# Mapping Interactions in a Computer Conferencing Environment

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## Abstract

In this paper we discuss some preliminary findings from an evaluation on online interactions within a large population undergraduate computing course offered by the Open University (UK). The course uses asynchronous electronic conferencing to provide students at a distance with a collaborative learning environment. One type of online activity on the course is group working, which is of a practical problem solving nature, and is formally assessed.

In our evaluation, we investigate the patterns and frequencies of interactions during online discussion for one of the course projects. In particular, we use content analysis to identify the nature of contributions that give rise to learning during the online discussion.

## Keywords

Computer conferencing, collaboration, online environments, distance education, problem-based learning, content analysis.

## 1. Introduction

Computer conferencing as an environment for collaborative learning is currently, and with growing frequency, being employed in education in many different subject areas and levels, to the point that "the utilisation of the medium in education has in many respects outstripped the development of theory on which to base such utilisation" (Gunawardena, *et al* 1997).

To redress the balance, focused studies are much needed on how the technology enhances and redefines academic learning environments. In particular, the question of how to assess the quality of interactions and the quality of the learning experience in such environments should be satisfactorily addressed. As educators we have a responsibility for understanding the pedagogical characteristics of electronic collaborative learning, such as identifying scenarios in which learning occurs and recognising the elements that give rise to learning. Such understanding will enable us to use the medium to its full potential and will provide guidance to our students throughout the learning process.

The purpose of our study is to investigate the quality of interactions in a computer conferencing environment used on an undergraduate computing course at the Open University. The course is a general introduction to computing and is taught at a distance. The remainder of the paper is an account of the investigation we have conducted and presents some preliminary results.

## 2. Background

There is a growing body of research concerning communication patterns, teacher roles and students performances when using online learning environments. There also seems to be an assumption that any possible use of online interaction is educationally valuable. At the same time most use of electronic communication tools in higher education still lacks theoretical grounding in contemporary learning theory (Koschman, 1994). Also it is quite easy to come across research on collaborative techniques placing more emphasis on the tool features, procedures and operational efficiency, than on the theoretical rationale of justification for using them (McCabe, 1998).

A surprising number of conferences that are discussed in the literature are self-referential: conferences about computer conferences, or at least, about online and independent learning. These contexts, which often have mature and postgraduate students, lend themselves to an emphasis on the peer interaction (Jones *et al*, 2000). There is a need for further research in wider contexts, e.g., undergraduate students and different subject areas.

There are many facets to computer conferencing including its role and integration within a course, the rationale for using it, the content of the course, the nature and structure of the task, the experience of participants and how confident they feel using this sort of environment. It is therefore important to study and document the different ways computer conferencing can enhance and inhibit the teaching/learning process.

### *2.1 Computer conferencing at the Open University (OU)*

Computer conferencing at the OU has a long history. The first large-scale use, and evaluation, of computer conferencing on a course was in 1988 (Mason and Kaye, 1989). Since then, the use of computer conferencing at the OU has grown steadily, both in terms of the number of courses making use of the technology, and in terms of student population per course. Most computer conferencing at the OU is carried out using FirstClass, a text-based asynchronous conferencing system for the Internet. A staggering 90,000 OU users were registered with FirstClass in the year 2000.

For most courses, the primary use of computer conferencing is tutorial support, but four major uses of the technology can be recognised (IET, 2000):

- *optional use*, such as self help conferences set up and managed by students;
- *tutorial support*, to complement face-to-face tutorial;
- *integrated conferencing model*, for courses where, for instance, students are required to perform some collaborative work online. This model is rapidly becoming the norm for newly presented OU courses;
- *wrap-around courses*, in which the course content is delivered largely online through discussions and other collaborative activities, with text books providing the remaining course content. This model is mainly adopted at post-graduate level.

Computer conferencing also has a social function for students and provides a fast route for course teams to make announcements.

More recently, synchronous audio visual computing conferencing has also been used on OU courses, through the deployment of an OU-built conferencing system called Lyceum (Rapanotti and Hall, 2000, Buckingham Shum, 2000). About 1,500 OU users were registered with Lyceum in the year 2000.

In this paper we focus on the use of the FirstClass computer conferencing system in a large-population undergraduate computing course. Within the course, computer conferencing is fully integrated and used both for peer-to-peer and tutorial support, and for group working, which is assessed. It is this latter use of computer conferencing that we address in the paper.

## 3. The study

### *3.1 The course*

In this study we consider the OU course *M206 Computing: an object-oriented approach.* The course provides a general introduction to computing, with an emphasis on modern software engineering practices (Woodman *et al*, 1998). The course, although second level, does not require any prior computing knowledge or expertise, other than being able to use a word processor on a Windows PC. The course itself makes use of a full range of media: paper, broadcast television, interactive CD-ROM, a programming environment, a Web site and computer conferencing. For its generality and introductory nature, the course attracts a large and heterogeneous student population. (For the past three years, just over 5,000 students per year have registered on the course; projections for 2001, predict that registrations will exceed 8,000 students.) On the course, students are supported by a network of tutors, with tutorial groups of 20-25 students.

One of the learning outcomes of the course is collaborative working, seen as an essential part of today’s software engineering profession. Hence, on the course, collaborative working is treated not only as a necessary transferable skill that students should acquire through an undergraduate course, but also as a necessary professional skill that is specific to the nature of developing software. Therefore, participation in collaborative working is a necessary and formally assessed part of the course.

Currently, collaborative working on the course spans over four group projects. The first project allows the students to practice their collaborative skills at a distance and is not assessed. The remaining projects cover essential software engineering skills and are all assessed. In this paper we focus on one such project.

### *3.2 Scope of the investigation*

One of the aims of our analysis is to evaluate how the current format of group working meets the course learning objectives of developing content specific and transferable skills. In this paper, we describe a first step of such an investigation, in which we focus on collecting evidence of collaborative learning through group working, and evaluate the extent to which participation to the conference is reflected in the material submitted by the students for assessment.

In conducting our study we had access to course material and course team policies, in particular with reference to the design of group working projects and their assessment. Our analysis complements a wider evaluation of the course, which includes:

- development testing, carried out during course production;
- one-line questionnaires and end-of year-surveys, used as yearly evaluation since the course was first presented in 1998;
- a research investigation into ways students on the course acquire programming skills through interaction with a purpose-built programming environment (AESOP, 2000).

### *3.3 General format of the projects*

Basic requirements in the design of group working for a large population course at a distance are scalability and fairness of assessment. Project tasks must be carefully specified so that are carried out in a similar manner in all groups. Strict marking schemes must be defined so that students are assessed on equal terms. Issues of plagiarism and *netiquette* (“network etiquette”) also need consideration.

On the course we consider, all projects are carried out within tutor groups and are assessed by the tutor leading the group. Some projects are divided into stages, and electronic reminders are sent to the project conferences to alert the students of the beginning of a new stage.

For each project, students are provided with a set of guidelines regarding the nature, extent and frequency of their contributions to the project conference. Examples of such guidelines are that a contribution may initiate a new thread of discussion, or should focus on one significant aspect of the project task and not try to address all issues at once, or that students should take time for reflection and measured judgement.

Tutors are provided with a marking scheme as well as guidelines on how it should be applied. This is a necessary procedure to guarantee that standards are maintained across tutor groups.

The group projects focus on peer collaborative learning. Students gain marks for participation and quality of contributions to group discussions. Tutors are prevented from taking part in the discussion, although they are required to monitor the conferences to ensure that *netiquette* and group working rules are not broken.

### *3.4 Description of the task*

The group working project we consider in our study focuses on issues of *object-oriented analysis* in the development of software systems. That is, it covers a set of engineering activities that a software developer has to undertake in order to understand the requirements of the users of a software system and produce a corresponding initial design of the system. Students are given a written statement of user requirements to analyse within their project conference. At the end of the project, they are assessed by their tutor on the basis of:

- their postings to the conference, as evidence of their participation in the project; and
- a system design, produced independently, after participation to the conference discussion. Such design cannot be published on the conference, but constitutes part of each student’s individual assessment.

The nature of the task is such that students collaboration is required both for the interpretation of the problem (the user’s requirements) and the application of appropriate techniques for its solution (a system design). Therefore the project task is of a problem solving nature, requiring the students to apply software engineering skills acquired on the course to a novel problem.

The statement of requirements is the same for all students on the course and they all carry out the activity over the same period of time. Students are told which course material they need to study in order to complete the task, and which range of techniques they should consider while carrying out the assignment.

The project is scheduled towards the end of the course, when students have already acquired great familiarity with the conferencing system and the rules of group working defined by the course. This allows the students to concentrate on the problem solving aspect of the activity. The project is not staged and the discussion is open for one calendar month. The number of participants is usually in the order of 10-15 students per tutor group (small differences between tutor groups are due to variations in student allocations and drop out rates).

## 4. The analysis

We started our analysis at the end of the 1999 academic year. During the study we had access to project conference transcripts as well as other material from the course. We also had access to the course evaluation data. The remainder of this section gives details of how we conducted our study.

### *4.1 Sample choice*

Among the tutor group projects set up in 1999, we selected one project conference from which all the message transcripts were taken. The choice was motivated by the fact that we had full access to that conference when we started our study. In the selected project conference, 12 students participated in the discussion, with a total of 29 messages.

Because of the way project conferences are organised on the course, a later comparison with other project conferences for the same year, showed that our sample was not significantly different from the other conferences in terms of number of participants and messages.

### *4.2 Content analysis*

In order to investigate the interaction patterns and nature of contributions we chose to carry out a content analysis of the messages that were sent to the group work conference.

Content analysis is a systematic, reliable way of coding content into a theoretically meaningful set of mutually exclusive categories. When conducted with the aim of understanding the learning process, content analysis can provide information on how learners use the medium to refine and present their ideas, and how collaborative their learning is.

In studies of computer conferencing in the literature there is a relatively little use of content analysis technique compared to other techniques such as surveys, interviews, participant observation and computer generated statistical manipulations (Mason, 1992). Some researchers even equate the interactive process with participation. However some studies show that the percentage of truly interactive sequences initiated by students was very low and "the analysis of the teleconferences did not indicate that the learners participated collectively in the reconstruction of knowledge, as the majority of the messages were independent" (Henri, 1992).

Our content analysis involved a thorough reading of all conference messages (saved in electronic form) by one of the authors, an expert in the field, with a view to discovering what kinds of contribution students were making towards the solution of the problem in hand. In particular, we looked at all the message transcripts in order to establish the relevance of each student's contributions in terms of the task set for the project; for example, whether contributions were on-task or off-task, cognitive or metacognitive.

We used this kind of classification of students' contributions to provide a means by which evidence of students' learning – in terms of 'fitness' of the contribution to the required task – could be sought in the transcript of their messages. This is in line with Mason's idea that "by focussing on an educational goal such as understanding of course material /applying it into a new context and by breaking it down into examples of behaviour or written work which display these characteristics, it is possible to analyse conference content and draw conclusions about the educational value of particular on line activity"(Mason, 1992).

In order to classify contributions, we chose as our unit of analysis an aggregation of statements within the message body that could be recognised as a meaningful whole. We classified such units into two main categories: *propositions* and *queries* Propositions represent students' suggested solutions for particular aspects of the system design. For example suggesting that a software component (e.g., a class of objects) should be included in the system design. Queries on the other hand, represent dialog extension questions on aspects of the system design, that is they are statements in which students express uncertainty and invite further comments. An example of this is expressing uncertainty on how a piece of information should be recorded within the system design in the presence of alternatives.

As well as classifying them, we labelled propositions and queries uniquely in order to keep track of them, and document agreement and disagreement.

We collected the information about propositions and queries in a *contributions table*, a fragment of which is given in Figure 1. Each row of the table corresponds to a contribution. The table columns, from left to right, include: the contribution unique label; the number of the message in which the contribution appears; the identifier of the message sender; the list of messages expressing agreement with the contribution; the list of messages expressing disagreement with the contribution; and the content of the contribution (in terms of project task).

| *Label* | *Message* | *Sender* | *Messages expressing agreement* | *Messages expressing disagreement* | *Content* |
|---|---|---|---|---|---|
| P1 | 1 | | 2/12/15/20 | | There should be a class User with subclasses IndividualUser and GroupUser |
| P2 | 1 | | 2 | | There should be a class Bike with subclasses RoadBike and MountainBike |
| P3 | 1 | | 2 | | Class Bike should have responsibility for recording the ID number; classs MountainBike for recording the police number; and RoadBike the size and equipment |

*Figure 1 Fragment of contributions table*

### *4.3 Representation*

In the absence of standard tools for content-dependent representation of conference interactions, we adopted a pictorial representation of the conference in the form of a directed graph (see Figure 3), which we have called a *conference interaction map*, or interaction map for short. Each node of the map (squares in the figure) represents a message posted to the conference. Nodes are annotated to indicate:

- time progression: nodes are totally ordered chronologically, based on the message timestamps;
- sender identity: coloured shapes within the nodes are used to identify messages from the same participant;
- propositions and queries: each node is annotated with a list of the labels indicating the contributions included in the message. This list may be empty – this happens when a message does not introduce any proposition or query, but addresses points made in previous messages.
- agreement and disagreement: each node shows whether the message includes agreement (+) or disagreement (-) with earlier contributions.

For instance, in Figure 2 the top left node is annotated as follows. The number 7 indicates that the node corresponds to the 7th message in the conference; such message introduces two propositions (P12 and P13); it expresses agreement with query Q2 (which was introduced in message 5) and disagreement with propositions P10 and P11 (also introduced in message 5). The coloured square identifies the message sender.

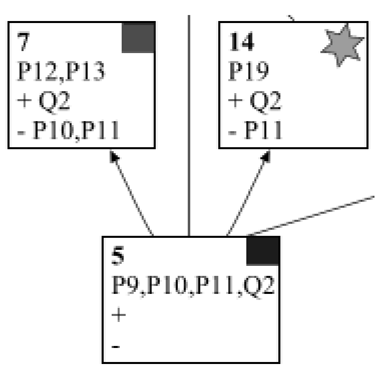


*Figure 2 Example of nodes and arrows*

Arrows between pairs of node in the interaction map indicate a relationship between the nodes in terms of agreements and disagreements, as in Figure 2 between nodes 7 and 5.

The interaction map of the whole project conference we considered is given in Figure 3.

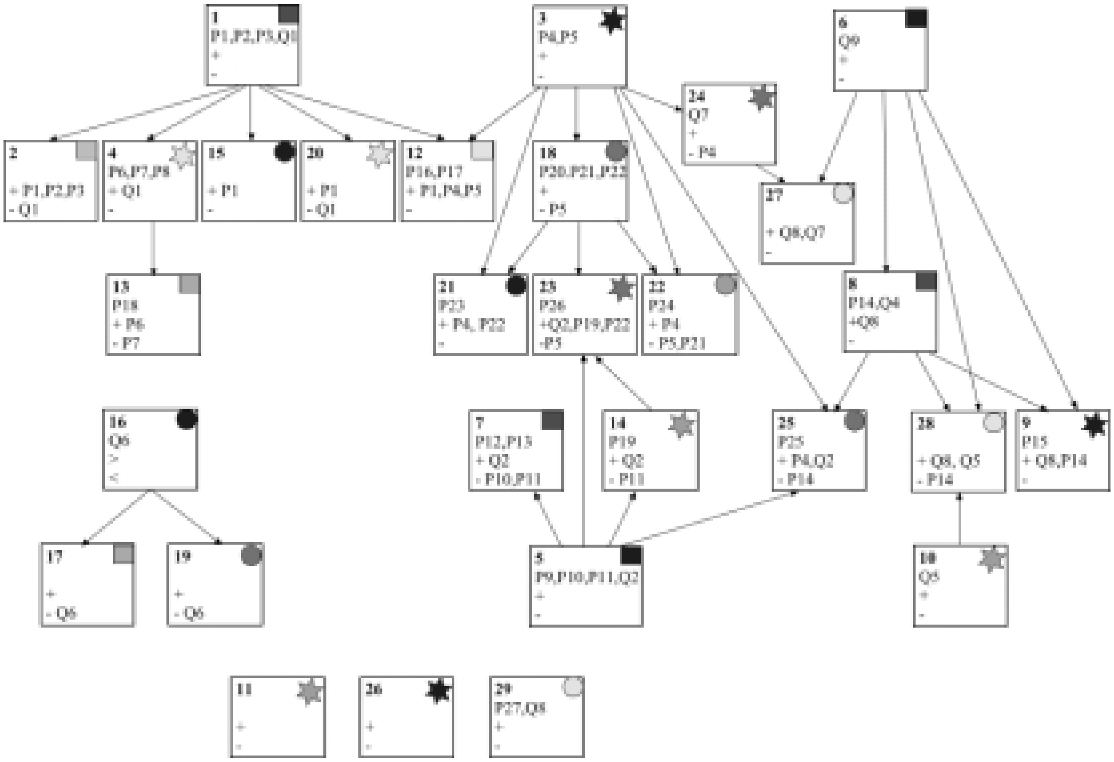


*Figure 3 Conference interaction map*

Our pictorial representation presents a number of advantages over, say, a purely tabular representation. As well as providing a succinct summary of the conference, the following information can be retrieved easily:

- clusters and trails of discussion: by looking at the way nodes are related through arrows, it is easy to identify messages that contribute to the same discussion. Also, node annotation allows one to navigate each trail within the discussion.
- influential contributions: by looking at the descendants of each node (i.e., the nodes at the end of arrows departing from the same node) and their annotations, it is possible to identify those contributions that generate large numbers of responses from conference participants;
- level of student participation: as nodes are colour-coded to identify message senders, it is easy to establish how wide and influential is each student's participation to the conference.

## 5. Findings

As already mentioned, 12 students participated in the group conference in our study, which is not atypical compared to the other project conferences in the same year. As in the other conferences and according to the project rules, there was no tutor participation – only monitoring.

In the students' messages, there was very little off-task content: the students were almost exclusively focusing on the requirement analysis they were asked to do. This may be due to the highly structured task specification and also to the presence of other conferences for social and other course related purposes.

From our classification of students' contributions we found 27 distinct propositions and 9 queries. Among the propositions, 9 represented acceptable solutions in terms of the project task and 5 partially correct statements. Almost all of the queries (8 out of 9) were appropriate in terms of the project task.

Our interaction map shows that in this conference students were talking to each other, not carrying out a monologue. Most messages in the map are connected through arrows representing agreements or disagreements. Looking at message contents, we observed examples of both explicit (mentioning other participants' names) and implicit (only addressing statements in previous messages) interactions, although there were significantly more explicit interactions than implicit ones. In other words students preferred to address explicitly the person whose idea they were considering in their contributions.

The number of isolated messages, i.e., not generating interaction, is very small (only 3) and they still contain on-task contributions.

Generally we found that both in stating propositions or queries, and in expressing agreement or disagreement, students were applying software engineering knowledge and skills acquired on the course. We also found evidence of inference skills, with agreements and disagreements leading to the formulation of new propositions and queries. For instance, in message 3 (see Figure 3), one student suggested that there should be a class Rental in the system design (proposition P5). Four more students (messages 12, 18, 22, 23) discussed the issue expressing both agreement and disagreement. In particular message 18 expresses disagreement and suggests an alternative solution (proposition P22). Incidentally, at the end of the discussion the proponent of P5 changed her position on reflection (in message 26).

Students also perceived this project work as a valuable contribution to their learning. In their responses to course evaluation surveys, the majority of students who participated indicated that they found computer conferencing helpful. For instance, one student stated that:

> *"while doing the group work I had a strong feeling of the whole thing being a bit mixed up with different people following different lines. Then I became real (sic) enthused about the subject and feel I learned a great deal from the conference"*

However, these views are not shared by all students, which is not unexpected given the heterogeneous student population of the course. The project work was not as equally interesting and stimulating for all them. For instance, another student said:

> *"difficult and a bit artificial. I do not think it simulates 'real' group work in a 'real'environment"*

One main concern students expressed about group working is in relation to timing and workload, and the reduced flexibility, which is always an issue in distance education courses. For instance, students reported that:

> *"because of the timing of them, it means that at times we are continually under pressure to meet deadlines. Yes, I know this is like the real world, but part of the point of being OU students it means that we have other responsibilities as well, e.g., families, homes, jobs…"*

## 6. Discussion and conclusions

In this study we applied content analysis to transcripts from a group work conference on an OU undergraduate computing course, with the intention of evaluating the extent to which students were involved in collaborative learning. Our findings showed that this group work project was a successful example of a collaborative learning environment and we think a number of factors contributed to this outcome.

Students' familiarity with the technology has an impact on how effectively and widely students can participate in on-line activities (Owen, 2000). The course we have considered does not assume any prior knowledge of computer conferencing. Instead it develops students' online skills through student participation in online tutor and social computer conferences, and through a practice work project early in the course. These provide the students with the necessary skills and confidence to carry out project work, free from technology-related concerns.

In a course in which group working is fully integrated, its effectiveness can only be evaluated in terms of its contribution to the course learning outcomes. In the course under consideration, group working aims at developing essential students' communication skills, such as being able to communicate effectively and professionally about various aspects of computing, and being an effective member of a team. Computer conferencing provides the means for students at a distance to develop and practice such skills, and course project tasks are designed to maximise this aspect of students' learning.

Students feel more comfortable in an environment where they are aware of what is expected of them and there are clear guidelines. One of the strong points of group working on this course is that tasks are highly structured, and guidelines are defined for students to take part in projects. The nature of the task (e.g. whether it is something students can share or not) has an effect on the results of collaboration, and also the whole process (see also Paiva, 1998). The presence of a common goal (designing a system for the given user requirements) supports the process of collaboration. Tutor monitoring of the project conferences also provides the necessary quality control for course guidelines to be enforced.

The fact that group working is formally assessed is a strong incentive for students' participation in projects. However, the course overall assessment strategy is such that students can still pass the course even if they don't participate in all the projects. Nevertheless, participation in group work conferences remains high throughout the year, which seems to indicate that students value group working as a positive learning experience.

The content analysis and mapping we performed in our study helped us gather evidence of truly collaborative learning within one of the projects of the course. It was possible to document student actions such as asking questions, forming hypotheses, providing evidence against and for the hypotheses proposed, providing and sharing information and commenting on contributions from fellow students. This has provided us with a framework for the analysis of online interactions in a small-population project conference with a tightly focused discussion. Because of the way the course projects are designed, we believe that a similar approach could be used for further analysis of data from the course, or on courses that adopt a similar approach to online collaborative projects.

We are aware that our approach will require some refinement in order to overcome some of its current shortcomings. For instance, the very specific nature of the task, use of a single problem for the whole group, and the relatively small size of the tutor group made it possible for us to code and classify the whole interaction. Many researchers in the literature work with larger groups and consequently the number of messages they have to deal with is much higher. Our method needs to be somehow adapted for mass analysis to be feasible for use in these situations.

Finally, we are also aware of the limitations of the interaction map in representing the full scale of multiple interactions taking place within single student messages. For instance, at present we are only recording agreement and disagreements among contributions. However, the representation of inferences on the map would be beneficial, and we are already working on ways to improve this aspect of the map.

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