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Virtual teamwork in very large undergraduate classes

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Abstract

Collaborative work is an important part of tertiary education but it is very difficult to arrange and supervise for extremely large classes of students in their first year. The possibility that computer-mediated communication can be used to facilitate this type of learning is appealing from a pragmatic organisational point of view. This paper explains in detail what a 'virtual team' is in the educational context. It reports on an interpretive field study where students taking an introductory course were allowed to choose where and when they did the required collaborative work. The paper discusses the factors that should be taken into account when offering students the option of working as a virtual team. These include factors that influence the students' choice. The project cannot be considered to have been successful but indicates reasons for the lack of success and suggests contexts in which it would be valuable to repeat the project. The importance of extensive preparation in terms of teaching the students necessary social and technological skills cannot be over emphasised.

Keywords: Computer-mediated communication; Cooperative and collaborative learning; Distributed learning environments; Virtual teams

1. Introduction

Sharing complex information and reconstructing meaning lies at the core of education, particular at university level. The Internet was adopted with unprecedented speed and enthusiasm and the idea that it could also be incorporated into education quickly followed. The World Wide

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Web can be, and is, used widely in education as a form of electronic notice board, a medium easily accessible from anywhere at any time, on which relatively unambiguous information can be stored. The essence of education is not, however, the provision of lecture summaries, schedules, or even allowing individuals access to their own, private information such as marks or account information.

It is widely accepted that students should actively construct their own knowledge. Within this constructivist model of learning, the cooperative model proposes that learning occurs most successfully when small groups of students share information and discuss it and in so doing jointly construct mental models and hence knowledge (Leidner & Jarvenpaa, 1995; Vogel & Davison, 2001). Furthermore, the interaction provides students with the synergy and motivation to excel (Leidner & Jarvenpaa, 1995). The sociocultural model, on the other hand, poses some serious questions regarding collaboration as it emphasises that each individual has a different view of the world, relates information obtained from outside sources to his or her own individual culture, and forms a unique mental model. Hence no single interpretation of reality should be proposed (Leidner & Jarvenpaa, 1995). This sociocultural model poses a contradictory point of view to that of the collaborative model since, even within a small group, the majority view can dominate. Differences between cooperation and collaboration in general, and more particularly in the context of learning will be discussed in detail under Basic Concepts in the next section.

The research reported in this paper explores the feasibility and efficacy of computer-supported collaborative learning for a very large group of first year students at a residential university in South Africa. WebCT is used as the Web-based Learning Management System (LMS) at this university and its group discussion facility was proposed as an option for different time, different place collaborative learning. This facility permits private groups to be set up and only group members have access to those messages. The feature provides threading so that topics are grouped separately.

South Africa has nine official languages and many different cultures and a healthy mixture of students from all of these now attend the ''previously advantaged'' universities as equals. Of the students in the group that was studied 52% had Afrikaans as their home language, 22% English, 22% one of the other official languages, and 4% a 'non-South African' mother tongue (these included European languages such as German, Portuguese or Spanish and languages from Asian countries). The diverse student body means that it is important to take cultural factors into account in learning as proposed by the sociocultural model. Thus within collaborative learning, opportunities should be created to ensure that individuals and minorities are allowed to develop mental models within their own context. This embraces the 'salad' model of diversity where the richness of the mixture is seen as valuable instead of the 'melting pot' where uniformity is encouraged.

Many, if not most South African students come from a distinctly authoritarian educational background and critical thinking and active participation have not been encouraged until quite recently (Le Grange, 2000). Although this is slowly changing, students are often not accustomed to relating what they learn to their own lifeworlds or judging the validity or applicability of what they learn. This is compounded by the fact that the personal experience of individual students differs widely in many respects and this spectrum of worldviews is also not reflected in the study material. These factors make it particularly important to introduce collaborative work but also to allow for different points of view and interpretations of reality.

During the research that is discussed in this paper, a compromise was reached between the cooperative and sociocultural models of learning by explicitly encouraging teams to select members with whom they believed they shared a worldview. A course was selected where lecturing seemed to be less productive than usual, namely a first year course introducing fundamental concepts and theory of Information Systems. This course is typical of many introductory courses in that it covers quite a broad field and presents lots of factual information. Hence the lowest level of cognition, namely, recall, and concrete examples predominate. This is basically a service course, with more than 1600 students registered and is compulsory for most of them. The students are particularly passive and lecturers have had to work hard not to fall into an objectivist mode of instruction (as described by Leidner & Jarvenpaa (1995)), in which there is simply a transfer of information from the lecturer to the learner. The course has over many years had various lecturers and has consistently been poorly attended, suggesting that the students themselves believe that self-study is a feasible option. Nevertheless, examination results have been disappointing, indicating that the students do not master the material. Just prior to, and independent of this research, group work was introduced as an integral part of the course and the number of formal lectures presented was reduced. This has continued to work well as all students are required to buy the prescribed course textbook, which covers the factual course material and hence it is really not necessary to present this material again during lectures. Instead, the remaining scheduled lecture time is used for group work, but initially the lecturers did not clearly indicate whether collaborative or cooperative work was expected. This approach was carried further in the research project and the students were given a choice as to where and how they did the collaborative homework assignments. It is this subsequent initiative that will be discussed here.

Student numbers at the university where this research was undertaken continue to increase and despite an ongoing process of refurbishing and building, it is difficult to keep expanding physical resources. The university has a clearly stated policy of seeking Information Technology solutions to this problem (Slabbert, 2003).

This paper is structured as follows: Sections 2 and 3 provide the theoretical basis for the paper. Section 2 defines and compares concepts related to group work that are important in the discussion that is provided later. Factors that are relevant when a decision is made regarding whether learners should do dispersed or virtual collaborative work are discussed in Section 3. The research itself is described in Section 4 and a discussion follows in Section 5. The final section provides conclusions.

2. Basic concepts

2.1. Collaboration versus cooperation

2.1.1. Cooperation

Cooperation is associated with tasks that are fairly structured and this makes it relatively easy for group members to divide up the work and to work on sections separately (Strijbos, Martens, & Jochems, 2004). Agreements need not necessarily be formalised and the work need not be synchronised. The individual members of the group are interdependent even

though they work fairly independently and individuals are accountable for their section of the work.

2.1.2. Collaboration

Collaboration is a conversational, relatively unstructured, iterative, but nevertheless, active process during which the participants work together to achieve a goal, reach a decision or a solution. (Moran, 2000; Strijbos et al., 2004).

> "Collaborators engage in sharing, proposing, discussing, ratifying, and disseminating to create and maintain a 'common ground"' (Moran, 2000)

Collaboration requires consensus, mutual understanding, reciprocity and trust (Skyrme, 1998). The collaborators are interdependent, and take joint responsibility for and jointly own the results of the collaboration (Strijbos et al., 2004). Some, but not all definitions include the idea that collaborators have different and complementary skills or knowledge (Moran, 2000). However, even in close collaboration team members may do some tasks independently (Brna, 2002) and Olson and co-authors have found that collocated collaborative groups about 40% spend of their time in discussion, about 30% in reviewing progress and 20% in coordination (Olson, Olson, Carter, & Storrosten, 1992).

2.2. Collaborative learning

Collaborative learning is a process of knowledge construction during which students actively search for information, engage in critical discussion, ask questions, discuss answers, make proposals and reply to other proposals (Alavi, 1994; Hiltz, 1988; Veerman & Veldhuis-Diermanse, 2001). Collaborative learning is well suited for tasks where students are required to jointly design, create or evaluate something, in other words where higher cognitive processes such as synthesis of knowledge and evaluation must be demonstrated.

Collaboration is a corner stone of the socioconstructivist models of learning (Panitz, 1997) and is equally important for knowledge sharing in organizations (Coleman & Schiller, 1999).

2.3. Cooperative learning

There is less uniformity in the definitions of cooperative learning than those of collaborative learning. Some authors use cooperative learning as an umbrella term, which encompasses both collaborative and co-ordinated work (De Villiers, 1995). This view is supported by Johnson, Johnson and Smith's quite general definition of cooperative learning,

> "...the instructional use of small groups so that students work together to maximize their own and each other's learning". (Johnson, Johnson and Smith, 1991 quoted by Fellers, 1996)

These same authors created a cooperative learning model that has five elements, positive interdependence, face-to-face promotive interaction, individual accountability, social skills and group process (Fellers, 1996). Clearly the second element needs to be adapted for *online* learning.

Various other authors define cooperative learning in a way that corresponds more closely with the definition of cooperation given in Section 2.1.1 above. For example, Panitz (1997), quoting John Myers (1991), differentiates between collaborative learning and cooperative learning by saying that collaborative learning is more student-centred than cooperative learning. Thus in cooperative learning the teacher will place learners in teams and in collaborative learning the learners will select their own team. Fellers agrees.

> "One of the key underpinnings to the cooperative learning model is the assignment of students to heterogeneous teams." (Fellers, 1996)

Roschelle and Teasley (1995 cited in Brna, 2002) define cooperative work as work "accomplished by the division of labour" and with individuals responsible only for their own section of work. Panitz (1997), quoting Rockwood (1995), highlights differences between cooperative and collaborative learning with respect to the type of knowledge that should be gained. In the case of cooperative learning this is more the "traditional (canonical) knowledge" or basic knowledge that needs to be mastered. The collaborative approach allows the student more freedom to develop ideas as knowledge is seen as a social construct.

In this paper the terms will be used to mean that collaborative learning is less structured and more student centred than cooperative learning.

2.4. Computer supported collaborative/cooperative learning

> "Geographically dispersed, cross-functional teams are increasingly espoused for enhancing learning and innovation, especially in research and development activities." (Sole & Applegate, 2000)

Computers may be used to support both cooperative and collaborative learning. Furthermore, computers may be used to support learning by co-located and by dispersed groups, and these groups may communicate synchronously, asynchronously or both. Hence, within the familiar time/place communication framework (Turban & Aronson, 1998), computer supported learning can be used in all four quadrants. Same time/same place use allows a number of separate conversations to be taking place simultaneously and, because they are recorded, a participant will be able to follow them all quite easily (Trauth & Jessup, 2000). Examples of same time/different place, different time/same place and different time/different place applications are easily imagined.

Unfortunately, in journal articles referring to CSCL it is not always clear which of these different types of interaction (that is, in which time-space combination) have taken place, as explicit definitions of the term are often not given. In addition, cooperation and collaboration are both referred to. Hence in learning or educational contexts there does not seem to be a single term that is sufficiently descriptive and is used consistently. 'Collaborative telelearning' (Alavi, Wheeler, & Valacich, 1995), 'internet-based collaborative learning' (Hurley, Proctor, & Ford, 1999) and 'online computer supported collaborative learning' (Suthers, Hundhausen, & Girardeau, 2003) are all used to refer to CSCL where the participants work online. Nor has one particular term been consistently adopted to refer to the type of team participating in this type of learning.

2.5. Virtual teams

A virtual team is a collection of a small number of interdependent, geographically dispersed, individuals that have a common goal and depend on electronic linking in order to collaborate and achieve it. The teams are often temporary and self managed (Jarvenpaa & Shaw, 1998).

> "A virtual team is a group of people who work interdependently with a shared purpose across space, time, and organization boundaries using technology" (Lipnack & Stamps, 2000).

In another early reference (Quick, 1995), the temporary nature, and novelty of such teams is emphasised.

> "Virtual teams ***will be*** [my emphasis] temporary work modules made up of cross-functional team members who come together to work on a particular project or task." (Quick, 1995)

The first references to 'virtual teams' in journals and newspapers appeared in the early 1990s (Orr, 1992; The Christian Science Monitor, 1991). However, these references are few and far between until about 1995 when there was a noticeable increase in the use of the term. The term 'virtual team' is now used quite routinely in the organizational, management and technology contexts.

The definitions of 'virtual team' do not specify the type of work (collaborative or cooperative) that is expected, but journal articles where the term is used usually imply that collaboration is expected in addition to cooperation and co-ordination (Baker, 2002). For example, Jarvenpaa and Shaw (1998) say that they "rally around a knowledge task". Members of virtual teams are usually assigned to a team because of their skills or organizational knowledge and although on some occasions they may volunteer.

2.6. Geographically dispersed

As is evident in many of the examples given by Lipnack and Stamps (2000) and as Jarvenpaa and Shaw (1998) explicitly point out, virtual teams may occur in virtual organizations but may also occur in other contexts such as a single multinational organization or where the staff work from a variety of locations including home offices. This view contradicts the narrower definition given by Jarvenpaa and Leidner (1998) where cultural diversity is included as one of the fundamental characteristics of a virtual team. It is particularly important to focus here on what is intended by 'geographically dispersed', as this is significant to the discussion on the research that will follow in Section 4. Can a team be referred to as a virtual team if the *individuals* are collocated at times, but for the particular task for which the team was instituted communication occurs almost entirely via an electronic medium? This form of virtual team is becoming increasingly common as computer-mediated communication becomes a part of everyday life. For example, in educational settings, where students usually work on assignments off campus and after lectures, teams may consist of students who attend the same lectures but who spend very little time discussing their group assignment face-to-face as a small group. Increasingly these teams collaborate (or possibly cooperate) via e-mail. The

use of the term 'virtual team' to describe such teams does not seem to contradict the generally accepted definition in any fundamental way.

Pliskin (1997) makes a distinction between telecommuters (home-based workers) with little infrastructure and virtual teams who are also dispersed but in offices with advanced infrastructure. And she asks "Are the concepts of telecommuting and virtual teams mutually exclusive." Once again this narrow interpretation does not seem to be justified.

2.7. Virtual teams in education

The fact that the term 'virtual team' has not been widely adopted is surprising since Hiltz used the word 'virtual' in conjunction with CSCL as long ago as 1988. Hiltz and her co-authors continue to use the term 'virtual classroom', which New Jersey Institute of Technology (NJIT) have trademarked, (for example, Benbunan-Fich & Hiltz, 1999; Hiltz & Wellman, 1997) but do not refer to 'virtual team'. References to 'virtual university' have become quite common in the education context (for example, Seely Brown & Duguid, 1996). And other authors include the word 'virtual' and other ways, for example, Joiner and Issroff (2003) refer to a 'distributed virtual task' when analyzing collaborative problem solving. This is not to say that the term 'virtual team' is never used in CSCL. Jarvenpaa and her co-authors (Jarvenpaa, Knoll, & Leidner, 1998; Jarvenpaa & Shaw, 1998) used the term "virtual teams" to refer to global teams of students as have others (Ishaya & Macaulay, 1999; Johnson, Suriya, Yoon, Berret, & La Fleur, 2002; Vogel et al., 2001). The use of the term in a blended, dual or flexible learning environment (Commonwealth of Learning, 2000) is possibly less common that in a strictly distance education setting.

In this paper the term 'virtual team' is used to describe teams of students that are dispersed, do some collaborative work but may also cooperate and coordinate their assigned tasks. They may communicate to a limited extent using other media but use computer-mediated communication (either asynchronously, synchronously or both) to a large extent. They are largely self-managed, but the team is required to work together on a clearly defined task set by 'an outside authority', that is, the lecturer. The task is the reason for the existence of the team and once the task has been completed the team will disband. However, the team members all attend the same university where they may meet as individuals in lecture rooms. They are a 'virtual team' only in the context of the assignments that they are jointly completing.

Table 1 serves as a summary of this discussion and indicates characteristics of computer supported group work and relates these to virtual teams, computer supported collaborative work and computer supported cooperative work.

2.8. Web-based course material

Web-based course material is used in this article to refer to information that may be downloaded either directly from the course website or via links provided on that site. This includes syllabi, lecture notes, lecture summaries, full transcripts of lectures, copies of the transparencies or

Table 1
Comparison of characteristics of virtual teams, computer supported collaboration and computer supported cooperation

	Virtual team	Computer supported collaboration	Computer supported cooperation
Synchronous/ asynchronous/both	Any or both but usually includes Synchronous	None, any or both but usually includes Synchronous	None, any or both but asynchronous predominates
Cooperative/collaborative	Collaborative but includes time spent in coordination and cooperation	Collaborative but includes time spent in coordination and cooperation	Cooperative
Self managed	Yes	Yes	No
A particular task (Temporary)/long term	Temporary	–	–
Team composition	Mostly assigned	Free	Assigned
Collocation/dispersed	Dispersed	–	–
CMC	Yes	Maybe	Maybe
Structured?	No but there is accountability to the organization	No	Yes

presentations that are used during lectures, supplementary and required reading materials, and assignments (Karuppan, 2001).

3. Factors influencing the introduction of virtual teams

3.1. Choice of academic level at which to introduce virtual teamwork

Numerous articles have been published in the last 10 years, which described projects where online collaborative or cooperative work was done. These include both undergraduate and post-graduate courses and undergraduate Information Systems courses are represented quite frequently in these reports. However, recommendations regarding where virtual teams should be used are rare. The early study by Hiltz (1988) says that online collaboration is more effective than classroom learning (for "mature, motivated learners").

3.2. Class size

Class size is certainly an issue when planning *cooperative* work but the burden placed on lecturers is reduced in *collaborative* work since there are fewer formal structures to set up and maintain and the students manage the teams themselves. Very large classes offer the greatest benefit when the work is to be done by virtual teams, as scarce physical resources can be saved by reducing the number of formal lectures and seminars in classrooms and adopting, at least partially, Web-based options. Hiltz and Wellman (1997) indicate that the New Jersey Institute of Technology use online learning activities for all courses. However, in comparison with this research project the class sizes reported were usually quite small.

3.3. Incentives to participate in the virtual team option

One of the principles of successful adoption of technology is that there should be a clear need to use it for a particular purpose (Tolmie & Boyle, 2000). What is more, many researchers report that students and staff of universities are conservative (Dewhurst, Macleod, & Norris, 2000; Kochtanek & Hein, 2000). Hence it is not surprising that a lack of incentive has been identified as a reason for the disappointing use of Web-based course material (Karuppan, 2001; Wilson & Whitelock, 1998). Different incentives can be offered. For example, the collaborative work can form a compulsory part of the assigned work for the course and contribute towards the year mark (Hara, Bonk, & Angeli, 2000). Maki, Maki, Patterson, and Whittaker (2000) did not make the use of the online study material compulsory, but the students could add to their course credits by completing online activities, such as quizzes, some of which were embedded in online study material.

Generally students do not do optional work, but making virtual teamwork compulsory may be counter-productive as it might not suit the learning style of some students and an authoritarian approach conflicts with the learner-centred philosophy upon which collaborative teamwork is based. Reluctant participation can result in outcomes entirely opposite to those that were

intended. Ideally, therefore, students and tutors should negotiate the use of technology and clarify expectations (Seale & Cann, 2000).

3.4. Discussion topics

Hammond (2000) has found that the more structured the forum, the deeper the discussion. This implies that the discussion threads in an online forum should be easy to follow and that it should be easy to review the discussion. Teams focusing on a specific task are more likely to get into a meaningful discussion than teams participating in news groups where the subject of discussion is ill defined. It is particularly important in the case of online collaboration that there is clarity about the task (Tolmie & Boyle, 2000).

Assignments to be done by a team should:

- Provide sufficient scope for a group effort to be meaningful, but be within the capabilities of the average student and even below average students in the class;
- Be relevant to the subject matter prescribed for the period for which the project runs;
- Allow for individual views of the topic;
- Require serious thought and discussion.

3.5. Team structure

The optimal size for teams in collaborative work is between four and seven. Individual students are sometimes assigned specific roles to encourage active participation but this contradicts the unstructured, self-managed philosophy of virtual teams. Various options have been used for assigning students to teams, for example, teams may be composed of members of mixed ability so that the higher achievers can assist team mates who find the subject difficult; students may be randomly placed in teams (Lind, 1996; Vance Wilson, 2000); or the physical location may be used in allocating them to a team (Warf, Vincent, & Purcell, 1999). These practical considerations are consistent with what occurs in the corporate world where members of virtual teams are usually chosen for these same reasons (skills and location). In many ways a virtual team model is a compromise between the collaborative and cooperative models. On the other hand it is more in keeping with the sociocultural learning model to allow students to select their own team members and research supports this as an established relationship based on trust contributes very considerably to the team's success (Jarvenpaa & Leidner, 1998; Seale & Cann, 2000; Tolmie & Boyle, 2000; Vogel et al., 2001; Warkentin & Beranek, 1999).

4. The research project

4.1. Description

The purpose of the research was to explore the viability of using virtual teamwork for first year Information Systems students and to compare the effectiveness of this option with

face-to-face collaboration. The existing infrastructure provided by the university for Web-based courses (namely, WebCT) was used. This research differs in a very important way from the other reported research in that it was used to determine the viability of collaborative teamwork using an asynchronous, text communication (that is, either the group discussions on WebCT or e-mail) for a very large group of students. In addition, most of these students had only recently started university and were unaccustomed to the relatively unsupervised environment and the corresponding need to take more responsibility for their own results.

An interpretive field study was undertaken to determine whether culturally homogeneous teams of university students can successfully complete tasks and projects, which require them to share meaning, if they communicate solely by means of e-mail or WebCT group discussions. The research focussed on collaboration by assigning tasks that required the team to understand what other team members meant (reconstructing meaning) and also to build on and advance meaning further (constructing meaning). This paper will be restricted to a discussion of findings that seem peculiar to large classes and first year courses.

The research methodology was non-positivist and participative as is usual in interpretive research. A pluralist approach was adopted, and numerical and course-grained textual analyses were used to interpret the data produced from interviews, a series of questionnaires, participant observation and discussion.

4.1.1. Choice of study options

Students were offered a choice between three different study scenarios:

- Face-to-face collaborative work during scheduled lecture periods;
- Face-to-face collaborative work at a time and place arranged by the team (referred to as independent teams);
- Virtual collaborative work communicating only via e-mail or WebCT group discussions.

The students were asked to select one option, confirm this in a second questionnaire, and then register their teams saying who would be in the team.

4.1.2. Infrastructure

Students who decided to use the virtual team option could access the WebCT facilities from home or the university's computer laboratories. WebCT's discussion group feature was used and a private discussion group was set up for each team and included the researcher. Many students had private e-mail accounts as well and used them instead of WebCT. Students who did the teamwork as independent teams, outside lecture times, were asked to record the discussion using a digital audio recorder.

4.1.3. Team structure

Teams were allowed to select their own members for a number of reasons. Trust within a team improves the likelihood of success (Jarvenpaa et al., 1998). Trust develops over time (Ishaya & Macaulay, 1999). Therefore, students were encouraged to choose team members whom they already knew. Allowing students to create their own team is consistent with a learner-centred

philosophy of learning. The possibility that a student might be disadvantaged because of the team he was allocated to is avoided. In addition it is time consuming to evaluate hundreds of students in order to allocate roles or balance team membership. In a multilingual, multicultural society, teams who select members who all speak the same language and have similar lifeworlds may communicate in that language and develop examples that are specifically meaningful to them and this is in accordance with the sociocultural model of learning. (In fact several students indicated on their questionnaires that they preferred diversity.)

4.1.4. Incentives to participate in the virtual team option

Students decided on a study option purely on the grounds of their own learning style and convenience. This meant that the students' perception of the need for, and viability of, virtual teams could be assessed. Ethical considerations similar to those mentioned for Team Structure, above, were also met.

4.1.5. Role of the lecturer

The researcher did not join the independent teams during their meetings, but instead asked them to record their discussions. This was considered appropriate because it allowed teams to communicate in the language of their choice without taking the researcher into account. (In actual fact several teams debated this and, since the discussions were being recorded, they decided to speak in English so that the researcher would understand the discussion, even though they remembered that they had been encouraged to use whatever language they were most comfortable speaking.) In addition, it meant that teams could meet off campus or at the same time as other teams without taking the researcher's schedule into account. In order to minimise the differences between the virtual and independent teams, the researcher also played a limited role in the discussions of the virtual teams. Nevertheless, she did participate in some online discussions in order to encourage genuine discussion of the assignment topics and to remind teams of the need for appropriate e-mail behaviour.

The researcher had to assist the few students who elected to be in virtual teams to find other virtual team members. She also organised initial information sessions.

4.2. Results

4.2.1. Selection of study options

A response of 63% was obtained to the first questionnaire. The majority of students (77% of those who answered the questionnaire) elected to continue with the option that they were accustomed to, that is, doing collaborative work in class during scheduled lecture periods. Of those who indicated that they wanted to meet outside the class (either virtual (4%) or independent (18.5%)) not all eventually registered teams, and of those who did, many did not work according to the procedures specified. Reasons given for joining virtual teams largely fell into two categories, convenience and interest in the technology. Registered team sizes varied from three to six. Many students setting up virtual teams found it difficult to get team members who they already knew and had to be assisted in this regard. Hence, the original intention of having self-selected, culturally homogeneous teams was not achieved.

4.2.2. Virtual teams and older students

The course for which this research was done was a first level course and hence a large percentage of the students taking it were in their first year at university. In Table 2 these are the students indicated as 2001 registrations. Although the year of first registration did not clearly influence the students' *original* choices (there was no clear correlation between year and choice), it became clear when the students actually did their teamwork that virtual teams were more popular amongst students who had not registered for the first time that year (Table 3). For example, although students who first registered in 2000 made up only 13% of the class as a whole, students from this group made up 56% of students who eventually participated in virtual teams. In contrast, the far more numerous first years, registered in 2001 and making up nearly 80% of the class, made up only 32% of those in virtual teams.

An explanation for this anomaly can be deduced from Table 4. The less recent the registration the less likely the student was to complete Questionnaire 1. Thus the preferences obtained

Table 2
Initial choice classified according to the year registered (number of students and the percentage of students *in that study option group* who were first registered during the year indicated)

Year first registered	Study group					
	Class		Virtual		Independent	
<1999	10	1.6%	1	2.9%	0	0.0%
1999	16	2.5%	1	2.9%	2	1.3%
2000	45	7.1%	4	11.8%	18	11.8%
2001	567	88.9%	28	82.4%	133	86.9%
Total in group	638	100%	34	100%	153	100%

Table 3
Actual teams registering classified according to the year registered (number of students and the percentage of students *in that study option group* who were first registered during the year indicated)

	Total number in the class		Virtual		Independent	
<1999	56	3.59%	1	4.00%	3	3.90%
1999	54	3.46%	2	8.00%	2	2.60%
2000	206	13.21%	14	56.00%	7	9.09%
2001	1243	79.73%	8	32.00%	65	84.42%
Total in group	1559	100%	25	100%	77	100%

Table 4
Students who answered Questionnaire 1 according to the year registered

	Answered	Did not answer	% registered for the year indicated that answered
<1999	28	53	34.57%
1999	33	45	42.31%
2000	96	112	46.15%
2001	841	351	70.55%
Total	998	561	64.02%

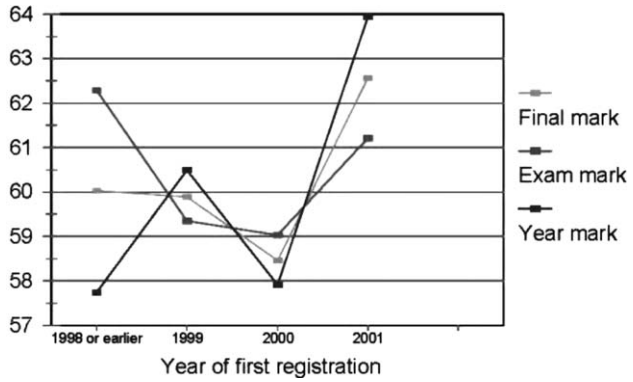

Fig. 1. Comparison of students' average marks according to year of first registration.

from that questionnaire and recorded in Table 2 do not reflect those of the 'older' students to the same extent as the first years and the preference of the more mature students did not show up initially. Presumably students who chose to be in virtual teams were those who did not attend lectures and hence did not get, or did not return, the questionnaire which was handed out in class.

Fig. 1 shows how the year mark and examination mark contribute to the final mark of students depending on the year of first registration. The year marks contributed *positively* to the final marks of students registered for the first time in 2001, (that is, students who were taking the course in the same year as they were registered for the first time). For these students the average year mark was almost exactly 64% and the average examination mark was slightly more than 61%. This is **not** the case for students first registered prior to 1998 (who had already been registered for more than three years and could already have graduated). For this group the year mark is a *negative* factor that is fortunately compensated for by an improved examination mark (the average year mark was over 62% and the average examination mark was slightly less than 58%). There is not a dramatic difference in scores but this indicates that there is a need to assist these "older" students with other class work options.

4.2.3. The virtual teams

Setting up teams. Only 34 students, (4% of students who filled in the form and 2% of the total number of registered students), indicated virtual teams as their first choice of study option. Of these, slightly more than half indicated that they would access WebCT from computers off campus but of the students selecting virtual teams as their second choice more than 70% said they would use computers on campus. Of the 25 students who eventually registered as part of a virtual team, 14 had not originally indicated a preference (had not completed the questionnaire) and three others had originally indicated other preferences. This means that of 34 students who originally committed in writing to being in virtual teams, only eight registered as members of such teams. This indicates a high degree of uncertainty or disorganisation or inability to find acceptable team members. Six virtual teams were eventually set up, two of which were made up of students who did not previously know each other. Several members of the virtual teams dropped out for

undisclosed reasons. In general these team members never formed bonds or contributed at all beyond initial contacts.

General questions. Only 13 students, from four of the six virtual teams, completed questionnaires after the teamwork was finished (compared with 87 independent team members and 1187 in total). These students were not very sure of the purpose of the research (61.5% said they understood it compared with 81% of the students in general) or how the option that they selected would work (58% compared with 85%). This is not surprising as these students were confronting the least familiar study option. More worrying is that this group found the module less interesting (38% of the students selected the 'interesting' or 'very interesting' option compared with 64% of students in general) and more difficult (38% compared with 22%) than the other students. Nevertheless they considered Assignment 01 to have been easier (69% compared with 39% of the general student body selected 'easy'; 30% compared with just under 50% believed that it was difficult). However, of the students who completed this questionnaire six actually did the first assignment as a member of an independent team not as a virtual team so this response is meaningful only in terms of original attitude. The assessment of Assignment 02, which all these students did as virtual team members, was very close to that of the general student body.

Questions regarding e-mail or WebCT. Students accessed the Internet almost equally often from home and from the university laboratories. They largely believed that they had sufficient contact with the rest of the team via e-mail (nine students said Yes, three said No). Most team members did participate (all members of two of the teams said everyone in the team participated, and members of two of the teams said that one or more than one team member did not participate.) Almost all of the team members said that they had discussed the assignments using other means than online (11 of the 12 students). E-mail messages were generally answered immediately, seven students said within a day and two more said within two days. A wide variety of problems were encountered with WebCT access. One team apparently could not access it at all. Half of the students believed that they needed more and better instructions on accessing it.

Questions regarding the team. Although six of the 13 participants who answered the question did not initially know their fellow team members at all, 10 thought they would remain friends. Only one person thought that team members were not friendly. This student felt that her team, who were all strangers, had not communicated successfully in any way. She said that the best feature of the teamwork was "Experimenting with something new that I have never done before and realising that sometimes things are not as easy as we thought." The worst feature was, "The fact that some of us never really got the chance to understand what was going on with the virtual teamwork and its importance." She did, however, say that she would do it again provided that changes were made. ". . .changes like training students for a week or so to get used to it other than just setting them to go and do it for the first time pretending to know what they have to do whereas they don't cause any way students are students. [sic]" However she did not attend contact sessions that were arranged, as "she was busy".

Most students felt that they were able to communicate freely and easily (10 of the students) although there was indication that no discussion which developed the teams understanding of concepts occurred (four said that there was little discussion as e-mail was largely used to transfer documents, four said they were inhibited by knowing the discussions were monitored, five said they read the messages but did not contribute much, and three said they were reluctant to defend their point of view).

Only one student was not happy with the quality of the assignment their team submitted. Most students said that both individuals and the group worked on the second assignment, and nine of the students believed they had done their fair share of the work.

Would it be worthwhile incorporating the option of virtual teams in other courses? This question got a definite thumbs down with five students saying No, only one saying Yes, five unsure, and one, already noted above saying Yes but with much more student preparation.

5. Virtual team discussions

A detailed analysis of the discussions of the virtual teams and a comparison between those and the discussions of the independent teams is reported elsewhere (Alexander, 2002, 2004a, 2004b). The results can be summarised as follows.

- Several teams who said they had worked as virtual teams did not use WebCT and did not include the researcher in e-mail giving rise to the suspicion that they did not work as a virtual team at all.
- Those teams that did communicate in an observable way via e-mail or WebCT did not discuss the work much. The construction of meaning was done offline and often as individuals. Some team members did seem to be aware that this was what they were meant to do but the rest of the team ignored their attempts.
- Some well-known pitfalls regarding e-mail communication were encountered. Very crude language was used on one occasion, and messages were sent on more than one occasion that seemed to reflect palpable insincerity or an attempt to manipulate other team members.
- Some messages were difficult to understand (for example whether the attached document was intended to be the final version of the assignment or not). The context was not clear sometimes.
- On the other hand some quite ambiguous messages were interpreted without difficulty.
- There was clear evidence of reflexivity.
- There was some evidence of learned behaviour such as trying to encourage group members who are not participating.
- The contrast between the way that frequent users expressed themselves and the messages of relatively new users was noticeable.
- The messages contained a form of information that has not previously been identified with respect to e-mail, namely implied information. Similar to the non-verbal cues that carry information in face-to-face conversations, e-mail messages carry implicit, unintentional information. This is often related to timing. For example, the thread created by the recorded e-mail creates a clear context. This can cause insincere actions to fail.
- There was also evidence of rich information being communicated despite the fact that there were relatively few messages. Nevertheless this did not lead to joint construction of theoretical meaning. The fact that it was not attempted shows clearly that team members need to be convinced that collaborative work is possible (assuming that it is, a point not yet conclusively proved or disproved (Majchrzak, Malhotra, & Chai, 2002)). The evidence that an experienced user of e-mail can communicate far more effectively than naïve users reinforces the idea that these skills can be taught and will improve with practice.

6. Discussion

6.1. Virtual teams

The term 'virtual team' has been used in this paper to indicate teams of learners whose primary means of communication is computer-mediated. The self-managed nature of the virtual team was endorsed by not appointing team members to fulfil a particular role and by permitting teams to select their own team members. In addition, the term was used with the deliberate intention of aligning the educational terminology with the terminology of the management and information technology arenas and to emphasize the similarities between virtual organisations and virtual universities, dispersed learning and dispersed work. In doing so, the example set by some well-known researchers is followed (Jarvenpaa et al., 1998; Jarvenpaa & Shaw, 1998; Ishaya & Macaulay, 1999; Johnson et al., 2002). As was pointed out earlier, it is not contrary to the definition of a virtual team to have students from the same organization, in this case the university, as the only participants. The research design also adheres to the view that in collaboration in general and particularly in virtual teams "there is less focus on individual specialities and more on general responsibilities and the range of skills needed to complete the task. Members are expected to be able to comment and provide input beyond any narrow role ..." (Jarvenpaa & Shaw, 1998).

The work done by the teams was designed to require substantial collaboration, but as was seen the virtual teams were far less successful in achieving this than the face-to-face teams. In fact, at best the virtual teams cooperated.

6.2. Success of the research project

This research project could not be classified as "a success" in terms of demonstrating the successful use of virtual teams in very large classes of first year students. Not only did few students choose to be in virtual teams, indicating the tendency of individuals to maintain the status quo, but those who attempted this were unsatisfied with the process. There was greater interest among students who were registered as students at least one year before the research. This might reflect timetable clashes or greater independence and self-confidence.

6.3. Incentives

The students participating in virtual teams perceived very little need to share meaning online, as other channels were available. In addition, when they tried to do so, either in the context of discussing the task or in trying to influence team members, they found it difficult to achieve their goals.

6.4. Team structure

Team members who did not immediately join in inevitably fell by the wayside. Individuals had to rely entirely on their own motivation and confidence, as the team were unable to help each other over the initial psychological barriers. This was because there was no pre-existing relationship between team members and hence no established trust. Mutual support is an important

feature of teams and this was limited to those team members who communicated immediately and appeared to identify with one another.

The extent of any individual's contribution to the work was bounded by their ability to join the discussion and hence technological barriers to access had the same effect as personal inhibitions and prevented a team from forming bonds. Although there was evidence of swift trust initially (Jarvenpaa & Shaw, 1998) this was very quickly replaced by action-based trust (Holland, 1998). This was because the deadlines for the assignments were quite soon after the teams were established. (Delays in finding team members meant that there was less time than expected to collaborate.) When action-based trust could not develop there was a high incidence of team members being ejected from teams. Team members who did not even promise a contribution were quickly placed in a position where they were forced to withdraw from the team. On the other hand rapid response, even if not accompanied by actual work, did serve to increase team loyalty. Hence, a form of identification-based trust (Jarvenpaa & Shaw, 1998), based solely on evidence of good will, could substitute for the action-based trust.

7. Conclusion

It was surprising that so few students showed any interest in being in virtual teams as the generally poor attendance at lectures for the course in previous years seemed to indicate that the students thought they could study on their own and would welcome greater flexibility with respect to time and place of study. It is difficult to say why these choices were made as the students rarely gave clear explanations (even though they were asked to do so). It seems likely that the familiar was considered to be a simpler and less risky option.

The effect of insufficient time to build trust between team members was very evident particularly since some students were never incorporated into the team. There was also a very clear need for detailed preparation in the form of explanation and training, both in terms of technology and with respect to effective collaboration as is confirmed by other reports of similar research (Warkentin & Beranek, 1999; Vogel et al., 2001). However, other authors have found that, if more time is allowed for establishing trust, some training is provided concerning using text as a means of communicating, and the participants have a real incentive for building virtual teams, it is not impossible that virtual teams will be able to collaborate effectively (Ishaya & Macaulay, 1999; Majchrzak, Rice, King, Malhotra, & Ba, 2000). The research showed clearly, however, that at a residential university, and in a context where there is little time to prepare for virtual teamwork, the majority of students do not immediately perceive this option as attractive.

This research suggests that virtual teams in subsequent years of study are more likely to be successful. In later years of study the students have a lifeworld that can withstand more stress, as a daily routine and substantial relationships with their classmates have already been established. They should, therefore, be able to handle a more complex system (the virtual world provided by the Internet) and be able to integrate teamwork into their lifeworlds. Having had more time at university they have already established trust between the individuals they select to join with in teams and should, therefore, be able to communicate more effectively. On the other hand, students who are out of step with their classmates in terms of academic progress could benefit from

an option allowing computer-supported collaboration. However, even these students need extensive preparation in order to successfully collaborate online.

It is important to do further research on collaboration in virtual teams in order to find out how we can effectively use current technology and groupware and guide future development. Communicating via e-mail has become a de facto means of working together in many environments although students at residential universities still seem reluctant to work this way. Its limitations and the need to deliberately improve the communication skills of the end-users are, however, often ignored. This is consistent with the findings of Olesen and Myers (1999) who say

> "...groupware applications have the potential to support radical changes in work processes, however, ...if the potential of these applications is not acted upon by knowledgeable actors, changes in the significant schemes and ways of working will not occur."

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