Exploiting connectedness in the informatics curriculum

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Abstract

The power of modern communication technology gives us an opportunity, as Informatics educators, to enhance our ability to develop our students' skills in virtual teamworking. We discuss why virtual teamworking is as relevant for students in traditional campus-based universities as it is in a distance learning context. We highlight some of the questions to be answered, and some of the problems to be overcome, in the context of our experiences in designing and delivering a virtual teamworking course at the UK Open University.

Key Words

Online Learning, Virtual Teams, Appropriate Technology

1 Introduction

The UK Open University (OU) has a long tradition of presenting courses spanning the whole range of academic computing provision, at both undergraduate and postgraduate level, but until recently did not offer a route leading to a named Computing degree.

One reason for this lack of a named degree in Computing was that it was not clear how to satisfy the teamworking criteria for accreditation by the British Computer Society (BCS) in a distance learning programme. However, continuing improvements in the capabilities of computer-based communication software led us to believe that a point had been reached where it would be worth attempting to provide an effective teamworking experience for distance learning students.

Making a virtue out of virtuality, we decided that this would be delivered entirely online. The authors were responsible for the production of the virtual teamworking course 'M253: Teamworking in distributed environments', first presented in 2005.

The call for papers for the 2006 Informatics Education Europe conference in Montpellier led us to consider the relevance of our introduction of this virtual teamworking experience, initially intended for distance learning students, to the wider context of computing education in campus-based institutions. This paper is an expanded version of our conference presentation.

2 The context of the problem

The conference call included an assertion that Informatics in universities is still mainly taught in the traditional way common to both science and technology, with ex-cathedra lectures accompanied by assignments and tutorials. Both the context and the mode of delivery reflect the way in which most university teaching staff themselves were taught.

Prensky (2001), in his seminal paper on the digital divide, observed that "*Our students have changed radically. Today's students are no longer the people our education system was designed to teach.*" Culligan (2006), discussing the implications of the digital divide for the world of education, comments that "*The challenge facing educators and trainers is to identify learning strategies that are appropriate for digital natives, recognising the different ways they process information, and developing learning tools that maximise the potential of their unique cognitive approach.*"

Given that our students have grown up in a digitally connected world, we would suggest that it is not so much that they need more learning tools, but rather that they need more structured learning tasks and activities which enable them to understand and evaluate the usefulness of such tools. We need to create a learning environment within which they can develop skills in choosing between, and effectively exploiting, appropriate tools from the plethora that are already available. The issues we need to address are pedagogical rather than technological.

Our education system is not set up to handle digital natives. We academics, as predominantly digital immigrants, are tasked with teaching predominantly digital natives, who come to us with expectations that their education will involve the use of modern communication technologies as an integral part of their learning experience. As educators, we need to identify teaching and learning strategies that are appropriate for digital natives, and to develop learning situations and environments that exploit our students' familiarity with, and comfort in using, modern technology.

2.1 The need for teamworking

A question that we should continually ask ourselves as educators is "*What are the skills that will be expected of our students when they leave the protected world of education and go out to work in the global market place*?"

Answers to this question can be found in many public pronouncements from potential employers of our graduates. For example, the Labour Market Focus (2005) section of the e-Skills Bulletin indicated that Communication and Teamworking are the two highest rated skills that employers expect from IT students. In the more general context of graduate employability, a recent article in the Guardian newspaper (Kosviner, 2007) quotes Miles Templeman, director-general of the Institute of Directors as saying "*One third of our members have reported that they are not happy with the employability of the graduates they recruit. We're talking about interpersonal skills, communication*

and teamwork and the ability to handle business situations - all things that are not taught in universities and schools. You can get very clever graduates who aren't any good at these essential skills." We need to move away from a view of education primarily as individual knowledge acquisition towards one incorporating significant development of social interaction skills.

Teamworking is clearly much in demand from employers, and this has long been recognised by professional computing institutions like the BCS and the ACM. For example the draft ACM Curricula (2005) state that "*Students need to learn to collaborate in teams to accomplish a common goal by integrating personal initiative and group cooperation*" and that "*Students need to be given the opportunity to work in teams beginning relatively early in the curriculum*". However they also strike a warning note that "*Learning to work in teams is not a natural process for many students but it is, nonetheless, extremely important.*"

Successful teamworking is not something that just happens when students are gathered into groups and assigned a shared task. To provide a worthwhile experience for the students who are members of the teams, leading to the development of skills which are transferable to other situations, attention must be given to the format and structure of the teamworking tasks, and to the environment in which the teamworking takes place. Much work has already been done in this area and a good survey, providing guidance and resources, can be found in the report of the EPCOS project (Fincher et al, 2001).

2.2 The need for *virtual* teamworking

When we think about preparing our students for social interaction in their future working environment, we also need to consider the impact that modern communication technology has had on that environment. Connectedness is the new business paradigm. As Lipnack and Stamps (2000) indicate "*There are no boundaries in today's work environment. Virtual teams from all over the world use technologies like the Internet, intranets and groupware to work together on projects*."

Typical examples of this new environment can be found in the adoption of virtual teams by multinational organisations such as Volvo (Hammar, 2005) and Ernst & Young (Lamont, 2000). Many of our graduates will be expected to work in such teams operating across functional boundaries, across institutions, across industries, across national boundaries, across time-zones, and we need to prepare them for this during their undergraduate studies. Such teams are particularly appropriate in the area of software development; see for example (Carmel, 1997).

3 The changing nature of university campuses

The study of Informatics is a natural context for developing teamworking skills. We have been doing this on campus with some success for many years in a face-to-face context, using real-world problems, in a variety of forms from groupwork on initial systems analysis courses to teamwork in final year

software engineering courses. Examples can be found in the EPCOS report mentioned earlier, and in the 'software hut' activities developed by the University of Sheffield (Holcombe et al, 1998).

But student attendance patterns have changed significantly over recent years, due to economic pressures, and we now find ourselves in a situation where (local) virtuality is already a reality. More and more students are living at home, working part-time to support their studies, only attending campus-based activities where these are seen to impact on assessment. Attendance at seminars is often very low, as students do not feel that they are getting any significant benefits from the limited exchange of ideas that typically takes place in this context. Anecdotally, we have evidence of significant lack of socialisation in face-to-face degree courses, with final year students not recognising each other although they have been nominally following the same course for 3 or 4 years.

Scheduling and attending regular team meetings on campus in such circumstances is increasingly difficult, even assuming that the institution has, and is willing to make available, suitable meeting spaces for teamworking. Moves to make all course materials and resources available electronically, even producing pod-casts of lectures, to convince students that we are in the vanguard when it comes to the use of modern technology, further decrease the incentive for students to be physically present on campus.

Most campus-based students have their own computers at home or in their lodgings, with a high bandwidth connection to the Internet. Much modern student accommodation provides networking as a standard feature. In their non-academic lives our students, as digital natives, are constantly engaging in a wide variety of online activities. Therefore the contrast between IS students studying at a campus-based institution and those studying in a distance learning environment is becoming increasingly blurred. As Turoff (2006) comments "*The technology of distance learning has extended to the on-campus student. The fundamental change that has brought this about is the introduction of blended courses where the face-to-face student is utilising the same technologies that are utilised by the distance students*". Blended learning is now a significant developmental issue in most higher education institutions.

Recognising that virtuality is no longer the prerogative of distance learning institutions, we should be taking advantage of our students' access to, and familiarity with, the technology. The ability this gives them to interact with each other - *potentially the most radical feature of technology enhanced learning* - means that we should be in a position to provide them with significant virtual teamworking experiences throughout their undergraduate studies, even in campus-based institutions.

If connectedness is the new paradigm for both living and working in the modern digital world, then connectedness has to become the new *educationa*l paradigm. Since access to, and usability of, online communication mechanisms has improved immensely in recent years we need to consider

how we incorporate this connectedness into our teaching, using it as a vehicle for developing our students' teamworking, reflection and communication skills.

4 Levels of online interaction

When we consider the way in which our students use modern communication technologies we soon realise that there is a potential problem in harnessing this experience in an educational context. Much of their use is of a social and leisure nature, with interaction taking place in the social-networking environment often referred to as Web 2.0, engaging in instant chat, use of online services, online information seeking, or games-playing, rather than being directed towards collaboration with others on the solution of some specific real-world problem. There is little need for them to reflect on the interactions that they experience in such contexts. Their use of the technology is very much focussed on the immediate results of using the technology itself, rather than the technology being a vehicle for an enterprise of longer duration and higher purpose.

What this means is that, although comfortable with active online engagement, our students will not necessarily enter higher education already able to use the available tools, purposefully and successfully, for online collaboration in the context of teamworking. We need to think about a gradual process of familiarisation with the relevant tools, and a gradual increase in the sophistication with which these are used, in a phased development of collaborative activities throughout a student's degree programme.

Much of the groupwork that takes place in computing courses is only sporadically interactive, in the sense that student teams get together at the beginning of their project to do some initial analysis, on the basis of which they allocate work packages to the individuals involved. After that they go off and do their individual software development in parallel, writing and testing their allocated software objects, etc, only coming back together briefly towards the end of the project to pool all their individually produced components together into a single product. The process is more one of *collation* than of *collaboration*, and the assessment is generally based on the final *product* and an associated group *presentation* of that product, with little attention given to any reflection on the *process* by which it was produced. This is true even for a major internationally-distributed team software development project like Runestone (Hause, 2003).

For the teamworking experience to be of any lasting value there must be a significant element of evidence-based *reflection* on the processes involved, both for the individual and also for the team, at all stages of their degree programme. Students need to develop an understanding of the *rules* to be adopted for working effectively as a team, the *roles* and *responsibilities* to be allocated and accepted by team members, and the *relationships* that need to be managed in order that the team can operate successfully.

Early in the first year it is probably enough to encourage use of appropriate communication media for *conversational* use, with the intention of developing

a sense of membership of an online student community. Later in the same year we can move into activities which require *cooperative* use for group working activities, where students pool the results of their investigations and comment on each others' work but eventually submit an individual assignment for assessment.

Moving on into the second year they can begin to make more *collaborative* use of the medium in a teamworking context, with a series of tasks to be shared, leading up to the submission of a co-authored team product for assessment. At this stage the task needs to be a relatively non-technical one, so that there is a possibility of concentrating more on the *process* of working together as a team rather than on the *product* of that working. Individual and team reflection should be major components of the activity in this phase.

In the final year, following this staged development of skills - both in using the online environment and working together within it - what they have learned can then be engaged in a *constructive* use of the medium to undertake a fully-fledged online teamworking project, involving the specification, design and implementation of an (online) information system.

5 Required changes to existing practice

In considering the introduction of virtual teamworking to the existing Informatics curriculum, whether it be delivered entirely in distance learning mode or as a blend of distance learning and face-to-face modes, we are presented with a number of problems which arise more from the attitudes and behaviours of the people involved than from their reactions to the introduction and use of any new technological platforms and tools. Students do not necessarily want to engage in collaborative activity and often see it as getting in the way of their individual progress. Tutors do not necessarily want to give up their role as the arbiters and purveyors of knowledge, leaving the students in their teams to find things out for themselves. In the following subsections we discuss some of the issues that arise from the attitudes of both learners and teachers.

5.1 Learner perspectives

Many of our Informatics students come to us not possessing or valuing skills in communication, reflection or collaboration. They regard themselves as technically competent individuals who just want to get on with the production of something that works, without all the restrictions imposed by any process that insists on elements of analysis, design, planning, scheduling, working to strict timescales, being dependent on the activities of others, or explaining and documenting their activities.

Waite et al (2004) provide an interesting analysis of their Computer Science students' resistance to collaboration. Initial attempts to introduce group work projects into their courses failed to develop the intended collaborative skills, due to the inherent bias against collaboration exhibited by their students. As a result of subsequent ethnographic observations and in-depth interviews of

students, the authors came up with a list of those student attitudes which inhibited their ability to engage in productive collaborative activity. The list included:

- a preference for working alone
- a tendency to procrastination
- a preference for experimentation
- a disregard for process
- a competitive, even combative, approach
- an unwillingness to support others
- an unwillingness to accept the authority of others

and, last but not least, an absence of passion / motivation for the task itself.

The strategies proposed for overcoming these attitudes focus on introducing more open discussion into the teaching process, incorporating more collaborative processes into technical assignments, and emphasising the formative nature of assignments - devaluing the product in favour of the process by which that product was produced.

Waite's study was based around teamworking courses run on a face-to-face basis in a campus-based institution. When we add an online dimension to the processes of collaboration we increase the degree to which students have to rely on the behaviour of others. When most of the interaction is through the medium of asynchronous communication, the timeliness of the responses from those with whom they must collaborate becomes critical. The regularity and frequency with which all virtual team members need to access and contribute to the shared work-in-progress puts significant pressure on all participants.

In expecting students to work together effectively in teams, handling fairly undefined real-life problems, we also encounter another dimension of students' resistance, not to collaboration as such but more to being willing to make decisions and then act on them without significant direction from their tutor. So much of their earlier education is founded on the concept that there is a *right* way to proceed in the solution of a given problem and a *right* answer at the end. Students are also trained to be passive receivers of education rather than active searchers for knowledge. We have to find ways of encouraging students to be not only more reliant on their fellow collaborators but also more self-confident and self-reliant, rather than expecting detailed instructions on how to proceed, and definite answers to all their concerns.

5.2 Teacher perspectives

There is a corresponding need to change the approach taken by teaching staff when they have the responsibility for handling students engaged in working together as teams. Tutors give up their 'lecturing' and 'directing' roles with great reluctance, they are not happy about relinquishing their control of the educational process. Many writers about online tutoring, whilst explicitly indicating that using the new technology empowers the student, still implicitly lay claim to a continuing controlling role for the tutor, even when they set this control in the context of adopting a *dialogic* rather than a *didactic* approach.

They imply that real power should still reside with the tutors, who will routinely intervene and organise their students' activities because they know best what the students should be doing.

For example Gilly Salmon (2000), whose 5-stage model has become almost the standard when discussing e-moderation of online student collaboration, says "*the best e-moderators undertake the weaving; they pull together the participants' contributions by, for example, collecting up statements and relating them to concepts and theories from the course. They enable development of ideas through discussion and collaboration. They summarize from time to time, span wide-ranging views and provide new topics when discussions go off track. They stimulate fresh strands of thought, introduce new themes and suggest alternative approaches.*"

An interesting recent paper by Blank et al (2007) discusses the *emergent* pedagogy which arises from the increased levels of collaborative activity made possible by developments in communication technology. It applies concepts of emergence - such as the way that complex patterns of behaviour, evolve from relatively simple interactions between simple autonomous elements in a system, the patterns themselves being unpredictable at the beginning of the process and only emerging when the system is allowed to play itself out - to the behaviour of groups of students collaborating online. But even here the authors appear to want to retain control of the process and they state that "*Finally, the teacher is the major synthesiser and reflector, the one who has responsibility for making activities visible and meaningful to all participants.*"

In the context of developing students' teamworking skills we believe that tutors have to take a further step backwards from overall direction or routine intervention. They need to take into account the fact that in an online teamworking context much of the more traditional *teaching* activity is not explicit, but is embedded in the structure of the course and its associated online resources, in the pattern of activities and assessment tasks that have been set for the team. See, for example, Gustafson & Gibbs (2000). What is important is that we, as course designers, ensure that we have created a course environment in which students can be left to experiment, even to fail. Failure in a controlled environment, meaningfully reflected upon, can provide a valuable learning opportunity. The tutors are there to create a SAFE environment, providing Support, Assessment, Feedback and Explanation.

This is not to diminish the importance of the tutor in the context of virtual teamworking, but rather to suggest that a *mentoring* rather than a managing model is adopted, with tutors operating as facilitators, but in a substantially hands-off mode. Our tutors are there to provide a safety net, but are only expected to intervene in extreme circumstances. They need to resist all temptations to *manage* the details of a team's organisation, or to *meddle* in the details of a team's activities and decisions.

The residual responsibilities of the online team tutors are by no means trivial, and include:

monitoring team activities and keeping an eye on whether the team is staying substantially on schedule;

moderating team conferences and forums, ensuring that team members are behaving appropriately, but intervening only if there is evidence that interactions within the team are getting seriously out of hand;

marking team and individual work submitted as assignments, and providing feedback that might assist team and individual reflection on progress to date and might help team members to improve their performance in subsequent phases of the project.

One specific reason why it is necessary to keep the level of active tutor intervention to a minimum is the need to ensure that tutors have a manageable workload. Generally reported experience of online tutoring, for example, Gustafson (2000) and Salmon (2000), suggests that it is even more demanding and time-consuming than operating equivalent courses in a face-to-face context.

6 Our current course

In the course "M253 Teamworking in Distributed Environments" which we have produced and delivered at the OU twice yearly since the beginning of 2005, we have attempted to address some of the issues relating to virtual teamworking discussed above. In particular we have aimed the course at the *collaborative* stage of the progression of online interactivity discussed in section 4, since most of our students have experienced the conversational and cooperative activities in earlier courses within their Computing degree studies. We would argue that this stage is the most important one to address because the insistence on significant reflective activity should provide students with opportunities to develop both an understanding of the issues of working as an online team and the skills that will be transferable to other teamworking environments in which they may subsequently find themselves.

The course is compulsory for all students on our Computing degree, since it is necessary to meet the BCS accreditation criteria. It is a free-standing course which takes place over a period of 6 months, with a weekly minimum commitment of 4 hours for each student. Students are randomly allocated across the UK to teams of about 6 members, and there is no opportunity whatsoever for face-to-face contact.

The course is built around a Requirements Specification scenario for a relatively simple online information system, and does not expect students to have prior knowledge of any particular systems methodology, or skills in programming. The emphasis of the course is on understanding the processes of working as a team, rather than on the products which the team produces, and we are attempting to develop students' skills in communication, reflection, and working with others.

Although the present paper is not the vehicle for discussing the course in detail, we present some important aspects here to give context to the earlier discussion. The rationale for our decisions about course structure and assessment is discussed in Oldfield & Morse (2005) and initial analysis of our experiences in running the early presentations of the course appears in Oldfield & Morse (2006).

6.1 Course structure

The course materials that students receive include a printed Course Guide and an extensive set of online Resource Sheets covering both theoretical and practical aspects of working in (virtual) teams, working on analysis of system requirements, and documentation issues such as keeping personal logs and writing reports. These Resource Sheets are provided as guides to the sort of techniques and notations that might help students with the tasks they have to undertake, rather than mandatory instructions on how they should proceed.

The Course Guide contains background course information, plus detailed explanations of which Resource Sheets students should read, and what activities they should undertake week by week, again presented as guidelines rather than mandatory instructions. We want our teams, as part of their collaborative activity, to make their own decisions about such matters, within the framework of the deadlines which we have set for intermediate and final assignments.

The basic structure of the course is shown in Figure 1. There are four distinct phases of project activity in which the team members have to interact with each other, each phase culminating in a Milestone (for example M1 on the figure) at which both team and individual deliverables have to be submitted to the tutor. The initial phase is formative and un-assessed but is critical to team formation, involving feedback from the tutor and reflection by the students. The summative assessment for the course is based on the deliverables from the three subsequent phases.

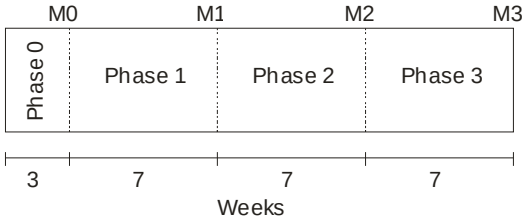

Figure 1. Overall schedule for the course.

The introductory phase is included as an ice-breaker, where students get to find out something about each other, in terms of their personal details, interests and experience, what they hope to get out of the course, and what particular skills they think that they can contribute to the team's activities. We want to reduce the effects of social as well as geographic distance on collaboration between our virtual team members as early as possible in their project (Bradner & Mark, 2002).

In this phase, students are tasked, as individuals, with choosing a website (for a specified application chosen by us as the Course Team) and evaluating this website according to criteria determined by the team members themselves as a result of some initial online discussion. They then have to share their choice and its evaluation with the rest of the team and, as a team, come up with a prioritized list of all the chosen websites, together with reasons for the ordering, agreed by the team. This material is submitted to their tutor for comment.

This activity gives students a safe, since un-assessed, space in which to start on the process of working together. They find out something about each others' personalities, preferences and priorities and begin to form personal relationships. At the same time they have an opportunity, as a team, to begin establishing some ground rules for such matters as the nature and frequency of communication necessary to complete such tasks, and the need for mechanisms to enable them to arrive at agreed team decisions.

There is much discussion in the literature about the problems of team formation, and about the benefits of face-to-face meetings to establish the team socially before any task-based work is undertaken. We did not have the resources to bring our distance learning students together for face-to-face meetings, and since there is evidence from studies such as those by Whitton (2005) that task-based ice-breakers are as effective in establishing team cohesion as socially-oriented activities, and are actually preferred by students, we made the main activity for this initial phase a simple task-based team exercise.

If a virtual teamworking course were to be run in a campus-based university then we would recommend some initial face-to-face contact at the beginning of the course to help with the establishment of the team's social structure. This view is endorsed by Lipnack and Stamps (2000) who state that "*Most people we talk to continue to stress the importance of face-to-face interaction to solidify virtual teams*", and that "*face-to-face is the fastest way to build trust, crucial in the early phases of virtual team life*", However, in practice, our course has proved surprisingly robust with no opportunity for face-to-face contact.

The rest of the course is made up of three distinct phases of project activity based on the scenario which we have provided. For the first presentation the scenario was based on a small enterprise involved in the business of letting holiday properties, which has asked for advice on how to computerise its activities and provide an online system for its clients. The three phases are structured around Activity Sheets, with both team and individual deliverables required for assessment by the tutor at each milestone. These Activity Sheets are only released at the beginning of the phase to which they apply, in an attempt to focus teams' attention on the current task, rather than rushing ahead towards design before analysis has been completed.

The work involved in each phase builds on what has already been achieved in earlier phases, but addresses a different aspect of the requirements for a

system to meet the problem posed in the scenario under consideration. In the first phase teams have to establish the essential facilities that the system should provide. In the second phase they have to investigate the way in which these facilities will be provided and establish the data needs of the system. In the third phase they have to decide on the design of the nature and content of the web pages through which clients will interact with the proposed system.

Over the course of the three phases the complexity of the tasks and the necessary degree of interaction between team members increases, as does the complexity of the decision making and the complexity of the shared documentation that has to be produced. In particular, in the second and third phases, we have incorporated activities requiring students to work in pairs (see figure 2) which has proved invaluable in ensuring that no students can sit back and leave all the work to the rest of the team.

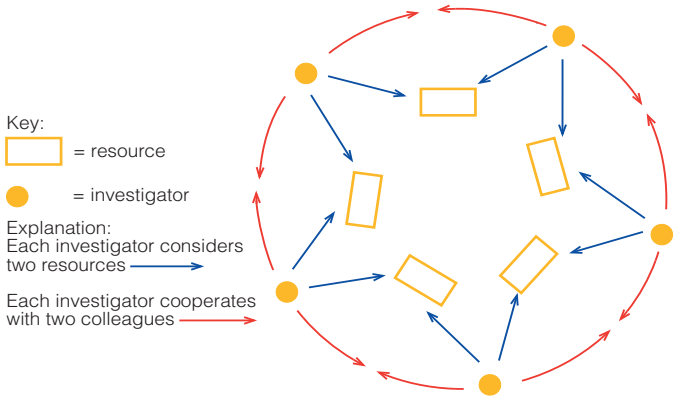

Figure 2. Pairwise Collaboration Diagram

The nature of the tasks in each phase is similar, in terms of the need for establishing rules for working together as a team, allocating roles and accepting responsibilities. In contrast with much of the literature on e-cooperation and e-collaboration, such as Salmon's work on e-tivities (2002), our course has an inbuilt iterative and incremental nature. Feedback from the reflection and assessment activities at the end of each phase provides the starting point for attempts to improve both individual and team performance in subsequent phases.

6.2 Course assessment

The deliverables at each milestone have a standard form which is illustrated in Figure 3. Each deliverable comprises both a partial product and reflections on the process by which that product was produced.

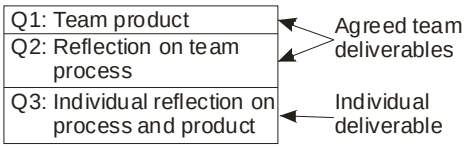

Figure 3. Assessment structure at Milestones 1, 2 and 3.

The partial product is an agreed, shared, document reporting on the technical results of the team's investigations and analyses. The team reflection is centred on the rules that the team has developed and adopted, and the way in which these have been followed, and the roles and responsibilities that the team has decided on and allocated, and the way in which these have been performed. It is again a shared document that has to be endorsed by all team members. The individual reflection is centred on the relationships that the individual has experienced during the process, and their feelings about the way that the team has formed and performed. Both these reflective elements have to be based on *evidence* from messages sent to and received from team members, documentation of team decisions, and individual project logs. One of the key emphases of the course is that we are attempting not only to improve student learning *through,* but also to improve student understanding *about,* collaborative working in teams.

We have built into the course the concept that partial success (in the sense of a team failing to produce a good solution to the problem posed in the scenario) should not be regarded as failure, provided lessons are learned that will improve future virtual teamworking performance. This approach is supported by the EPCOS report (Fincher et al, 2001). One of their key recommendations is to "consider awarding academic credit for successful accomplishment of tasks rather than assessing the products of those tasks" (op. cit. p. 218).

6.3 Course activity

Figure 4 illustrates the overall weekly volume of messages for a typical team over the course of the project. Visible peaks of activity can be observed immediately prior to the submission of shared deliverables at each milestone. The total number of student messages for this team over the 24 week period was 480, an average of 20 per week, but with 50 or more messages in peak weeks. Other teams ranged in message volume from as low as 275 to as high as 1285 messages.

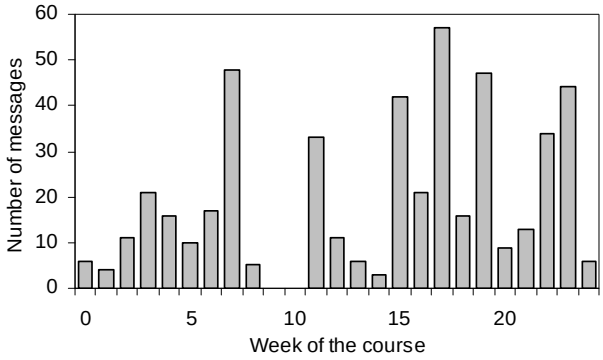

Figure 4. Messages posted per week by one team.

Figure 5 shows the levels of individual contributions (each student colour coded) to the same team conference over each phase, and indicates the increasing intensity with which students engage in collaborative activity as the course develops.

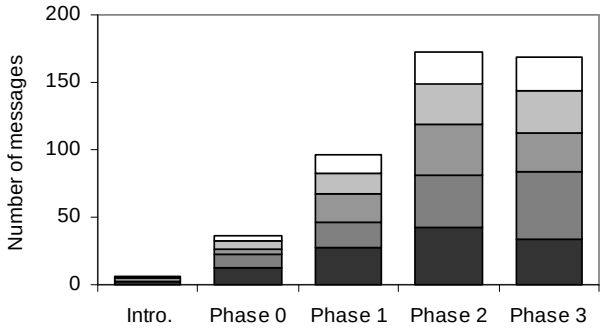

Figure 5. Messages posted per phase, grouped by student.

Both graphs provide some idea of the volume of messages that have to be processed by both the team members and the tutor. We indicated to prospective students that they should be prepared to go online at least three times a week to keep up with the expected volume of communications from fellow team members. This advice was based on a trial run of the course prior to commencing its first delivery, but in practice the majority of students report that they have been online at least once a day. Table 1 indicates the relative frequency with which students found it necessary to access their team conference in order to keep up with the volume of communication.

More than once a day	18.6%
Daily	58.1%
A few times a week	23.3%
Weekly or less	0.0%

Table 1 Frequency of student access to team conferences

Each tutor is responsible for 4 teams, which together generate about 120 messages a week for a typical tutor to take cognizance of, with peak volumes nearer 300 in weeks immediately preceding the assignment deadlines. The load that this volume of monitoring places on the tutor reinforces our earlier comment about the need to keep other aspects of the tutor role to a minimum, only intervening in extreme circumstances.

7 Appropriate technology

Although our concerns are predominantly about developing teamworking skills, the fact that we are suggesting that most, if not all, of the work will be carried out online means that we cannot ignore technology issues, even though we would agree in principle with Lipnack & Stamps (2000) that "*A virtual team's success is based 90% on the people involved and 10% on the technology.*" If you haven't sorted out your team rules, roles and responsibilities, and if relationships between team members are poor, it doesn't matter what technology is available.

However, by selecting the most appropriate technology for each task, and then using it effectively, any team's performance can be enhanced. Olson and Olson (2000) provide a substantial taxonomic analysis of the different ways of communicating, in terms of the dimensions on which different communication media can be categorised, and used effectively. Our task is to guide our students through the maze of competing tools and technologies that are available to them, and to help them get behind the hype with which these tools are pushed at them, both by the tool distributors and by those educators wanting to jump on the latest e-bandwagon.

We need to give the students guidelines on when chats, forums, blogs, Wikis and other collaborative systems are most appropriate and most effective for the range of tasks that they have to undertake in their teamworking activity. We need to make them aware of the advantages and disadvantages of asynchronous and synchronous communication, and when each can be used to best effect. We need to encourage them to develop and adhere to sensible communication protocols which will increase the effectiveness of their interactions, and to use the technology in a purposeful way to enhance their communication and collaboration.

There is an associated issue which requires our serious attention. Do we ourselves, as educators, have sufficient familiarity with, and understanding of, the available tools to give relevant advice on their use to our students? And if not, how do we develop the necessary skills and acquire the appropriate understanding? This is not so much an issue about our technical familiarity with the features of a particular tool, but about how the use of that class of tool can improve our achievement of the collaborative tasks we need to undertake; once again not so much about technology as about pedagogy.

Even for the more technically competent academics amongst us, this issue is compounded by the rapidity with which new, often free, tools appear in the public domain. When we started the course audio-visual communication tools

like Skype (http://skype.com), and co-authoring tools like Google Docs (http://docs.google.com) were not available, but as time has gone on student teams have been successfully experimenting with them. We need to draw on their experience to improve our overall course environment.

The primary communication medium used in the early presentations of the course was the existing FirstClass environment familiar to all our OU students, since it has been their standard communication platform for many years. It is predominantly an asynchronous text-based messaging system, although it does also provide synchronous online chat.

Although First Class is limited in some respects it does have the advantage that all messages are recorded and accessible in one place, allowing tutors to follow their teams' progress in real time. The asynchronous nature of the basic communication system also has the advantage of allowing time for reflection on issues being discussed, rather than requiring an instant response. Students rapidly realised that synchronous chat was a better way to make decisions on task allocation, scheduling, etc, than attempting to do this via multiple messages which often crossed each other in the ether.

In the initial end-of-course survey most students indicated that they found FirstClass to be an adequate vehicle for their task, pointing out that more problems arose because of people's failure to respond in a timely manner or to deliver on their agreed task allocation than because of the limitations of the technology. However, as we reflected on the experience of delivering the first few presentations of the course, it became obvious that, to improve team performance and to reduce the communication load on students, better mechanisms for shared writing and reviewing of team documents were essential. In addition, it was clear that a range of voting tools for making decisions and prioritising lists of items would be beneficial.

In our current presentation we are experimenting with the use of team Wikis as shared document space, and as a vehicle for collaborative writing activities, and with the use of team Forums to provide a more accessible and navigable space within which to organise threaded discussions. Initial student reactions to the introduction of these tools have been very positive. Our recommendations on these issues are being taken on by the development team currently producing the new OU Virtual Learning Environment, and we expect to see the benefits of their introduction in future course presentations.

8 Observations

What we have observed from running early presentations of the course is that many of the practices that one might think were 'obvious' do not come naturally to students who have not had any significant online teamworking experience. Through both the Resource Sheets and the tutor feedback we have had to emphasise to students a number of important points which include:

The need to establish, as early as possible, the rules by which the team will operate, and to allocate and accept appropriate roles and responsibilities.

The need to ensure that individuals inform the rest of the team of any times when they will not be available, so that responsibilities can be re-configured during their absence

The need to treat synchronous chat sessions as *meetings,* with all the usual rules and roles, setting an agenda and preparing in advance so that time is not wasted whilst online, and avoiding excessive socialisation and concentrating on task, which requires a strong lead from whoever takes on the responsibility of chairing the meeting

The need for teams to record the content of all online or offline discussions and decisions, so that they can be revisited at a later date, and are also available for those members unable to participate at the time.

The need for individuals to keep a personal log in which their actions and reactions are recorded *at the time* and can subsequently be revisited and selected from when reflection is required (not something our students are very good at, so we insist that relevant extracts are included in the personal reflection elements of their assessment).

To make the most effective use of whatever asynchronous communication tools are available by sensible use of message titles, ensuring that replies are threaded to maintain continuity of discussion, and using threads mono-thematically to keep discussions coherent.

To consider how documents should be written to address different audiences, for example when writing a technical analysis for the rest of the team as opposed to writing a more descriptive analysis for the client to whom the system is being proposed.

In order that one individual should not dominate any particular aspect of a team's activities we expect teams to democratically re-distribute roles when moving into each new phase.

From the perspective of the individual, one of the most difficult things to accept is behaving altruistically, giving up one's autonomy and submitting to the will of the majority for the good of the team. We need to emphasise the old adage that there is no I in TEAM.

From the perspective of the course team, and of the course tutors, the most important *management* issue is ensuring that as much as possible of the activity taking place within the student teams is visible and accessible from within a single workspace, so that monitoring team progress is facilitated. This is why the virtual learning environment needs to be enhanced to incorporate as many of the new collaborative tools as can be demonstrated to support effective teamworking.

9 Conclusion

In the first presentation end-of-course survey 58% of the students who responded asserted that they were 'fairly confident', and 26% 'very confident', that they would be able to apply the skills they had developed on the course to other teamworking situations. When taken together with the fact that all the tutors involved in the first presentation, despite the workload, asked to work on the second presentation, because they found it such a satisfying teaching experience, we consider these figures to be an endorsement of the pedagogic principles underpinning the design and delivery of the course.

In this paper we have argued that it would be valuable to introduce a substantial element of virtual teamworking into the curriculum for *all* Informatics undergraduates, whether campus-based or studying at a distance. Our experience of doing this as a distance learning institution, which is probably the more difficult of the two contexts, leads us to suggest that this is a worthwhile endeavour. However, to be successful in this endeavour we, as educators, need to become more familiar with the appropriate and effective use of tools and technologies for supporting online collaborative activity. More importantly, we need to develop our understanding of the pedagogy of online learning and teaching, in particular as it relates to the change in balance of control between student and tutor, with students taking more responsibility for their own progress and tutors taking more of a mentoring role.

The call for conference papers asked "*Are there other, better ways of teaching Informatics…Is there a silver bullet to improve the situation? Networked computers and e-learning offer new facilities…what is possible and what should be done?*" Whilst not claiming that Virtual Teamworking is the silver bullet, we believe that its introduction would be a shot in the right direction for all undergraduate Informatics courses!

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