

***HIERARCHICAL VS. SEQUENTIAL WEB FORUMS.***  
***METHODOLOGICAL ISSUES IN INTERACTION ANALYSIS***

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**Sommario:** La continua diffusione della Social Network Analysis nell'ambito delle interazioni online sta sviluppando interessanti filoni di ricerca per quanto riguarda le metodologie da adottare nella codifica dei dati e nella fase di interpretazione dei risultati. Emergono, infatti, importanti implicazioni metodologiche nell'applicazione della SNA con sistemi automatizzati rispetto a strumenti non automatizzati. La problematica indagata dal paper riguarda, in particolare, l'attribuzione del ruolo del destinatario e del mittente in ambienti di comunicazione sequenziali e gerarchici, con particolare riguardo ai forum (dove i messaggi vengono spesso indirizzati a tutto il gruppo) ed estensibile anche a contesti interattivi diversi, in cui sia difficile individuare in modo univoco la direzione dei messaggi. Gli autori presentano alcuni sviluppi del *semantic analysis combined with potentiated structural analysis (S/SC) model*, con la proposta di soluzioni operative utili a diversi contesti di interazione e apprendimento online.

**Summary:** The wide spread of Social Network Analysis in the field of online interactions is developing interesting lines of research regarding methodologies to be adopted in encoding data and interpretation of results. Many important methodological implications in the application of SNA are becoming central in the comparison between automated systems versus non-automatic procedures. The paper investigates the attribution of addressees role in sequential and hierarchical web forums. Specific empirical issues are presented about generic messages (no addressee is selected), regards and coding procedures in different online environments. The authors also present some developments in the *semantic analysis combined with structural analysis potentiated (S/SC)*, together with some operational proposals suitable for different kinds of communication contexts.

**Keywords:** Social Network Analysis; Computer-Mediated Communication; Asynchronous Learning environment; Interaction patterns; Automatic coding procedure; Qualitative coding procedure.

**Parole chiave:** interazioni online, comunicazione, codifica qualitativa, Interaction patterns

# Hierarchical vs. Sequential Web Forums.

## Methodological issues in Interaction Analysis.

### 1 - INTRODUCTION

In Computer-Supported Collaborative Learning (CSCL) environments, also in the early stages of group formation and development, forms of participation are externalized by interactions among group members, starting from very simple and sometimes much dispersed connections to richer and interconnected patterns of exchanges. From this point of view, methods of Social Network Analysis (SNA) seem to be appropriate to study these patterns as they focus on the interrelationships among individuals rather than assuming an individualistic perspective. Through the concepts of nodes and links that constitute the network of participants, SNA displays relationships as graphs, with nodes representing individuals and edges representing interaction types [Scott (1991); Wasserman & Faust (1997)].

In recent years SNA has been successfully applied in Computer Mediated Communication (CMC) scenarios to the study of participatory aspects of learning, especially when it is used in combination with other methods, such as content analysis and quantitative techniques [Daradoumis et al. (2004); Zhu (2006); Martinez et al. (2006); De Laat et al. (2007)] or multidimensional scaling and correspondence analysis [Hurme et al. (2006)]. Approaches aimed at visualizing participation have proved to be successful in fostering and improving participation during CSCL learning [Janssen et al. (2007)].

SNA has been used to investigate the role that key communicators occupy in a social communication network and how they influence others' behaviours in the form of social navigation [Cho et al. (2002)].

In conjunction with quantitative and qualitative analysis, Martinez et al. (2006) underline how SNA is suitable to carry out analysis techniques, data collection and processing tools that are flexible enough to be applied in different kind of learning contexts, either

blended and distance courses or synchronous learning events.

Most of the studies that use indices and methods of SNA take computers logs as input data and perform specialised SNA by means of software tools (i.e., Ucinet, NetMiner, etc.). Indeed, server programs record significant events in log files, which are the most widespread method of collecting data. Tracking of raw data and subsequent analysis of log files is often used for gaining on-the-fly information about the participative dimension.

Examples of raw data are: the number of sessions for each participant (with starting and ending time), the number of messages sent (sorted according to participant, area/conference, given periods, etc.), the size of the messages sent by each participant, the number of messages read (opened) by each participant, the number of threads activated by students and by tutors, the number of documents produced; the number of chats, etc. [Pozzi et al. (2007)].

Nurmela et al. (1999) look at log files as the basis for data collection and analyse these to provide a perspective on how well the collaboration has worked. In their study data were obtained as a subset of the several actions made by students and recorded in a log file. They state that log files can be used effectively to evaluate relevant behaviours in a CSCL environment as they are a quick way to select and organize large amounts of information.

Martinez et al. (2003) developed a tool called SAMSA (System for Adjacency Matrix and Sociogram-based Analysis), that processes interaction from log files. This tool takes in input the interaction data represented in an XML syntax and builds a sociomatrix representing the social network and computes the indices chosen to describe the participatory patterns of the network. It also shows the sociogram based on multidimensional scaling statistics and allows for the visualization of the actors' attributes.

All these studies assume that the kind of data source recorded in log files reflects the way people have really interacted. However, meaning of information contained in these files varies deeply on the type of forum used. For instance, posting a message in a sequential forum is very different from posting a message in a hierarchized forum where all messages are arranged in branches of trees [Hewitt (1991)] (see Figure 1).

In a sequential web forum (i.e. PhpBB, Vbulletin, Docebo, etc.) users read all the messages posted and then send their message or their answer to the forum. With this interface visualization the reader answers to the solicitations coming from the previous messages, so it is very difficult to know if answers are personally or collectively directed. Another difficulty arising with this type of visualization regards the notion of conversation. Since discussion takes the form of an interaction one-to-many, the sender speaks to the group of participants in a sort of monologue that requires to be read, but not necessarily replied to.

In a hierarchized web forum (e.g., Knowledge Forum, Synergeia or Moodle platform in hierarchized visualization) users can read only one message at a time and their answer is a reply to that precise message. This interface induces an interaction that is more similar to face-to-face conversation, in which the addressee replies to a specific speaker and each reply is addressed to a specific message.

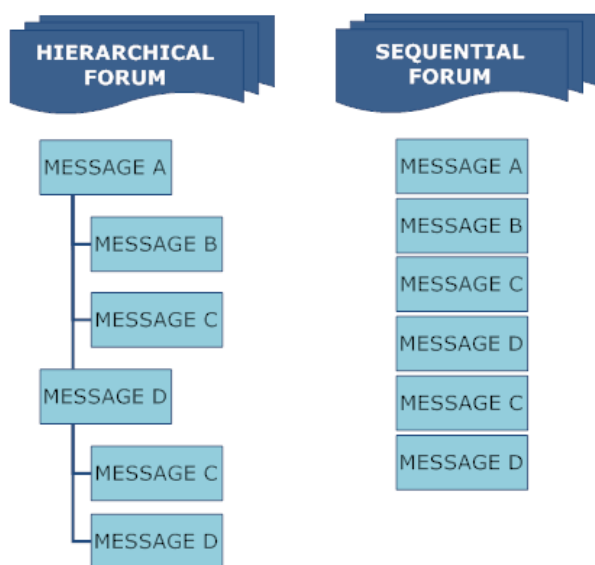


Figure 1. Hierarchical and Sequential Web Forums.

The outlined comparison between sequential and hierarchized visualization interface of messages is a critical aspect for SNA. On one side, it is not clear how to consider the messages sent to the whole group of participants in a web forum with sequential interface visualization: is it correct to consider these messages as they were sent only to repliers? On the other, different visualizations imply different tracking of the user's action. For instance, in a sequential web forum reading only one message within a thread coincides with reading the entire thread. In contrast, the tracking system of a hierarchized visualization interface differentiates between individual message read or not by a specific user. This is a crucial aspect in SNA, especially when it is chosen to conduct an analysis considering each message as it was directed to all its readers.

Another critical aspect of web forum is the user expertise in relation to the visualization interface of messages. Observing different web forums on the web, we can note that a lot of people, especially novices and beginners, face difficulties in using "properly" the communication functions provided by the environment. For instance, in hierarchized visualization of the messages, it is common to find messages posted in a wrong thread, or reply messages posted as they were the thread starters. These problems affect the way interaction are recorded and stored in the system tracking and, consequently, the relations visualized in a SNA sociogram and the relative structural indices.

On these premises and considerations, objective of this study is to provide answers to the problems usually faced when coding interaction patterns that rely on web forum in natural CMC contexts. Applying recent issues in coding procedures [Manca et al. (2009)], the paper compares results coming from a sequential and a hierarchical web forum coming from two different online learning environments.

## 2 - METHOD

### 2.1 - Context of the study

Data are collected from two different blended learning contexts, in which a semi-structured metaphorical activity was planned for initial socialization purposes.

The Welcome activity is based on a metaphorical approach to online interaction and familiarization with web forums: like sailors, distance students browse in a world of online resources (learning object, documents, tools, etc.) [Delfino & Manca (2007); Manca & Delfino (2007)]. In the first step of activities students have to choose a boat (symbolized by a specific thread or a conference area) just replying to a tutor's posting or creating a new one. In the second step, collaborating with tutors and the other students that choose the same boat, they have to find a name and an evocative phrase for the boat.

This simple three week activity aims to familiarize users with online tools, preparing them for following online educational activities [Piskurich (2003); Vanin et al. (2008); Wesson & Gogus (2005)], as well as to socialize with the community of participants [Kim (2000)].

The sample is composed by two blended learning courses:

1. **Genoa Sample.** The research context is a twelve-week post-graduate course on Educational Technology addressed to 95 student teachers of the Postgraduate School for Secondary School-teaching (SSIS) of the University of Genoa, in the 2004/2005 academic year. The course adopted the blended approach combining five face-to-face lessons and twelve weeks of online activities delivered at a distance via a computer conferencing system, through a hierarchical web forum (Centrinity FirstClass®).

The group of participants object of the present study was composed of 82 student teachers and 5 tutors<sup>1</sup>. The group of the students consisted of 65 females and 17 males. Their mean age was 31.3 years (SD=5.3), from 24 to 45 years old.

2. **Milan Sample.** The context is a three year Distance Degree in Psychology at University of Milan Bicocca – Psychology Faculty (Nettuno Consortium) in the 2008/2009 academic year. The activity is the last step of a previous online guidance

process [Vanin et al. (2008)], that aims to integrate newbie students with online community and represents the first occasion in which old and new students (virtually) meet. The activity took place in a PhPBB Bulletin Board, a popular sequential web forum.

The group of participants is composed of 70 first year students and 5 tutors (expert students coming from the second and the third year). The students were 51 females and 19 males, with a mean age of 34.7 (SD=6.4).

## 2.2 - Coding procedure

In a previous study [Manca et al. (2009)] authors defined a complete procedure to code postings and to define interactions (and addressees) for SNA purposes. On the basis of a comparison between what normally happens in an automatic structural coding (Traditional Structural Coding, TSC) adopted by most of the CMC systems and a new and innovative coding approach based also on semantic coding, authors propose what they call *Structural/Semantic Coding (S/SC)*.

As a matter of fact, systems that build automatically matrices for SNA analysis by use of tracking and log files data normally follow a procedure according to which postings are coded on the basis of senders of repliers. Any posting, independently of its role in hierarchized tree (i.e. first posting of the thread, isolated posting or reply), is coded as a posting with or without reply (see Figure 2).

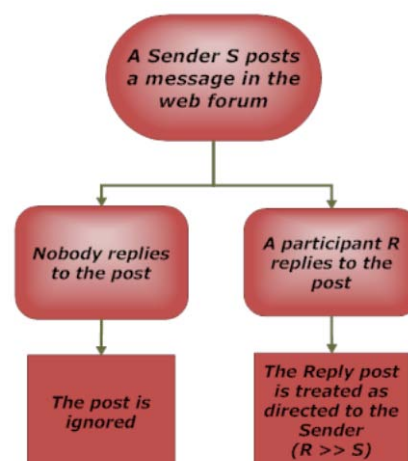


Figure 2. Traditional structural coding procedure (TSC).

In the coding procedure proposed a content analysis approach was used in combination

<sup>1</sup> The reason why a subset of the sample was chosen is that authors wanted to compare what happened in the five boats the two contexts have in common.

with exogenous data (i.e., properties of postings, such as name of sender, name of the area, date and time of dispatch, etc.) to detect senders and repliers/responders to the postings, so that also interaction patterns usually neglected by traditional structural coding might be included in an adjacency matrix for SNA purposes.

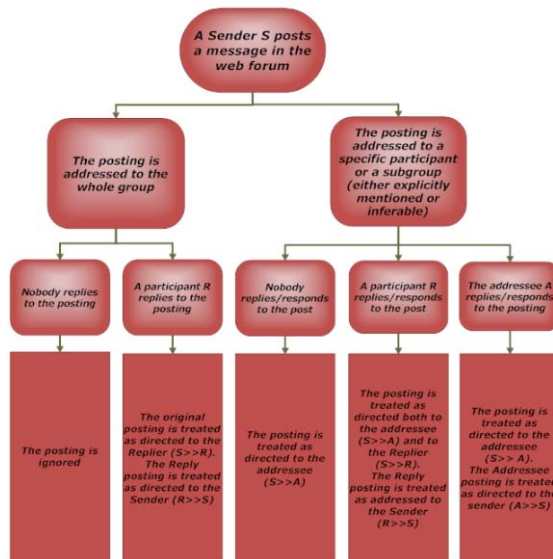


Figure 3. Coding procedure based on semantic analysis combined with potentiated structural analysis (S/SC).

In this paper we define two further specific cases that complete that model.

- 1) Thematic Fork.** In automatic coding *off-topic* posting (i.e. a posting that does not match with the main discussion theme) is threaded at the same semantic level of other *in-topic* postings. In non-automatic coding, this kind of posting is specifically coded. In particular, as shown in Figure 4, D's and F's postings are not directed to the main discussion (the blue thread), but they create a new discussion line.
- 2) Final regards.** The coding system of a generic posting presents a top-down flow: to code this kind of message we should verify all the following postings. In this way the last posting in a thread could not be located in the discussion (in Figure 4: E >> All – Regards). A specific case is closing regards, with specific addressees: in this case (i.e. "Goodbye to all of you, sailor men!") could be addressed to all participants who wrote at least a posting in that thread.

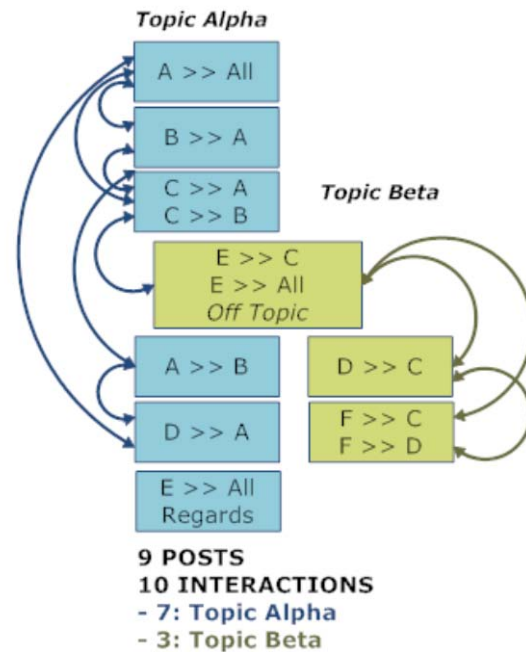


Figure 4. Two specific cases: off-topics and Final regards postings.

### 2.3 - Research questions

- Can S/SC Coding Schema be applied to sequential forums and with what results?
- Are there any relevant differences between sequential and hierarchical web forums in terms of online interactions?
- May these differences influence data and compromise social network analysis?

### 3 - SAMPLE COMPARISONS

The two samples were object of comparison, both in terms of postings and interactions included in an adjacency matrix for SNA purposes. For all Chi Square Analysis contingency index is shown. This index presents a 0-to-1 range, where 1 means that there is no effect of sample dimension and 0 attributes significant differences to dimension of sample. This means that in almost all of the analyses presented in the following, since the C index is >.5, all the significant differences can be attributed to the dimension of the samples.

### 3.1 - Postings

For comparative reasons a previous exploratory analysis was conducted on main interactive and descriptive variables. There are no meaningful statistical differences between the two sample dimensions, except for the difference between the number of messages (Chi Square= 279.22; DF=4; p<.01; c=0.44) (see Table 1). The difference could be explained by the dimension of the sample, as the Contingency Index indicates.

Conference area	Participants*		Number of postings <sup>o</sup>	
	Genoa	Milan	Genoa	Milan
Sailing boat	21	22	250	219
Caravel	17	13	132	81
Cruise liner	17	10	174	58
Fishing-boat	21	17	194	180
Submarine	11	13	48	326
<b>TOT</b>	<b>87</b>	<b>75</b>	<b>798</b>	<b>864</b>

\* Chi Square=2.08; df=4; p N.S.; C=.11  
<sup>o</sup> Chi Square=277.24; df=4; p <.01; C=.44

Table 1. Distribution of messages.

Difference in participation could be attributed to the percentage of tutor interaction in the samples: as shown in Table 2 the huge intervention of tutor in Milan sample is significantly relevant, even if it could be still explained by the dimension of the sample itself (see note at the beginning of the paragraph). However, there is no doubt that tutors in Milan produced a much larger amount of postings than tutors in Genoa (see below for explanations).

Conference area	N (and %) of tutors' postings*		N (and %) of students' postings <sup>o</sup>	
	Genoa	Milan	Genoa	Milan
Sailing boat	16 (6.4%)	79 (36.1%)	234 (93.6%)	140 (63.9%)
Caravel	31 (23.5%)	39 (48.1%)	101 (76.5%)	42 (51.9%)
Cruise liner	12 (6.9%)	21 (36.2%)	162 (93.1%)	37 (63.8%)
Fishing-boat	24 (12.4%)	45 (25.0%)	170 (87.6%)	135 (75.0%)
Submarine	8 (16.7%)	93 (28.5%)	40 (83.3%)	233 (71.5%)
<b>TOT</b>	<b>91 (11.4%)</b>	<b>277 (32.1%)</b>	<b>707 (88.6%)</b>	<b>587 (67.9%)</b>

\* Chi Square=28.92; df=4; p <.01; C=.29  
<sup>o</sup> Chi Square=258.03; df=4; p <.01; C=.49

Table 2. Distribution of tutors' and students' postings.

### 3.2 - Interactions

The same difference has a relevant impact on the interaction profile, as shown in Table 3: interaction profile reflects the proportional combination of messages shown in Table 1. As explained in Coding Procedure, the main purpose of the paper is to compare data coming

from different coding procedures (traditional structural coding vs. a coding procedure based on semantic analysis) and from different educational contexts (Genoa vs. Milan).

Conference area	Participants*		Number of interactions <sup>o</sup>	
	Genoa	Milan	Genoa	Milan
Sailing boat	21	22	275	367
Caravel	17	13	143	122
Cruise liner	17	10	213	109
Fishing-boat	21	17	209	350
Submarine	11	13	27	552
<b>TOT</b>	<b>87</b>	<b>75</b>	<b>867</b>	<b>1500</b>

\* Chi Square=2.08; df=4; p N.S.; C=.11

<sup>o</sup> Chi Square=420.85; df=4; p <.01; C=.46

Table 3. Distribution of interactions.

Composition of groups and tutors' behaviour (see Table 4) can explain the different patterns of postings and interactions: tutors in Milan were requested to use specific interactive behaviours (i.e. correct quoting, structure postings, define addressees, etc.) and their frequent interventions can describe differences in numbers of postings and interactions.

Conference area	N (and %) of tutors' interactions*		N (and %) of students' interactions <sup>o</sup>	
	Genoa	Milan	Genoa	Milan
Sailing boat	37 (13.5%)	146 (39.8%)	238 (86.5%)	221 (60.2%)
Caravel	38 (26.6%)	65 (53.3%)	105 (73.4%)	57 (46.7%)
Cruise liner	22 (10.3%)	43 (39.4%)	191 (89.7%)	66 (60.6%)
Fishing-boat	34 (16.3%)	122 (34.9%)	175 (83.7%)	228 (65.1%)
Submarine	4 (14.8.0%)	210 (38.0%)	23 (85.2%)	342 (62.0%)
<b>TOT</b>	<b>135 (15.6%)</b>	<b>586 (39.1%)</b>	<b>732 (84.4%)</b>	<b>914 (60.9%)</b>

\* Chi Square=73.29; df=4; p <.01; C=.33

<sup>o</sup> Chi Square=345.51; df=4; p <.01; C=.51

Table 4. Distribution of tutors' and students' interactions.

## 4 - RESULTS

Previous studies [Manca et al. (2009)] have shown that the coding procedure based on S/SC reveals its potential to detect flows of communication that would be neglected through a TSC. The two key results of the approach, in terms of the advantages achieved, are the greater number of postings included in the adjacency matrix, and the greater number of identified addressees, both implicit and explicit.

As shown in Table 5, only a total amount of 331 postings (41.5%) produced by the Genoa sample were included in the adjacency matrix according to the TSC approach. This percentage is a bit higher in the Milan case (77.8%), since the nature of sequential forums



constraints to “append” replies one after another, thus limiting the number of isolated or dispersed postings.

Conference area	Postings included by TSC*		Postings excluded by TSC°	
	Genoa	Milan	Genoa	Milan
Sailing boat	121 (48.4%)	166 (75.8%)	129 (51.6%)	53 (24.2%)
Caravel	57 (43.2%)	65 (80.2%)	75 (56.8%)	16 (19.8%)
Cruise liner	93 (53.4%)	48 (82.8%)	81 (46.6%)	10 (17.2%)
Fishing-boat	56 (28.9%)	134 (74.4%)	138 (71.1%)	46 (25.6%)
Submarine	4 (8.3%)	259 (79.4%)	44 (91.7%)	67 (20.6%)
<b>TOT</b>	<b>331 (41.5%)</b>	<b>672 (77.8%)</b>	<b>467 (58.5%)</b>	<b>192 (22.2%)</b>

Table 5. Number of postings included/excluded by TSC.

This difference is highlighted also by data managed by S/SC. In the Genoa sample 594 (74.4%) were the postings with addressees in the S/SC approach proposed; whereas this percentage is even higher in the second sample (90.9%) (See Table 6).

Conference area	Postings with addressee(s) in S/SC *		Postings without addressee(s) in S/SC°		Postings recovered by S/SC #	
	Genoa	Milan	Genoa	Milan	Genoa	Milan
Sailing boat	195 (78.0%)	186 (84.9%)	55 (22.0%)	33 (15.1%)	74 (29.6%)	20 (9.1%)
Caravel	93 (70.5%)	72 (88.9%)	39 (29.5%)	9 (11.1%)	36 (27.3%)	7 (8.6%)
Cruise liner	138 (79.3%)	55 (94.8%)	36 (20.7%)	3 (5.2%)	45 (25.9%)	7 (12.1%)
Fishing-boat	146 (75.3%)	167 (92.8%)	48 (24.7%)	13 (7.2%)	90 (46.4%)	33 (18.3%)
Submarine	22 (45.8%)	305 (93.6%)	26 (54.2%)	21 (6.4%)	18 (37.5%)	46 (14.1%)
<b>TOT</b>	<b>594 (74.4%)</b>	<b>785 (90.9%)</b>	<b>204 (25.6%)</b>	<b>79 (9.1%)</b>	<b>263 (33.0%)</b>	<b>113 (13.1%)</b>

\* Chi Square=263.50; df=4; p <.01; C=.48

° Chi Square=21.83; df=4; p <.01; C=.28

# Chi Square=67.99; df=4; p <.01; C=.46

Table 6. Number of postings included/excluded by S/SC and recovered by S/SC.

This means that S/SC allowed to include in the adjacency matrix 263 postings (33.0% of the total amount of postings for sample 1) and 113 postings (13.1% of the total amount of postings for sample 2) that otherwise would not have been considered.

## 5 – DISCUSSION AND CONCLUSIONS

This paper presents a comparison between two different web forum systems: a hierarchical web forum and a sequential web forum. The main difference between these systems is the way of visualization of interaction among participants and the reply procedure. In hierarchical forum, participants reply to others choosing a specific part of the thread (such as it happens in newsgroups). A reply that does not reply to a specific posting starts a new thread.

In sequential web forum, only a generic Reply function is shown and all posts are visualized in a sequential way, one after another. To highlight that one is replying to a specific posting, user can “quote” the posting (or part of it), and a part of the first message is shown in the reply.

The paper presents some empirical issues in coding these kinds of interaction in different web forums and results can respond to research questions:

### I) Can S/SC Coding Schema be applied to sequential forum and with what results?

Since the S/SC Coding Schema reduces the effects of TSC and implicates a relevant role of researchers who analyse data, differences between sequential and hierarchical forum is not central. Moreover, also in the case of sequential forums S/SC reveals to be able to include a significant percentage of postings that otherwise would be excluded.

### II) Are there relevant differences between sequential and hierarchical web forums in terms of online interaction?

Differences could be relevant in the way users interact in different web forums, adopting different replying procedures, but not in the nature of the interaction.

Results show significative differences in the composition of groups (Genoa vs. Milan, Tutor vs. Participants), but not significative differences in content and quality of interaction.

### III) May these differences influence data and compromise social network analysis?

SNA bases analysis on sociometrical adjacency matrix which could be elaborated by S/SC or TSC procedures. The type of procedure influences both qualitative and quantitative aspects of interaction, but not the SNA procedure in itself.

Results in data analysis define the S/SC coding procedures as a valid approach to the processing of data from both hierarchical and sequential web forums.

However, the main limit of this method is the cost in terms of time spent in coding, the involvement of independent judges and the assessment of ambiguous situations.

The quality of the matrix prepared with the S/SC, on the other hand, allows researchers to develop a valid and reliable database: the interactions between participants can be treated with a sufficient level of accuracy and completeness.

For what concerns differences in the two types of forums investigated, by an educational perspective, the choices depends on the educational model that designers adopt, the type of people involved, their level of technical expertise and their previous experiences in e-learning classrooms.

These choices do not seem to affect significantly the side of research: both types of forums allow a good level of investigation with regard to Social Network Analysis, although they both have benefits and costs, clearly highlighted in the paper.

Further investigations in this direction may relate to the influence that different forums has on participants (i.e., how users perceive the interactive space, different obstacles encountered in using these environments, which effects can be controlled in some way, etc.) and the social relationships participants are able to build - differences manifested in terms of social networks, effects on cliques, determination of the dynamics of belonging to the group, etc.

## ACKNOWLEDGMENTS

Thanks are due to Giancarlo Lavazza who provided help and support in the collection and elaboration of data. A special thank is also due to all Participants and Educational and organisational staff, both of ITD-CNR and University of Milan Bicocca.

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