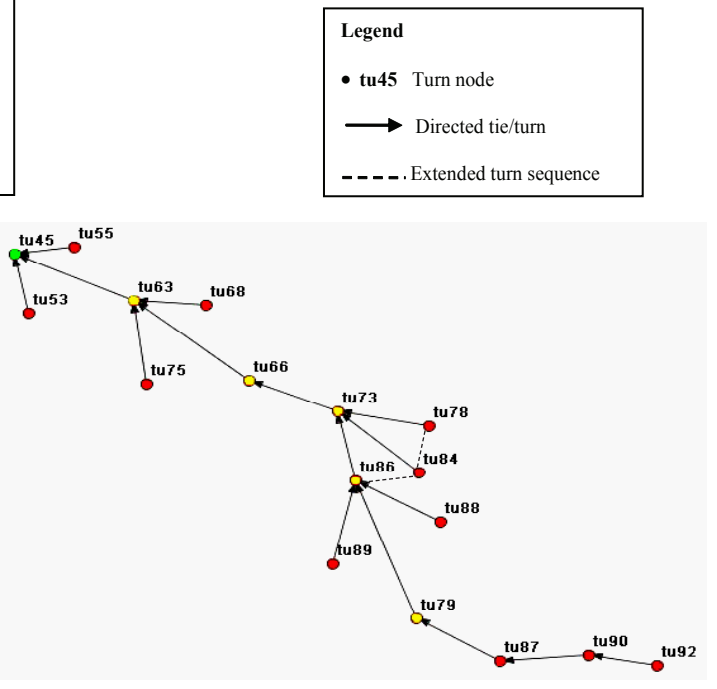


Figure 12b. Chat exchange: Turn network sociogram



- Isolate: actor-node with no ties incident to or from it.
- Transmitter: actor-node with only ties originating from it.
- Receiver: actor-node with only ties terminating at it.
- Carrier: actor-node with ties incident to and from it.

The next section presents findings from the application of the integrated method to examining the presence of topic development phases in chat exchanges and the extent of participant involvement in the online collaborative learning process.

RESULTS FROM THE INTEGRATED METHOD

This section presents a sub-set of results from Lim (2006) which applied the integrated method of ESA and SNA to examining educational chat interaction during collaborative group learning. Specifically, this section discusses findings on the presence of topic development phases in chat exchanges as indicators of knowledge construction and on network analysis of actor-node type showing the extent of participant involvement in knowledge construction processes.

The presence of topic development is operationalized as the frequency of {INQ, CHK,

Figure 13. Actor-node types: isolate, transmitter, receiver, and carrier

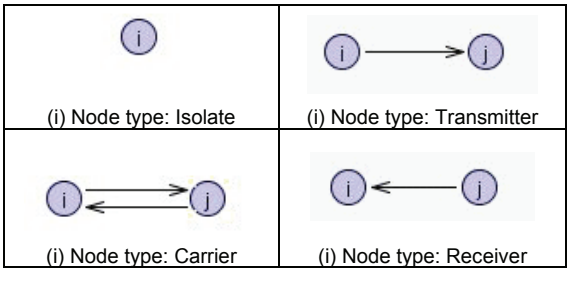


Table 1. Descriptors for move set

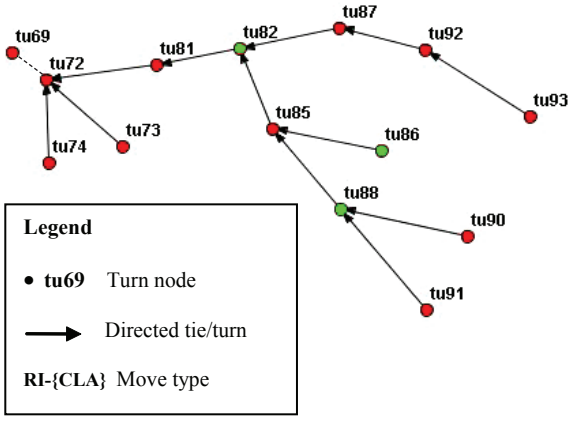
Move Set	Description
{INQ}	- functions to elicit more information with a question that may stimulate discussion on a new topic hence initiating a new exchange.
{CHK}	- used in responses to make certain the meaning of previous turns in exchanges with questions/statements that may start sub-exchanges.
{CLA}	- used for seeking additional information on what was said in previous turns with questions or statements that may start sub-exchanges.
{CHA}	- serves to propose/assert the need for another direction for discussion or consideration that may start sub-exchanges.

CLA, CHA} moves from the ESA scheme. The main pragmatic purposes of this set of moves are explained in Table 1. Essentially, the presence of these moves in exchanges could signal phases where information shared is questioned, checked, clarified, or challenged, reflecting efforts at developing main conversational threads further in terms of direction and depth. Hence, from a sociocultural constructivist perspective, the presence of such topic development phases in exchanges could indicate participant involvement in the activity of meaning negotiation that builds new knowledge.

More specifically, the presences of these moves convey the following implications regarding topic development in chat exchanges.

- The presence of Initiate-{INQUIRE}, that is, I-{INQ}, signals the formation of a new conversational thread in an episode that opens discussion on another aspect of the issue(s) in the set-readings(s).
- The presences of Reinitiate-{CHECK} and Reinitiate-{CLARIFY}, that is, RI-{CHK}, RI-{CLA}, indicate attempts to progress further in understanding the topic by questioning rather than merely accepting the shared information.

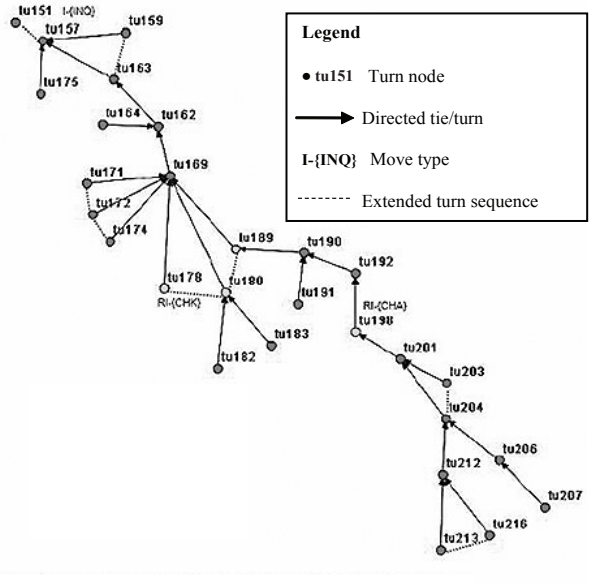
Figure 14a. Topic development with I-{INQ} and RI-{CLA} in abridged exchange



- The presence of Reinitiate-{CHALLENGE}, that is, RI-{CHA}, suggests efforts at critical appraisal of what was said in previous turns, resulting in the proposal of alternatives for further discussion.

With the further application of SNA visualization techniques, topic development in chat

Figure 14b. Topic development with I-{INQ}, RI-{CHK} and RI-{CHA} in abridged exchange



Example 8. I-{INQ} and RI-{CLA} moves in abridged exchange

No.	Participant	Turn	EXG-4-g4S3-E1						
69	Fay>>	what is the best way to resolve conflicts in a team?	I+						INQ
72	Fay>>	as an example, if you had conflict in your team project, how would you deal with it?	I						INQ
73	Robin>>	i think open communication....and perhaps also having time during the project just to discuss if any problems come with other team members		R					INF
74	Jack>>	if it was over the internet there would be a lot of flaming! =)		R					INF
81	Jack>>	In an ideal world you would want to discuss the problem among all members of the team and come to a unanimous consensus		R					INF
82	Lim>>	in not so ideal world Jack?			RI				CLA
87	Jack>>	there would be a last-minute decision made by someone in a dictatorship-like role				R			INF
92	Evan>>	but a good dictator might be able to get things done faster					R		JUS
93	Jack>>	it's good to be the king, but only if you're seen to be a "good" king (which obviously differs depending on who you ask)						R	JUS
85	Pete>>	Democracy if there are an odd number of people in the team? The will of the majority?				R			INF
86	Robin>>	what if there isn't a majority??					RI		CLA
88	Eric>>	what if the will has made a bad choice					RI		CLA
90	Evan>>	democracy allows for check and balances against bad decisions,						R	INF
91	Pete>>	Democracy is the freedom to make choices...even if they're bad. Its the price for social cohesion						R	JUS

exchanges could be illustrated as sociograms depicting turn networks. In turn networks, nodes are turns, ties are the directional links between turns and relations are the types of turns exchanged. The following examples and sociograms of exchanges reveal the development of discussion strands that branch from the main conversational thread as indicated by the presence of I-{INQ}, RI-{CHK}, RI-{CLA} and RI-{CHA} Moves (Example 8/9, Figure 14a/b). The sociogram in Figure 14a shows that the exchange was started with an extended turn sequence (tu69+72). Two of the three RI-{CLA} turns (tu82, tu88) play key roles in extending the discussion direction as a number of subsequent turns were responses to them but tu86 clearly did not receive a response.

In Figure 14b, the sociogram illustrates the opening of the exchange with an extended turn sequence (tu151+157). The (RI) turns (tu198, tu178+180+189) play crucial roles in extending the direction of discussion as a number of subsequent turns were responses to them. Also, compared to Figure 14a, there are more extended turn sequences present in this exchange (tu151+157, tu159+163, tu171+172+174, tu178+180+189, tu203+204, tu213+216), which suggest a greater depth of discussion with the exchange of more information through longer messages.

Example 9. I-{INQ}, RI-{CHK} and RI-{CHA} moves in abridged exchange

No.	Partici-pant	Turn	EXG-7-g4S1-E1												
151	Evan>>	Sorry guys but to get back on topic - Pete asked the question - What sub cultures or ?communities of practice? would you expect to find within an organization? anyone like to discuss there experiences	I+												INQ
157	Evan>>	pete this was your question anything you would like to add	I												INQ
175	Ian>>	i found that there may be less com-munication		R											INF
159	Pete>>	Engineers tend to follow their pro-fession - Reliability Engineers are the most reliable, Control Engineers like to have the situation under con-trol , and Electrical Engineers just look for the coloured wire.! :-)		R+											INF
163	Pete>>	I think there are different communi-ties of practice - definite groups who use information systems in distincty patterns.		R											INF
162	Robin>>	i find network adminstrators.....can well kinda be a bit no it alls at times			R										INF
164	Jack>>	I find that from techies...esp. at Rocko campus!				R									INF
169	Evan>>	I agree - they tend to hoard knowl-edge - you find alot of them are afraid if you know to much you might take their job				R									JUS
171	Eric>>	Likewise but it is there job to know what is wrong so that they may fix the problem asap even if some of them are impatient					R+								JUS
172	Eric>>	and less understanding					R+								JUS
174	Eric>>	when it comes down to the end users problem only at times though					R								JUS
178	Jack>>	Wouldn't it be in their best interests to educate others about how to fix certain "smaller" problems so they can concentrate on larger issues?					RI+								CHK
180	Jack>>	I'm referring more to end users					RI+								CHK
182	Fay>>	good point jack						RC							FBK-E
183	Ian>>	its benificial as a whole to do that						R							INF
189	Jack>>	Maybe I'm thinking more from a managers' point of view?					RI								CHK

Continued on following page

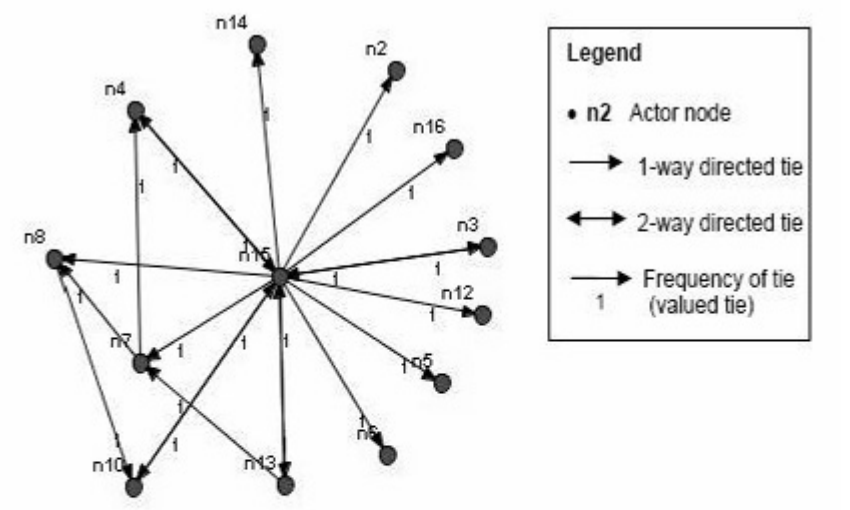
Example 9. Continued

190	Pete>>	The other problem is that immediate problems may not be seen as a priority by management.						R							INF
191	Robin>>	but as a priority to the user with the problem													INF
192	Jack>>	I think "my" business would be more effecient and productive if end users were capable of fixing problems (and perhaps not making them in the first place)...													REA
198	Eric>>	What if the end user has no technical expertise to fix the problem								RI					CHA
201	Jack>>	that's where the IT Pro should spend a little extra time educating the person, rather than just fixing the problem									R				REA
203	Eric>>	but it takes time to learn new things which the organisation may not want to waste										R+			JUS
204	Eric>>	if it is not benefiial										R			JUS
206	Jack>>	they may not learn a lot, but if they learn enough to save 10 minutes while they would wait for someone else to fix the problem, that's a net gain in my book											R		REA
207	Eric>>	agreed												RC	FBK-E
212	Ian>>	i think training a organisation can be of immense value											R		INF
213	Eric>>	at a cost if it does not increase production												R+	JUS
216	Eric>>	like training them to use a chat system may or may not increase productivity it depends if the organisation will profit from it												R	JUS

Example 10. Exchange for actor-node type analysis

No.	Participant	Turn	EXG-6-g1S1-E1					
n15	Wendy>>	an issue will be why people still making n upgrading newer applications if win3.1 is so good?	I					INQ
n4	Cliff>>	it's becasue win 3.1 is not good		R				JUS
n7	Sam>>	and the graphics are not to hot			R			JUS
n13	Barry>>	yea				RC		FBK-E
n3	Alvin>>	technically speaking, play game		R				INF
n13	Barry>>	ppl r probably upgrading and making new technology because its never enough		R				JUS
n10	Alan>>	they want more features, power etc.		R				INF
n8	Diane>>	the perpetual hunt for more			R			INF
n7	Sam>>	development cant be stopped				R		INF

Figure 15. Actor-node type analysis: Sociogram and actor-node types in exchange



NUMBER OF NODE TYPE

Isolate	Transmitter	Receiver	Carrier
0	0	6	7

The additional analysis of actor-node type could indicate the extent of participant involvement in mutual sharing of information which is an essential aspect of the collaborative learning process. Actor-node type analysis, handled by NetMiner II, reveals the proportion of isolates, transmitters, receivers and carriers present in the exchange (Example 10, Figure 15). The sociogram in Figure 15 highlights the central position of n15 (Wendy) who sends and receives (a carrier) most ties from adjacent actors. When ties are regarded as means for exchange of information, social and emotional support between actors in the exchange, the interactional patterns revealed through visualization and network analysis reflect the involvement of mainly receivers (with only ties terminating at them) and carriers (with ties incident to and from one another). The presence of valued ties connecting all nodes in the network also indicates the involvement of all participants in the exchange. Broadly, such findings indicate the extent to which participants were involved in tutorial discussions, and the exclusion and inclusion of certain participants from the collaborative dialogic process of knowledge construction.

In summary, the application of the integrated method of ESA and SNA to the analysis of dialogic participation in virtual tutorial discussions revealed the following aspects in the collaborative group learning processes facilitated by chat interaction:

- Presence of knowledge construction as a set of Moves, from the ESA scheme, indicating instances of topic development phases in exchanges. The presence of such phases where the information shared by participants is questioned, checked, clarified, or challenged, suggests efforts at meaning negotiation that build new knowledge.
- Direction and depth of discussion in chat exchanges with the presence of divergence

in conversational threads and extended turn sequences from SNA visualization of exchanges as turn networks.

- Extent of participant involvement in the mutual sharing of information as the proportion of actor-node types in exchanges, suggesting the exclusion and inclusion of certain participants from the collaborative construction of learning conversations.

Given the constructivist view held here that knowledge is constituted in dialogic interaction, and the scarcity of research and analytical frameworks that investigate knowledge construction processes facilitated by online synchronous interaction, the integrated method of DA and SNA offers an effective analytical approach for examining the quality of educational chat interaction at the following levels of granularity.

Using only the ESA coding scheme, an analysis of chat interaction at the ES level reveals the structural organization of pedagogical chat exchanges, which could indicate individual/group tendencies towards initiating or responding in exchanges from the quantitative counts of turn frequency and types. An ES level analysis alone could also indicate coherence of discussions in episodes from the proportion of completed exchanges to other turns that are not part of any exchange in terms of their relevance to the discussion context or content. The finer level of Move analysis reveals the communicative intentions underlying the turns, which could indicate individual/group efforts at meaning negotiation that lead to shared understandings.

The addition of SNA reveals the dynamic nature of relational ties in online learning groups, formed from dialogic interaction, which are means for exchanging information, social and emotional support. The visualization of education chat exchanges as turn network sociograms could show direction and depth of discussion as, respectively, divergence in main conversational threads and extended turn sequences that convey longer messages. Also, actor network sociograms could be used to illustrate network positions occupied by individuals from their overall behavioural tendencies towards sending or receiving ties during group discussions. Furthermore, SNA measures of actor-node type and degree could be used to analyze participant involvement in information sharing and knowledge building as the extent of directional symmetry of information flow between actors in learning conversations. In effect, the full analytical suite of DA and SNA offers a powerful yet flexible approach for investigating educational CMC interaction at various levels of granularity depending on the focus of the research.

CONCLUSION

This chapter specifically covered the issue of the quality of educational interaction facilitated by synchronous CMC technology. In addition, the chapter provided an in-depth description of the integrated method of ESA and SNA for analyzing educational chat exchanges present in computer mediated discourse, and illustrated the application of the integrated method to coding and visualizing exchanges during collaborative group learning. Findings from a wider study (Lim, 2006) showed the extent of participant involvement in the sharing of information during discussions as actor-node types in exchanges. The results also showed the presence of topic development in exchanges which indicates participants' efforts at meaning negotiation. When interpreted from a sociocultural constructivist perspective, these findings revealed participants' involvement in information sharing and meaning negotiation during education chat interaction which are activities characteristic of knowledge building processes.

The integrated method of ESA and SNA, introduced in this chapter, for examining knowledge construction processes in educational chat interaction, will be of interest to researchers who are concerned with the use of technology for online

learning; higher education faculty responsible for the design and delivery of distance learning programs; and promoters of educational technology who may benefit from a greater understanding of the role of synchronous CMC media in supporting the learning process. The next section suggests future research areas with the integrated method for studying online collaborative learning processes.

FUTURE TRENDS

The integrated method of ESA and SNA was shown to enable the examination of knowledge building processes in educational chat interaction from a sociocultural constructivist perspective. Since the integrated method was applied primarily for analyzing task-oriented turns related to knowledge construction, a future research area could include an investigation of non task-oriented turns, reflecting social-emotional content, which could provide more insight for online facilitators on managing online learning communities. As chat exchanges were the primary focus of analysis here, further work could investigate the actors in terms of shifts in actor positions within networks over time, which could be highly informative regarding the effects of cliques and centrality of actor positions on online learning processes.

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KEY TERMS

Adjacency Matrices: Display relational data with cases represented by both rows and columns, and the relations represented by entries in matrix cells.

Chat Exchange: Consists of at least an initiating and a responding turn, performed by a minimum of two participants.

Chat Rooms: Data communication channels that link computers supporting real-time interaction by users mainly via text messages.

Move: Refers to the pragmatic purpose or communicative intention underlying turns at speech-act level.

Sociograms: Graphical displays of nodes representing entities and lines representing ties or relations.

Turn: Refers to contributions that fall within Episode boundaries in the transcript. In chat discourse, "a carriage return effectively sends a message and automatically delimits a turn" (Kneser et al., 2001, p.67).

Utterance: "Everything said by one speaker before another began to speak" (Sinclair & Coulthard, 1992, p.2). The term refers to all contributions made by participants within a Session in the transcript.