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Visual Representation of Computer Mediated Communication Patterns in Distance Learning

Georgios A. Dafoulas, School of Computing Science, Middlesex University, The Burroughs, Hendon, London, NW4 4BT,
T: ++ (0) 20 8411 4402, F: ++ (0)20 8411 2332, g.dafoulas@mdx.ac.uk

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 beneficiary 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 fully 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 bulleting 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].

Table 1. CMC practices

Issues	Description
Content & Objectives	Discussion, brainstorming, problem solving, collaboration, and reflection are activities best suited to CMC. Investigating the applicability of CMC to other disciplines and courses.
Interactivity & Interaction Processes	Message exchange patterns support the perspective that communication patterns are more democratic and group discussion oriented than would be found in classrooms. This can be testified by assessing the impressive volume of discussion in several modules, primarily due to the asynchronous nature of communication and the use of participation as an indexed repository.
Learning Strategies & Tactics	There is enough consideration of the actual differences on learning styles when CMC is introduced. The analysed modules are directly comparable with residential courses and an interesting finding is the time spent online compared to suggested study time for residential courses.
Learner Control & System Control	CMC is regarded as merely a supporting technique for learning, flexible to learner needs. The aims f this research is based on case studies that communication is highly structured and becomes part of the curriculum.
Outcomes & Evaluation	A concern exists with respect to the actual benefits of CMC on performance of students. This study attempts an analysis to online courses including assessment before and after the introduction of communication tools linked to coursework and assessment.

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 there was no immediate/face-to-face interaction between members who 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

Table 2. Factors associated with successful CMC

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

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 patters 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 main objective is also to make sure that students can familiarise

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

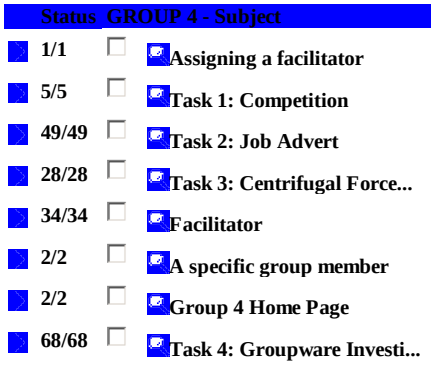
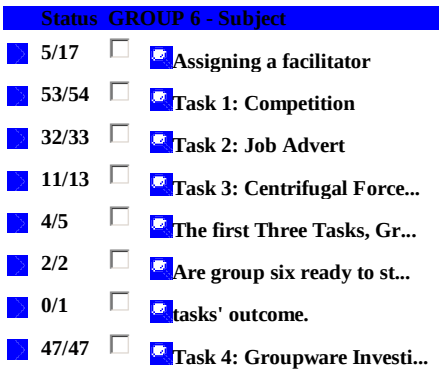


Figure 2. Learning tasks and communication volume (group 6)



themselves with using the threaded discussion facility, shows high number of participation due to the clear structure of the task.

In the third task we have the majority of groups with less than 40 postings, except for three groups that show a far higher number of posts. These groups also show a communication pattern consisting of a single productive thread reaching a high number of maximum level of branches. This may due to the clarity of task causing misunderstanding to particular group members in conjunction with the role played by the facilitator for the group's participation.

The fourth task of the case study is concerned with an in depth analysis of Groupware technology, requiring more critique compared to the previous tasks. Although the number of participation is almost the same as in task 3, the maximum level tends to increase for some groups. This may due to students engaging in in-depth discussion while attempting the analysis task. This fact is linked with the number of interactions required by students to reach consensus and document their final group decision. What is not clear is if groups that show maximum level of posts have problems in clarifying the task or reaching an agreement.

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

Table 3: Factors affecting communication patterns (FaCP)

Communication elements	Factors affecting communication patterns
(**T**) Threads	Cohesion
(**RB**) Root Branches	Diversity
(**B**) Branches	Richness
(**I**) Initiators	Proactive
(**P**) Posts	Participation
(**R**) Replies	Interaction
(**Rs**) Responses	Reactive
(**L**) Max Level	Clarification
(**W**) Total text	Interest
(**S**) Average text	Consistency
(**A**) Authors	Engagement

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:

$$G1\text{-}T1 = \Sigma\,(T, B, I, P, R, Rs) + (L, D, W, S, A)$$

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

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

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

Figure 3. Classifying group performance for a single learning activity according to FaCP

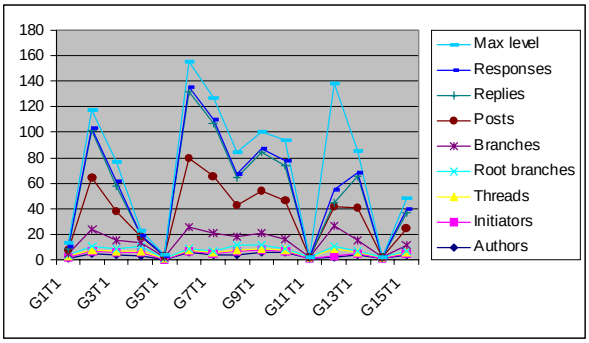


Figure 4. Classifying communication patterns for a specific learning activity in different groups

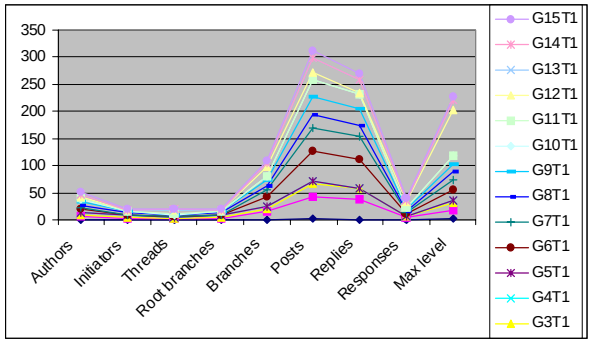
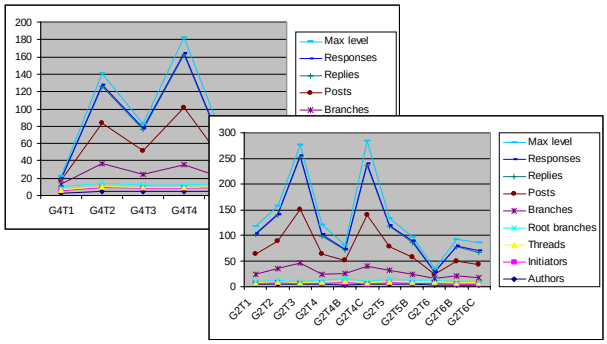


Figure 5. Two groups with similar communication patterns for all most learning activities

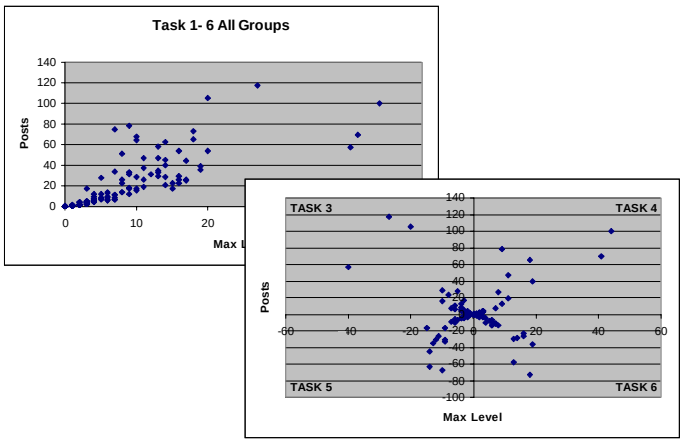


is yet to be justified and seems to be linking to group formation or even with individual participation to the discussion.

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 tasks 2 and 4. However it seems that motivation, participation and initiation remain the same throughout the different tasks.

Finally, as shown in figure 6 we can see an almost linear pattern for all groups participating in tasks 1-6 with the maximum level of threads being increased as number of posts increase regardless to the task and group structure. This provides sufficient evidence that participation and clarification are strongly related in learning activities. It seems that

Figure 6. Correlation between number of posts and max level of thread



whiled 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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