Journal of Computer Assisted Learning (1999) **15**, 129–138

Learning and teaching in a synchronous collaborative environment

O. Marjanovic
Department of Computer Science and Electrical Engineering, University of Queensland

Abstract Despite obvious domination of asynchronous collaborative technologies, especially for virtual classrooms and distance education, the work presented in this paper is based on the assumption that some students will still prefer the experience of on-campus, face-to-face collaborative learning. For those students a new synchronous collaborative environment is created by combining an innovative methodology for 'same-time, same-place' interactive learning and the technology called Group Support Systems which is designed to provide not only communication but rather computer-mediated collaboration. This paper introduces this learning methodology and illustrates its potential to improve critical thinking, problem solving and communication skills of all students who are stimulated to participate as equal learners. It also describes how teachers are transformed from 'information delivery specialists' to guides and facilitators of learning.

Keywords: Electronic collaborative learning; Group support systems; Synchronous

Introduction

There is growing evidence that collaborative learning methods tend to encourage construction of knowledge, 'deeper' understanding and greater skill development by their ability to engage students dynamically in the learning process and move them away from the role of spectators in the classroom (Alavi, 1994). Furthermore, collaborative learning, especially in the face-to-face mode, has an important social dimension as it gives rise to other positive outcomes which are not usually considered academic such as self assurance and personal insight (Hodgson & McConnell, 1995).

However, collaborative learning in the classroom environment is not without problems. For example passive students, students who like to dominate, students who are reluctant or shy to participate or present their ideas (especially if they contradict the teacher's), students not doing any work at the ex-

Accepted: 21 August 1998

Correspondence: Olivera Marjanovic, Department of Computer Science and Electrical Engineering, University of Queensland, Brisbane, QLD 4072, Australia
Email: o.marjanovic@mailbox.uq.edu.au

pense of other members of the group or students who experience the 'stage fright' every time they are required to present their ideas in front of a live audience of peers. Furthermore, international students may experience even more problems (such as isolation from other members of the group, or greater pressure to participate) due to language difficulties as well as different cultural and educational background (Marjanovic, 1997). It is evident that collaborative work may present a difficult challenge for teachers (lecturers, tutors, professors) and many of them have given up on the technique as a result of problems they have experienced (Cohen, 1994). As Hodgson and McConnell (1995) pointed out, collaborative learning makes public our own learning, learning of others and learning of the group. Although that makes collaborative learning a social and democratic process, one may argue that it also contributes to the problems of collaborative learners mentioned earlier.

On the other hand, recent times have seen a greater impact of new informational technologies on education. One influential category of these new emerging technologies is the category of technologies for computer-mediated collaboration. However, despite the growing popularity of technologies for 'anytime, any-place' collaborative work and flexible delivery, some students will still prefer the experience of face-to-face collaborative learning in small tutorial groups. That argument may be further supported by the fact that "collaborative learning is a social phenomenon and not just something which occurs on one's own" (Hodgson & McConnell, 1995, p. 211). Furthermore, computer-mediated communic-ation is as relevant to full-time residential higher education as for distance learning (Mason & Kaye, 1989 as cited in Light *et al.*, 1997) though residential students need a different learning environment from traditional tutorials which will help them to overcome various objective and subjective barriers to effective collaborative learning.

This paper proposes an innovative methodology for interactive learning in an advanced synchronous electronic environment. The methodology is supported by Group Support Systems (Jessup & Valacic, 1993; McGrath & Hollingshead, 1994) designed to provide not only communication but more importantly computer-mediated collaboration. This technology does not replace verbal face-to-face communication nor does it allow students to 'hide' behind their computers in the collaborative process. Rather, it supports various active learning activities that have the potential to improve problem-solving, critical thinking and communication skills of all students. At this point it is important to distinguish computer-mediated collaboration as used in this paper from the 'groupwork around computers' where students collaborate in the groups of two to three on the same computer-based problem (see for example: Jackson & Kutnick, 1996).

Collaborative technologies

Collaborative technologies are information technologies specially designed to support and enhance human interaction and teamwork. There are two general categories of such systems: asynchronous and synchronous.

Asynchronous collaborative technologies enable 'any-time, any-place' collaboration providing freedom of time (so learners participate when and if they choose), opportunities to research and backup assertions, more time for reflection, more time to phrase the intervention. While asynchronous collaborative systems have been more dominant in recent times, especially Internet-based conferencing tools and news groups, they may be more suitable for distance learning than for the face-to-face classroom environment due to their asynchronous character.

Synchronous collaborative technologies enable 'same-time, same-place' or 'same-time, any-place' collaboration providing immediacy, faster planning, problem solving, scheduling and decision making processes. However, the majority of synchronous collaborative tools enable *communication* (such as text-based chat systems or video teleconferencing) rather than computer-mediated *collaboration*.

The most advanced synchronous systems for computer-mediated collaboration are Group Support Systems (also called electronic meeting systems). They provide a generic set of tools for various collaborative processes such as: generation and organisation of ideas, evaluation of alternatives and consensus building, group analysis and multiple-criteria decision making, group writing, action planning and information management. They are suitable for both 'same-time, same-place' and 'same-time, any-place' modes of work.

In the 'same-time, same-place' (or face-to-face) scenario for collaborative work, all participants have computers which are connected via the local area network which enables information sharing and exchange. For a group, a central public screen is used to focus attention and present the group results. Participants enter comments or ideas via their computer. Group support systems (GSS) enable parallel work so that all participants can work simultaneously without waiting for their turn. All contributions form an *electronic transcript* available to all participants almost immediately either on participants' screens and/or on the public screen. In this process, all partic-ipants have an equal opportunity to contribute because the system provides an egalitarian (anonymous) way of working. It is important to point out that anonymity is not also appreciated or warranted in organisational settings. Furthermore, there is evidence that technology only reinforces existing interaction patterns in an organisation (Mantovani, 1994). However, this may be less important for student groups "where evaluation apprehension and conformance pressure are low" (Jessup & Valacic, 1993, p. 144).

Furthermore, previous research findings in this area, indicate that the use of synchronous group support systems within an actual educational environment has enabled more effective learning practices and improved group performance and output. For example, the synchronous-based studies presented in Davenport and McKim (1996) and Butler (1990) have indicated greater improvements in the level of active participation, discussion quality and group dynamics compared to the traditional classroom setting. Other studies also indicated improvement in self-reported mastery of material, critical thinking and analysis skills (Alavi, 1994; Cerratto & Belisle, 1994).

However, new learning and teaching methodologies for the face-to-face synchronous collaboration is still in its infancy. As Nunamaker *et al.* (1997, p. 201) pointed out:

> "The main difficulty for a teacher new to group support systems is not with running the technology — that they appear to learn in three to four days. It is that they face a new teaching paradigm that has no support from past experience, textbooks, manuals, activity books or any other resources that would help them to figure out what to do with the GSS technology".

The main challenge in that process is to recognise new, unfamiliar capabilities of the technology and to create new ways of learning/teaching.

New teaching and learning paradigm

The methodology presented in this paper extends the work introduced by Marjanovic (1995) where collaborative learning is described as a three-phase process consisting of *preparation for collaborative learning, the electronic session* and *evaluation of collaborative learning*. It is primarily designed for the 'same-time, same-place' collaborative work and its extension to the 'same-time, any-place' scenario is beyond the scope of this paper.

Preparation for collaborative learning

Prior to the actual work in the electronic collaborative classroom, all classes (electronic sessions) have to be properly prepared. The key role in preparation is played by a facilitator — a person responsible for the technology and its proper use. The facilitator works with the teacher and gathers information about the class to be organised and provides information about technology. When the teacher becomes confident with technology, s/he may assume the role of a facilitator as well. Since a collaborative learning activity may be designed in many ways, the facilitator and the teacher together decide which tools to use and how to use them. The main challenge in this process is the expertise needed to combine different tools to design active learning activities that will achieve intended learning objectives. The underlying assumption is that technology must fit classroom activities and not vice-versa.

Also during a preparation phase, all necessary learning resources in the electronic form such as: lecture notes, instructions, handouts and exercises to be used during a session are loaded into the system. The final result of the preparation phase is a learning plan of all classroom activities accompanied by the list of electronic tools to be used. Note that the plan may also contain 'manual' activities for which GSS support is not used e.g. reading of an article. It is important to note that the plan is very flexible and can be modified during a session.

Prior to the first session, it is necessary to organise a presentation of the technology and ways in which it may be used. The technology is very 'user-friendly' and even students who don't have much experience with computers can easily learn how to use the system. When students feel confident with the technology, then the next step is to prepare them for collaborative work. It is a great mistake to assume that students will know how to work together in a

constructive and collegiate fashion (Cohen, 1994). The teacher and students together define the set of norms (or rules) for group behaviour. For example: "If you don't understand something type in a question", "Avoid all comments that are likely to be misinterpreted by other students", etc. Therefore, rules are expressed as explicit instructions. However, rules may be "signalled implicitly via activities such as asking questions, thereby providing 'natural' spaces for responses of a particular kind (McAteer *et al.*, 197, p. 224). Further, rules also need to include non-formal aspects of interaction (Lewis, 1997).

Electronic session — collaborative learning

Electronic collaborative learning is a dynamic process guided by the learning plan. If necessary the plan can be modified. For example it is possible to change the order of collaborative activities, their duration or even to design and include new collaborative activities during the session. Students participate by performing various computer-based activities i.e. they suggest new ideas or comment on other students' ideas, organise ideas, analyse the list of alternatives and cast their votes, collaboratively write a report, etc. All student contributions are exchanged and cumulative results may be presented on a public screen to stimulate further discussion. At the same time a teacher facilitates the learning process and provides help when needed. It is important to stress again, that the computer-mediated collaboration is not a substitute for face-to-face communication.

Learning activities can be split into several phases to enable off-site work such as library research and collection of materials. It is also possible to combine the results of various learning sessions and preserve them for future sessions. This reduces the problem of students who after the tutorial remember something important they "wish they had said in the tutorial" (see for example: Light *et al.*, 1997).

The following are some examples of learning activities that are possible in the electronic classroom.

Interactive lecturing. While a teacher lectures, students may make silent comments or questions by typing them into the system without disturbing the other students or interrupting the teacher. All comments and questions are exchanged and may be projected on the public screen during or at the end of the lecture. Then the teacher may use the questions and comments to stimulate the discussion with the students and help them find the way to an answer. This learning activity develops students' critical thinking skills and overall understanding of the material which has been presented. By seeing other students' questions, a student gets a better perception of his/her own learning level compared to others.

Group dictionary. This activity enables students to define meaning for new terms or phrases collaboratively. A teacher may provide an initial list of important terms. After the presentation of a new topic, students may extend the list with new terms they didn't understand during the presentation. Then students try to define the meaning of new terms by exchanging and discussing various pro-

posals. In this process the teacher provides guidelines for discussion and contextual knowledge. This activity contributes to the students' understanding of the materials presented in lectures.

Collaborative problem-based learning. A real life problem is presented to students and they are challenged to find a solution collaboratively. Students start by generating a preliminary list of ideas — solutions to the proposed problem. Each student may enter a new idea and in that way extend the initial list of solutions or may comment on other students' ideas. Then the whole list is split into several different categories where each represents one alternative solution to the problem. Students may then use one of the electronic voting tools to further reduce the list of alternatives into, for example, the 'Top-five'. The next step may be to define different criteria and evaluate each alternative against the criteria to obtain the best solution for the problem. Students may work as one large group or several small groups each investigating alternative solutions. This learning activity is very complex and may take several electronic sessions. Between the electronic sessions students may collect additional and relevant materials or interview relevant people. The role of the teacher is to guide students through the process and help them generate the final solution. This learning activity contributes to the development of students' problem solving and critical thinking skills. Using real problems that students find relevant and challenging energizes their participation and learning.

Collaborative writing. This activity enables students to write a document (an essay, a report, a proposal, a plan or a seminar paper) collaboratively. The initial structure of the document is usually prepared in advance. For example, in a case of report writing the standard set of sections is used (such as: executive summary, introduction, body, etc.) while is a case of a non-standard document, students have to prepare an initial list of sections. The list of sections is presented on a public screen and all students' screens. Students work simultaneously and each student can pick one of the sections from the list and write one or more paragraphs. As soon as a student finishes with one section, his/her contribution is automatically visible to others. All individual contributions are combined and exchanged. This activity develops students' critical thinking and writing skills.

Collaborative exercises. Diametrically opposed to the standard drill-and-practice exercises designed for individual students, collaborative exercises are designed for groups of students. Various collaborative exercises such as multiple choice, yes/no or short answer questions may be easily setup to test a group's understanding after each session. All results are combined and statistically processed. Each student may compare his/her answer with the group's answers. When used in an anonymous way these exercises cannot be used for individual assessment as the individual results cannot be identified from the collective result. However, students may be asked by a teacher to identify their answers. These exercises provide an overall insight into group knowledge which is useful for the teacher.

Feedback from the students. Each electronic session should finish with an electronic questionnaire or survey giving students the opportunity to enter their general comments and observations about the session and to suggest improvements for the future.

Evaluation of collaborative learning

An evaluation phase should follow each electronic session giving the teacher and the facilitator the opportunity to evaluate all collected results, to discuss problems and redesign future learning activities, if necessary. For that purpose an electronic transcript of a session, the survey and questionnaires are valuable sources of information and suggestions. For example, the electronic transcript may be used for evaluation of students' contribution and participation based on the number of comments, questions raised, the vocabulary used, etc.

Benefits and problems of the proposed methodology

The methodology presented in this paper has been used experimentally for two semesters mainly in the information systems area. However, it is planned to extend its application to other subject areas such as accounting, finance and small business management. Three groups of postgraduate students (on average 17 students per group) enroled in the subject 'Distributed Decision Support Systems' and used the system on a regular basis for one three-hour session per week during the whole semester. Other groups of undergraduate and postgraduate students (enroled in the subjects: 'Information Systems Analysis', 'Advanced Information Systems Analysis' and 'Decision Support Systems') have used the system occasionally from two to four three-hour sessions per semester. One preparatory session was organised for each group of students; this included presentation of technology and demonstration of all tools as well as principles of collaborative work. Teachers were introduced to the system by a two-day training seminar. The technology used was *GROUPSYSTEMS* developed by Ventana Corporation.

The initial results were very encouraging. The level of interaction, participation in all activities, and the students' overall results were reported to be much better than in previous years. In order to identify and better understand the benefits of the methodology as well as initial problems, various research methods have been used. These included electronic transcripts of the sessions, electronic questionnaires and surveys used at the end of each session, interviews with students, group discussions, observations of teachers and facilitators as well as formal teaching evaluations at the end of each semester. The major results can be summarised as follows:

Learners' perspectives

Learning experience. All student comments about their overall learning experience were very positive; for example, several students reported that 'learning

was fun!'. The majority of students reported that their problem solving skills, critical thinking and especially written communication skills were considerably improved. Anonymity provided by the technology was identified as very important. The importance and value of one idea was measured on its own merit, not by the person who suggested the idea. International students reported that anonymity enabled them to participate as equal participants in spite of their language difficulties and differences in cultural and educational background although some of them commented that they sometimes needed more time to complete the required activity. Students had few problem with the technology but they appreciated help provided by a facilitator or a teacher during the electronic session. Many students reported the importance of team spirit and mutual respect created by electronic collaborative learning.

Preparation for collaborative learning. To be able to participate effectively in an electronic session, students should have a basic understanding of various collaborative tools as well as principles of teamwork and intercultural communications. The purpose of the preparatory session was to equip students with these skills.

Furthermore, students are also required to prepare for each session. Preparation typically includes reading a chapter from a textbook, collection of relevant learning resources (e.g. journal or magazine articles, Internet materials, preparation of a short report or a list of questions). Students reported that this electronic collaborative learning requires much more preparation for each electronic session than for a traditional tutorial. As they commented "it was more obvious when we were not properly prepared" and "we couldn't just turn-up and 'free-ride'". Though a few students reported that preparation for each session could be a problem (because "it took long time to prepare"), it made the learning process more effective and it was beneficial in the long term.

Student expectations. After analysing students' comments and suggestions, it became evident that electronic collaborative learning had increased their expectations about the quality and versatility of the learning process. For example, students who used the system on regular basis, came to expect new and different activities. Also, the majority of students commented that they would like to use this way of learning in other subject areas as well.

Teacher's perspectives

Teaching experience. From a teacher's perspective, the methodology enabled more interactions with students. Teaching was no longer one-way but became more of a two-way discussion. In addition to basic technical skills, teachers are required to have good problem solving and team management skills. Although one could argue that these skills are also required in the traditional environment, electronic collaborative learning emphasises their importance. For example, during the planning phase teachers should combine different collaborative activities to achieve learning objectives, and then during the session the teacher should be ready, if necessary, to adjust an initial learning plan for each

individual group of learners, e.g. change duration and order of various activities and to include new ones.

Furthermore, basic computing skills and a sound understanding of collaborative tools are important. Although the teachers surveyed didn't report any technical problems, it could be envisaged that when teachers from other non-technical areas become involved, good technical support will become crucial. Also, based on teachers' comments, it became clear that an initial training session was not sufficient, as they needed on-going support sessions to exchange ideas about new learning activities.

As the teacher gets immediate feedback from the students and s/he can adjust the learning activities to target the problems identified. For example, the technology provides different tools for analysing a student's participation and a teacher may analyse the nature and the number of comments, questions asked and the frequency of participation. However, teachers needed new evaluation methods and tools which would help them to evaluate the student comments.

Anonymity, although a great benefit, may also be a potential source of problems for teachers as well as for some students. Having the opportunity to express anything at all anonymously, may result in student misuse. Although it did happened few times (and the facilitator had to delete several inappropriate comments so they were not projected on the public screen), teachers didn't identify it as a problem.

Preparation for collaborative work. This methodology requires much more detailed preparation than traditional teaching and it has little support available from previous experience. Additional time is required to set-up exercises, meet with the facilitator, test the teaching and learning plan and evaluate the results. As expected, teachers reported that the biggest problem was the lack of teaching resources such as study guides and activity books that would help them to redesign their teaching curricula to include new collaborative activities.

Teaching paradigm. Electronic collaborative learning requires teachers to rethink and change their own assumptions about the teaching and learning process. This may be a very powerful barrier for some teachers as they will have difficulties in not thinking of themselves as 'information-delivery specialists' instead of participants and guides in the learning process (Nunamaker, 1997). It is clear, that teachers need time and very good support to understand and accept the new more powerful role they play in the electronic collaborative classroom.

Conclusion

This paper describes an interactive methodology for learning and teaching in a synchronous electronic collaborative environment. The methodology, combined with Groups Support System collaborative technology, has the potential to improve students' problem solving, critical thinking and communication skills. However, further research into the area of synchronous collaborative learning

is necessary to understand collaborative processes and design better methodologies.

Another more important problem is the recognition of the new way of teaching and learning. This is not a simple process. However, rather than adopting old teaching methods along with new information technologies, it is necessary to investigate new previously unknown possibilities offered by new technologies and design new methodologies for learning and teaching. The approach presented here may be one possible direction to follow.

References

Alavi, M. (1994) Computer-Mediated Collaborative Learning: An Empirical Evaluation. *MIS Quarterly*, **18**, 3. 159-174.

Butler, W. (1990) *The Construction of Knowledge in an Electronic Discourse Community.* Working Paper, University of Texas.

Cerratto, T. & Belisle, C. (1995) Reframing Learning in CSCL Environments. *Conference on Computer Supported Collaborative Learning*. Lawrence Erlbaum and Associates, Indiana. http://www-cscl95.indiana.edu/cscl95/cerratto.html

Cohen, E.G. (1994) *Designing Groupwork Strategies for Heterogeneous Classroom.* Teachers College Press, New York.

Davenport, E. & McKim, G. (1996) *Groupware in LIS Education*. Working Paper, Communication and Information Studies Department, Queen Margaret College, UK.

Hodgson, V. & McConnell, D. (1995) Co-operative learning and development networks. *Journal of Computer Assisted Learning*, **11**, 4, 210-224.

Jackson, A. & Kutnick, P. (1996) Groupwork and computers: task type and children's performance. *Journal of Computer Assisted Learning*, **12**, 3, 162-171.

Jessup, L.M. & Valacic, J.S. (1993) Group Support Systems: New Perspectives. Maximillian Publishing Company, U.S.

Lewis, R. (1997) An Activity Theory framework to explore distributed communities. *Journal of Computer Assisted Learning*, **13**, 4, 210-218.

Light, P., Colbourn, C. & Light, V. (1997) Computer mediated tutorial support for conventional university courses. *Journal of Computer Assisted Learning*, **13**, 4, 228-235.

Mantovani, G. (1994) Is Computer-mediated communication intrinsically apt to enhance democracy in organizations? *Human Relations,* **47**, 1, 45-62.

Marjanovic, O. (1997) Teaching International Students in the Electronic Collaborative Classroom. *Proceedings of the 8th Annual Conference, ISANA'98. International Education: In it Together*, p. 94-104. Melbourne, Australia. International Student Advisers' Network of Australia.

Marjanovic, O., Cecez-Kecmanovic, D. & Bonner, R. (1995) Electronic Collaborative Classroom. *Proceedings of the Conference: ASCILITE'95 - Learning With Technology*. ASCILITE, Melbourne

McAteer, E., Tolmie, A. Duffy, C. & Corbett, J. (1997) Computer-mediated communication as a learning resource. *Journal of Computer Assisted Learning*, **13**, 4, 219-227.

McGrath, J.E. & Hollingshead, A.B. (1994) *Groups interacting with technology: Ideas, evidence, and an agenda.* Sage, Thousand Oaks, CA.

Nunamaker, J.F., Briggs, R.O., Mittleman, D.D., Vogel, D.R. & Balthazard, P.A. (1997) Lessons from Dozen Years of Group Support Systems Research: A Discussion of Lab and Field Findings. *Journal of Management Information Systems*, **13**, 3, 163-207.