Visual Representation of Computer Mediated Communication Patterns in Distance Learning

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ABSTRACT
The aim of this paper is to present a study for the visualisation of communication patterns evident in distance learning. More specifically, computer mediated communication in distance learning online communities, shows emerging patterns that differ according to team formation and learning activities. In this paper a list of factors affecting communication patterns in distance learning is discussed. This study is primarily concerned with the correlation between patterns of communication and the affecting factors. Findings from such efforts can prove beneficial to instructors in distance learning during the selection of criteria suitable for designing successful learning activities. Initially in this study, student interaction of several hundred posts (approx. 1500) in three modules delivered via blended teaching is analysed. The second phase of the study is concerned with the observation and analysis of 30+ threaded discussions taking place in full distance learning mode.

1. INTRODUCTION
Computer-mediated communication (CMC) is generally used to indicate systems for communication between people by means of networked computers. Despite its evident benefits, CMC is not always effective when used as an enabling technology for e-learning. The fact that supporting technologies exist for threaded discussions, synchronous chat, poll taking and messaging does not guarantee a successful e-learning experience for instructors and learners. There is significant work concerned with the identification of factors which best predict successful implementations of CMC in higher education [9].

From the plethora of available CMC techniques, a rather common choice in an educational context is supporting asynchronous communication through bulletin boards or online threaded discussions. Despite findings suggesting the benefits of using such facilities, only a few pieces of work are concerned with the specific characteristics of threaded discussions and their use for increasing effectiveness of e-learning and skill development [10]. Placing an electronic bulletin board on a course website does not simply allow learning to take place [8].

This study attempts to identify what constitutes a successful learning activity with respect to the generation of constructive and productive communication between instructors-learners and learners-learners. The author argues that the volume of a generated discussion is irrelevant to the design of a “good learning activity/task”. Performing both quantitative and qualitative analysis of visible communication patterns is essential in order to identify that such patterns are products of a successful learning structure and not side-effects of bad pedagogical practices.

2. SUCCESS FACTORS FOR CMC IN E-LEARNING
Case studies used in this research are heavily based on instructors assuming facilitator roles throughout a highly structured interaction via threaded discussions. The role of the facilitator in such discussions is critical for initiation, motivation, conflict resolution and progress. It is therefore the role of an instructor to enable learners moving from dependence to ownership. The aim is to align learners’ expectations with the intended pedagogical approach, moving from the current “instructor controlled” “specified tasks” towards future “open ended” “learner-managed” learning activities [7].

There are several educational and technological issues regarding the practices of CMC in e-learning and more specifically any CMC tools that are included in a Virtual Learning Environment (VLE). Learning concerns regarding the uses of CMC exist since the early 90s [5, 6] as seen in table 1.

There is also enough work on factors associated with successful CMC resources in higher education [9].

3. IDENTIFYING CMC PATTERNS IN DISTANCE LEARNING: A CASE STUDY
The foundation for this project is provided by an initial investigation involving a Computer-Supported Cooperative Work (CSCW) course delivered via a WebCT VLE to 16 groups of students. Each one of these groups simulated the structure and behaviour of ‘virtual teams’, meaning that they were hypothetically residing over different time zones. Among other tools, the teams were using a discussion board to communicate over a number of steps that were suggested by the instructors. Each step corresponded to specific tasks that were common for all groups. Group members were not allowed to alter the series of project stages but could add further topics as required. The resulting threaded discussion provided very interesting finding with respect to the communication patterns that existed both within each group and between different groups.

As shown in figures 1 and 2, the same group could show dramatic changes in the communication volume and frequency based on the learning tasks assigned. It is also obvious that two groups have significant differences...
in the amount of effort they invest and the communication patterns they follow even during the same tasks. Eventually each group had to restructure their discussion patterns based on consensus. For example, group 4 had 34 message exchanges regarding the facilitation of the group and even had a topic dedicated to a group member and his support during a task. On the other hand, group 6 needed a summary topic for the first three tasks of the project.

Observation of the emerging CMC patterns in the particular case study has led to certain assumption with respect to the behaviour of student groups under similar circumstances following the same discussion structure. It becomes evident that differences in communication pattern are linked with success factors of the e-learning process and the characteristics of the learning activities.

Even from early straight forward tasks and supporting topics certain groups were engaged in discussion far more actively. This is based on their rather high numbers of posts but also on the maximum level of threads that these groups showed. An assumption is made that a certain number of students from certain groups can catch up on using the discussion tool while other groups with less postings are still catching up with the technology and the learning activities.

An interesting finding is that the first couple of tasks that are used for students to familiarize with themselves and understand the objectives of the tasks, show high participation. More specifically, task 2 where then student experience is crucial. It becomes evident that differences in communication pattern are directly affected by difficulty of a learning task.

Following from the main findings of this study, some guidelines regarding communication patterns associated with learning tasks include:

- There are certain communication patterns that are directly affected by difficulty of a learning task.
- Group formation is a factor affecting communication frequency. Demonstrator tasks can be used to identify any communication conflicts in early stages.
- Based on their use of computer-mediated communication tools, group members can be classified in several categories such as starters, followers, facilitators and lurkers.

### 4. RESEARCH QUESTIONS AND METHOD

Initially the number of posts, responses, views as well as the frequency of interaction, preferences to certain posters, lurking and even the text size of messages were used to classify each group and its student members. The findings showed that the stronger students were more active during the later stages of the assessment or closer to interim deadlines, while weaker students had a more consistent communication pattern. However, the most exciting results involved the association of communication patterns with learning tasks and group formation. It became obvious that certain tasks attracted more posts in the group discussion either for clarification or for interaction to accomplish a specific task. Furthermore, the threaded discussion not only became busier with more posts and a larger number of frequent posters, but involved the creation of more sub-branches from initial, root topics. It seemed that certain tasks made groups proactive, motivated and innovative. It also became obvious that certain groups had a maximum capacity of effective communication while others could side-track to endless discussions without achieving the actual goals. The later groups were usually quite heterogeneous, with personal and cultural conflicts leading to failure to

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**Table 2. Factors associated with successful CMC**

<table>
<thead>
<tr>
<th>Issues</th>
<th>Description</th>
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<tbody>
<tr>
<td>Size of group</td>
<td>Findings show small groups of six students made more frequent, longer and</td>
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<td></td>
<td>balanced use of CMC [3]. In this study, all modules including group work</td>
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<td></td>
<td>have a maximum of six members allowed.</td>
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<tr>
<td>Knowledge of other participants</td>
<td>Existing work showed that use of CMC for identical tasks was greater</td>
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<td></td>
<td>where participants were familiar with each other [4]. Participants of</td>
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<td>residential courses are familiar with the most fellow learners. E-learning</td>
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<td></td>
<td>modules are supported by a Local Support Centres with a residential tutor</td>
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<td>and regular meetings, providing the opportunity to group members at the</td>
</tr>
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<td></td>
<td>beginning of the project.</td>
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<tr>
<td>Student experience</td>
<td>There is evidence of greater spread of use of CMC amongst students in</td>
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<td></td>
<td>later years in their course [3]. In agreement with early findings from</td>
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<td></td>
<td>undergraduate courses. However, postgraduate courses can be comparable</td>
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<td></td>
<td>only between two semesters.</td>
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<tr>
<td>Clarity about task</td>
<td>Consensus over what the task involves in a major determinant of smooth</td>
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<td>online contact [2]. Tasks are clearly defined through module handbooks and</td>
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<td>highly structured.</td>
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<td>Ownership of task</td>
<td>Students commonly become more active online as they negotiate roles for</td>
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<td></td>
<td>themselves [1]. The suggested format in most modules is for students to</td>
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<td></td>
<td>identify and allocate roles within their own groups.</td>
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<tr>
<td>Need for system</td>
<td>Use of conferencing resources can be minimal or non-existent when students</td>
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<td></td>
<td>have little explicit reason for doing so [4]. The findings from this</td>
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<td>study show exactly the same pattern. Use of communication tools is now</td>
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<td>compulsory within the specification of learning activities for several</td>
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<td>modules.</td>
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<td>Prior experience of CMC</td>
<td>All students participating in this study are highly experienced with</td>
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<td>communication tools both synchronous and asynchronous.</td>
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</tbody>
</table>

**Figure 2. Learning tasks and communication volume (group 6)**

- Status GROUP 6 - Subject
  - 5/17 [ ] Assigning a facilitator
  - 53/54 [ ] Task 1: Competition
  - 32/33 [ ] Task 2: Job Advert
  - 11/13 [ ] Task 3: Centrifugal Force...
  - 4/5 [ ] The first Three Tasks, Gr...
  - 2/2 [ ] Are group six ready to st...
  - 0/1 [ ] tasks' outcome.
  - 47/47 [ ] Task 4: Groupware Investi...

**Figure 1. Learning tasks and communication volume (group 4)**

- Status GROUP 4 - Subject
  - 1/1 [ ] Assigning a facilitator
  - 5/5 [ ] Task 1: Competition
  - 49/49 [ ] Task 2: Job Advert
  - 28/28 [ ] Task 3: Centrifugal Force...
  - 34/34 [ ] Facilitator
  - 2/2 [ ] A specific group member
  - 2/2 [ ] Group 4 Home Page
  - 68/68 [ ] Task 4: Groupware Investi...

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reach rapid consensus. A communication protocol had to be invented in order to make decisions and solve problems.

A number of factors affecting these communication patterns (FaCP) are identified as included in table 3. Key factors are: (T) the number of threads showing cohesion, (B) the number of branches per thread showing communication richness, (I) number of initiators, showing proactive members, (P) No of posts per thread, showing participation, (R) number of replies per thread, showing interactivity, (Rs) number of responses per thread, showing reactive members, (L) maximum and average level/depth of discussions in the same thread, linked to clarification and passion, (W) Total Text Size and (S) Average Text Size for posts in a single thread, showing contribution, (A) number of unique authors in each thread showing involvement.

These factors lead to the suggestion of a formula used to provide a break down of characteristics for every single thread of each group. In such structured assessment the norm is that a thread corresponds to a specific task. Therefore the formula used for the first task of group one should look as follows:

\[
G1-T1 = \sum (T, B, I, P, R, Rs) + (L, D, W, S, A)
\]

The formula provides a detailed set of characteristics and can be extended to provide details of specific branches of the thread/task:

\[
G1-T1-B1 = \text{total}[P, R, D S(low)] S(medium) S(high)]
\]

These formulas are used to transform a rather unusable set of data from threaded discussions as shown in figure 1 to a more meaningful graphical representation of group behaviour and task efficiency patterns shown in figures 2 and 3.

5. DISCUSSING THE FINDINGS

This study is concerned with the analysis of communication patterns and CMC data in two dimensions: (i) across tasks and (ii) across groups. The objective of the research is to identify what constitutes a successful learning activity and success criteria for group formation accordingly.

In figure 3 the 16 groups are classified following their performance for a single activity according to different FaCP. An interesting observation relates to the fact that there is no overlapping between group performances, indicating that most if not all of these factors are linked. Figure 4 shows communication patterns for a specific learning activity and the differences between groups. It is apparent that there is a number of clusters especially regarding posts, replies and responses and there seems to be a regular interval between the different group clusters. This finding is yet to be justified and seems to be linking to group formation or even with individual participation to the discussion.

Furthermore, the group clusters become more obvious when analysing each group data separately. In figure 5 two groups show similar picks on communication and more specifically on clarification and reaction for each group data separately. In figure 5 two groups show similar picks on communication and more specifically on clarification and reaction for each group data separately. In figure 6 we can see an almost linear pattern for all most learning activities.
While designing a learning activity it is important to identify those criteria that can assist participants engaging in constructive discussions while minimising the unproductive interaction that is a side effect of poorly designed learning activities, lacking clarification.

In the second diagram of figure 6, it becomes clear how different groups and tasks are responsible for communication patterns. In task 3 (top-left quadrant) there is evidence for three groups facing serious problems with respect to understanding the task, clarifying the objectives and reaching agreement. It is obvious that these groups exchange numerous posts in limited number of threads with maximum level. In task 4 we have far more groups showing high number of posts but the maximum level is not significant, showing diversity of ideas and constructive interaction. However, it is still evident that the majority of groups show a linear relation between these two variables, resulting in this symmetrical pattern close to the centre of both axis.

Following these initial efforts, it is currently attempted to integrate the project in the Global Campus (GC) program of Middlesex University. The GC program uses mostly Web technologies to offer a distance learning mode for both undergraduate and postgraduate degrees. This program has been consistently committed to an essentially asynchronous model of delivery in which face-to-face tutorials, deadlines for continuous assessment and formal examinations are the only synchronisation points. This research study is focusing on the investigation of more than 50 case studies of courses run in the previous two years and the analysis of communication patterns in threaded discussions supporting group projects.

6. CONCLUSIONS

Some of the key benefits of this study concern the facilitation of instructors in setting up successful learning activities, further supporting learners in various content related tasks, structure successful discussions and evaluate existing questions based on a certain set of success criteria. More specifically, in terms of possible deliverables, the study attempts to:

- Suggest guidelines to instructors who want to create threaded discussions, especially for identifying a suitable structure for a discussion and effective discussion topics and prompting questions.
- Provide instructors with the means for evaluating any existing discussion topics and questions based on several success criteria.
- Identify which success criteria must be met for each discussion topic and question so it can be beneficial to learners (e.g. the role of feedback in distance learning).

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