ABSTRACT

Computer-mediated-communication (CMC) plays a great role in increasing students’ interactions especially when students are separated by time and space. Students’ interactions using asynchronous CMC specifically the use of discussion forums is the concern of this paper. Previous research have given focus on many different facets of interactions using different types of analysis methods such as statistical analysis, content analysis and social network analysis (SNA). The method of analysis used is closely related to the objective of the research involved. In this paper, we studied the structure and relationships of students’ interactions using SNA. This study which uses the multi-methodological method [Nunamaker et al, 1990-91] is part of a larger study which aims to contribute towards developing guidelines for students’ interactions and tasks design for creating effective virtual students teams’ (VST) asynchronous discussions. Eight VST working in groups of five have been analysed. The students were involved in interacting with each other in completing seven different tasks as part of their course assignments using WebCT discussion forums.

INTRODUCTION

Interactions using CMC can be categorised as synchronous CMC and asynchronous CMC. A type of widely used asynchronous CMC is the discussion forum (DF) or computer conferencing tool. There are various research themes on students’ interactions via the DF such as investigating students’ perceptions of using the DF [Vonderwell, 2003], strategies for promoting students’ interactions [Pawan and Paulus et al., 2003],[Wozniak and Silveira, 2004], investigating interaction patterns [Palonen and Hakkarainen, 2000], identifying knowledge construction through the use of TD [Aviv and Erlich et al., 2003],[Pena-Shaff and Nicholls, 2004] and assessing social presence [Rourke, Anderson et al., 1999]. The focus of this study is to investigate the structural aspect of task-based group online discussions via DF. Previous researches have given focus on many different facets of interactions using different types of analysis methods such as statistical analysis, content analysis and social network analysis (SNA).

It is important to note here that the interest of this research is to investigate on how the design and structure of task given to students and group interaction patterns affect students’ discussions. As for this the best analysis method to chose is Social Network Analysis. The application of Social Network Analysis in this study will be on studying the patterns in the task-based group structure on the connectedness and density of the group network. In the next sections the research methodology for conducting this research will be discussed briefly and then followed by the overview of Social Network Analysis. Next the data collection and findings from the data analysis will be explained. Finally, the discussions based on the findings will be presented.

RESEARCH METHODOLOGY

This research will embark by applying the Multi-methodological Research Approach [Nunamaker, Chen at al, 1990-91]. This approach has been selected as it allows multiple perspectives and flexible choices of methods to be considered in various stages of the research process. This research methodology involves theory building, observation, experimentation and systems development. Theory building included reviewing the literature on computer supported collaborative learning, virtual teams and social network analysis. Observation involved the investigation of content of discussions in order to identify the nature of interactions such as the existence of the instructor and either the interactions among students are monologue or dialogue. Experimentation involved the analysis of data using
Social Network Analysis. Finally, systems development integrated all previous phases in developing a set of guidelines designing students' tasks and collaborations. The focus of this paper is on the experimentation part of the multimethodological research. Four hypotheses have been developed for this research which are:

H1: Group cohesiveness will increase over time for a group  
H2: Choice of group leader will affect the level of cohesiveness for a given group  
H3: Groups who exhibit a high level of group cohesiveness with training task will exhibit cohesiveness for all future tasks  
H4: Groups cohesiveness are higher when the task is assessed.

SOCIAL NETWORK ANALYSIS
Social Network Analysis provides a set of techniques for understanding how people and groups relate to each other. The aim of the analysis is to describe the purpose people communicate individually or in groups. Software mentioned in the literature for Social Network Analysis are UNICET and the NetMiner. SNA methods quantify social relations in terms of network structure parameters which encode certain causal group forces [Aviv and Erlich et al., 2003]. Its major objective is to characterise the group’s structure and, in particular, the influence of each of the members on that group, reasoning on the relationships that can be observed in that group [Reffay and Chanier, 2003]. SNA focuses on the relationships between individuals instead of the individuals themselves [Reffay and Chanier, 2003]. Three main focuses of network analysts are [Wasserman and Faust, 1994]: i) Patterns in the overall structure for example on the connectedness and density of the network, ii) The embeddedness of the actors for example on centrality and power that an actor holds and iii) The sub-structures which are on grouping of actors which are closer to one another. An example is the use of the term “cliques” to describe actors that are divided into sub-groups. The concern of this research is on studying the structure of students by measuring the group density or in other words group cohesiveness.

Density
Density is one of the measurements of cohesion in Social Network Analysis. The density of a graph is defined as the number of lines in a graph, expressed as a proportion of the maximum possible number of lines. Cohesion refers to how well connected is the overall network and how connected are particular groups. A calculation which is closely related to density is the degree centrality. Degree centrality includes outdegree and indegree. Outdegree refers to the frequency of posts and replies made by a specific actor in the network. While the indegree refers to the frequency of posts and replies received by the actor in the network. The outdegree and indegree forms the relationships among actors. In this study, the students were actors while the interactions among them formed the relationships. The density of a graph is defined as the number of lines in a graph, expressed as a proportion of the maximum possible number of lines. The formula for calculating Density is as follows:

$$\text{Density} = \frac{\text{Number of lines present}}{n(n-1)/2}$$

By using UCINET, figures known as sociogram can be generated. Actors and relationships in the network can be visualised through the sociogram. Figure 1 below shows the value of density and its corresponding sociogram. The highest measurement of density is 1.0. Density of 1.0 means all actors are connected to each other.
For the analysis, both calculations have been encountered, whereby both calculations can be seen as complementary to each other. In other words, the calculation of density encounters the group development in general while the degree centrality encounters the interactions of students within each given task.

DATA COLLECTION
The data involved in the analysis were transcripts of students’ group-based discussion using the threaded discussion tool on WebCT for the subject CT334/CT434: Computer Supported Co-operative Working (CSCW). The transcripts were generated into text files from the threaded discussion in WebCT. The number of groups analysed included 14 groups accomplishing 6 tasks. The total number of text files for all groups were 145. The students worked in groups of different sizes between 3 to 4 students each group. The discussions were almost not moderated. The first thread for each group was initiated by a Teaching Assistant. The transcripts showed the presence of two other moderators assigned to other Teaching Assistants. However, most of the time the role that they played were to send reminders to students regarding the need to upload the groups’ completed tasks to a specific space allocated for them online and to remind them of the final presentation.

Description of Group-Based Tasks
- The title for the first thread created by the Teaching Assistant was ‘Assigning Facilitator’. Students were required to select one of their group members to become a facilitator of the group.
- The next two threads were titled ‘Task 1’ and ‘Task 2’. These two tasks were the training tasks assigned to students for the purpose of training the students in using the threaded discussion tool within WebCT.
- For Task 1, the facilitator who has been assigned in the previous thread (‘Assigning Facilitator’) was asked to think of an animal. Then the other members will ask question to guess what the animal was.
- Task 2 to Task 6 included questions related to the Computer Supported Collaborative Work.

DATA ANALYSIS
Before going further to the data analysis, few important terms will be defined based on figure 2. It is important to note here that the posts and replies in a threaded discussion can be viewed by all team members. Depending on the content of the post or reply, it might be dedicated to a person in the group or the content can be directed to everyone in the group.
Topic : Refers to the topic of the discussion. For the above example, the topic is ‘Task 2: Job Advert’. Normally the topic will be created by the Instructor.

Initiator : The person who initiates the topic. In the example above, the Instructor is the initiator.

Post : A message sent to create a new topic.

Reply : A message sent to reply to an existing topic. In the example, there were 5 replies to the topic initiated by the Instructor.

Thread : A chain of replies to the topic initiated. In the above example, there were 2 threads. Both threads were created by Student 1.

Figure 3 shows the density for all groups over all tasks. From the calculation of density for all groups, groups with density of more than 0.5 have been selected for detailed analysis against the hypotheses.

<table>
<thead>
<tr>
<th>Group Total Number of Groups</th>
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</thead>
<tbody>
<tr>
<td>AF</td>
</tr>
<tr>
<td>G6</td>
</tr>
<tr>
<td>G2, G9</td>
</tr>
<tr>
<td>G3, G2, G9</td>
</tr>
<tr>
<td>G14, G10, G6, G4</td>
</tr>
<tr>
<td>G6, G9</td>
</tr>
<tr>
<td>G9</td>
</tr>
</tbody>
</table>

Table 1: Groups and total number of groups with density of more than 0.5

Findings & Hypotheses

Earlier in this paper, four hypotheses have been outlined. Next sub sections will present the findings, with the hypotheses being revisited.

H1: Group cohesiveness will increase over time for a group

Based on Figure 4.3, three groups namely groups 2, 3 and 9 showed increment in density throughout the AF to T3, however it happened that their density dropped dramatically for T4. Their density increased on the other last 2 tasks. G10 showed almost consistent density across all tasks.

The decrease in density for G2, G3 and G9 might be due to certain factors. For instance, for G2, one of the group members had withdrawn from the group. Other possible factor is because the individual assessment contribution to group activity will be assessed during these three tasks: T1, T2 and T3. These will be discussed further in the hypothesis on group activity.
cohesiveness assessment in section 4.4.5. The sociograms below show the degree centrality of students in G2, G3 and G9.

![Sociograms showing degree centrality of students in G2, G3 and G9](image)

G9T2 – 1 thread 36 posts  
G2T2 – 1 thread 55 posts  
G3T2 – 1 thread 51 posts

**H2: Group leader will affect the level of cohesiveness for a given group**

In this particular CSCW course, the students were asked to assign a facilitator in the AF task. In addition to this, students were asked to rotate among group members to summarise the threaded discussion. From the content analysis, only a few students that acted as the group leader or facilitator can be detected. This is not surprising as in Johnson et al 2002, only two of the seven teams had a leader emerge in the group [Johnson and Suriya et al., 2002].

Based on the literature review in Chapter 3, assigning roles to students is one of the critical success factors for virtual teams. From the analysis and observation made, for some groups so many new topics had been initiated by students. As a result, discussion might not be smooth thus lower the density. Topics created by members of G12 can be one of the examples that might cause low density for this group. The number of topics created for T3 and T5 totals up to 7 and 6 respectively. Therefore, having a leader alone is not enough. The need of system as suggested by Tolmie and Boyle (2000) is obvious in this case. The author suggest that the instructor provide the leader with guidelines containing the role of the leader.

In addition to assigning the role of a leader in the discussions, the presence of a moderator is of importance. The increased density for G2 from AF to T3 might due to the presence of a group member S1. The outdegree for S1 was 24 out of 55 overall outdegree. This group member had withdrawn from G2 at the end of T3. It happened that S1 has been holding responsibilities as one of the Teaching Assistant mentioned in Section 4.2. Thus, with the maturity and experience of S1, S1 might have played a role as a moderator in leading G2 early in the threaded discussion. This is consistent with the findings in the previous chapter that suggest the need to provide facilitation [Vonderwell, 2003], [Danchak and Kenyon, 2002] and the role of instructor to be present in the discussion and monitor the discussion [Ahern, Thomas et al, 2006].

**H3: Groups who exhibit a high level of group cohesiveness with the training task will exhibit cohesiveness for all future tasks.**

According to the tasks description given to students, the training tasks should be Task 1 and Task 2 as shown below:

<table>
<thead>
<tr>
<th>Mon 19th Feb</th>
<th>Task 1: Competition: WebCT Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon 19th Feb</td>
<td>Task 2: Job Advert: WebCT Training</td>
</tr>
</tbody>
</table>

**Figure 4:** Excerpt from the Task Description

However, from the observation of the discussion transcripts, there were few cases where students discussed T1 in the AF. As for this, in this discussion, the author includes AF, T1 and T2 as the training tasks.
From Figure 5, it is obvious that groups with many occurrences of density of more than 0.5 as in Table 4.1 in section 4.4 showed high density in the training tasks. This verifies the findings from Chapter 3 on the importance of providing training tasks [Wu, 2003],[Alexander, 2006],[Duarte and Snyder, 2006].

The author suggested that instructor should give clear guidelines about the training task and assign only one specific task for the purpose of training. In relation to what have been discussed in section 4.4.2, regarding facilitation, the author suggests that one of the contributing factors that might increase students interactions, thus the density is, by instructor’s involvement in facilitating students in the training task to ensure increased cohesiveness in the future tasks. This can be implemented either by the instructor facilitating the discussions or assigning another person for the role of facilitator in addition to the role of a group leader by a student.

**H5: Groups cohesiveness is higher when the task is assessed.**
Tasks which were assessed in Week 4 were T1, T2 and T3. For Week 7, the task involved is T6. For discussion purposes, the author divided these tasks into 2. T1 will be discussed together with T2. T3 and T6 which have the same structure will be discussed together.
Figure 6 above shows that G2, G3, G6, and G9 scored high density. Among these groups, only G10 had almost consistent level of density throughout all tasks. This situation might happen due to the group preferences in discussing online instead of having to meet each other in a face-to-face situation. In addition to this another factor that might attract the groups that scored high density in T4 might be that An extra 2% will be available for the group who is shown to have undertaken the best research into groupware. This finding indicates that it will be worthwhile to give students incentives for their efforts in the discussions. Students will tend to participate thus increase the density of group interaction when their discussions are being assessed [Macdonald, 2003], [Alexander, 2006].

**DISCUSSION & CONCLUSION**

Based on the analysis results and discussions above, few factors have been identified as factors that can contribute towards cohesive interactions among group members. The findings are summarized as in the table below.

<table>
<thead>
<tr>
<th>SNA 1</th>
<th>Provide the leader with guidelines role of the leader</th>
</tr>
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<tbody>
<tr>
<td>•</td>
<td>SNA 1.1: Leader initiate two main threads and the wrapper initiate one thread. Only the leader and wrapper can initiate threads.</td>
</tr>
<tr>
<td>•</td>
<td>SNA 1.2: Leader initiate 1 thread for task management and task division. Each member creates one thread. The wrapper initiates the last thread to summarise the discussion.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SNA 2</th>
<th>Instructors should get involved early in the discussion.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SNA 3</th>
<th>Provide training task. It is likely that with training groups tend to exhibit cohesiveness for all other future tasks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td>SNA 3.1: Facilitate the training task</td>
</tr>
<tr>
<td>•</td>
<td>SNA 3.2: Give clear guidelines about the training task and assign one specific thread/topic for Training.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SNA 4</th>
<th>Specify the minimum number of messages in order to maintain the cohesiveness.</th>
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</table>

<table>
<thead>
<tr>
<th>SNA 5</th>
<th>Assess the discussions.</th>
</tr>
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</table>

Based on the Social Network Analysis done, few factors that might contribute to the effectiveness of virtual students teams’ online discussions via discussion forums have been identified. However, these factors alone are not sufficient as they have been developed only from the data analysis on the course mentioned. More data analysis on students’ online asynchronous discussions on variety types of courses should be done. In addition, the findings from this research should be integrated with findings from the literature. Through this integrated approach, it is hoped that a set of guidelines for designing students’ collaboration and designing tasks will be developed.

**REFERENCES**


