A review of Computer Supported Collaborative Learning environments

Montse Novell, Xavier Jaén, Xavier Bohigas.

Escola Tècnica Superior d'Enginyeria Industrial. Universitat Politècnica de Catalunya
ETSEIB-UPC. Diagonal 647. 08028 Barcelona. Spain
Tlf:34934016566. Fax: 34934016566. E-mail: montse.novell@upc.es

Abstract

Over the last few years, the majority of higher education institutions have been incorporating web-based environments to support their academic activities. These environments, along with the possibility of publishing content files, managing them and using a course agenda, often incorporate computer supported communication tools, such as forums, chat rooms, conferencing systems and so on. In addition, the traditional model of teaching is facing some challenges and we are all aware that knowledge is not something that can be transferred from the faculty to the students, but has to be jointly constructed by students and faculty collaborating together. The goal now is to integrate technology with collaborative learning; which is known as Computer Supported Collaborative Learning (CSCL). This paper’s intention is to review recently published literature and reflect on the potential of CSCL for science and technology education, and also provide the prototype of a simple tool for synchronous discussion.

1. Introduction

The work presented here has evolved in some sense due to the activities of the THEIERE (Thematic Harmonisation in Electrical and Information Engineering in Europe) Thematic Network [1]. This project ran from 2000 to 2003 and one of the tasks was to provide a set of web available educational resources in the field of information and electrical engineering. The aim was to allow the students to deal with other countries educational resources as a complementary activity to the usual Erasmus exchange. The contents were grouped in packages: Computer and Information systems, Telecommunication, Electronics, Power systems, Instrumentation and control, Internet services and applications, Fundamental, Virtual labs. Each package contains contents presented in HTML, XML, PHP, or Java simulations. One of us (M.Novell) as a responsible for the support of didactics of the project had to monitor the quality and usefulness of the resources designed from an educational point of view, the next point was to incorporate a way in using them.

Thus we decided to think up of some kind of computer supported tool needed to enhance the communication among the users including both students and teachers in an learning process using the resources available. As science teachers and to some extent having skills in the technological aspects related with web environments, we tend to design and set up the technical resources first and to check whether they serve to our purposes or not later. This paper tries to look in the opposite direction, that is, to reflect on what is important from the learning effectiveness point of view first by taking it into account the design of CSCL.
environments. At the end, we present a synchronous communication tool that has been developed as a support for using THEIERE educational resources.

2. Web-based learning

When one uses the web in educational situations, as is the case of THEIERE resources, every time the contents are uploaded in the web-server we ask ourselves: ‘Ok, and now what?’. We will find the answer after reflecting upon our teaching activity: the way we teach, the way we think the students learn, in other words the model of learning that we would like to apply to achieve the learning objectives.

The traditional model of teaching and learning in higher education is sustained by the idea that learning is a consequence of a passive reception process, which means that a body of knowledge exists everywhere and teachers are the transmission belt between this body of knowledge and the learner. Learners are nothing else than empty vessels to be filled and the classroom lectures are nothing but content transmission, where the knowledge is something inert that can be passed almost intact from the teacher to the learner. We, as university teachers, naturally have, without being aware of it, an instructional plan that comes from an objetivist tradition, which holds that the world is completely and correctly structured in terms of entities, properties and relations. The goal of understanding is to know those entities properties and relations [2]. In spite of this, most teachers do not behave as mere content deliverers in our classroom lectures. Inside the classroom a lot of things happen: explanations, repeated terms, emphasis, waiting time, and, in the case of science contents, use of mathematical language, demonstrations on the blackboard, some things are erased from the board, some things remain until the end of the lecture.

Nowadays there is a wide consensus on the idea that learning is an individual process of knowledge construction and it occurs interacting with the social environment. In his approach, the teacher scaffolds the learners' knowledge construction through thought oriented learning activities that give them the opportunity to apply and generalise their initial understandings. To achieve this deep change in the instructional model it is necessary that all the participants in the process have internalised it and this is not easy; it requires experience in specific contents teaching as well as reflection on the learning and teaching practice.

In the transition from face to face to web-based environments, we do not have to put aside our classroom experience. The reflection on our own practice as face to face teachers will help us do things easier, and it will provide us with experiences that we can replicate in on-line situations. Teacher's behaviours that contribute to better student outcomes in a face to face situation are still valid in a virtual environment, which is in fact a virtual classroom, as Mällinen pointed out [3]. However, apart from this, we have to adopt new teaching strategies that enhance the learners to construct their own knowledge.

In the context of research science education, the models of science learning have been evolving along with the learning theories that have been established over the last century. Since the eighties, there has been a great consensus among science education specialists regarding constructivism as the suitable model for science teaching and learning. At the beginning, theorists advocated for a radical constructivist model but research on science education has shown contradictions [4]. However, when we talk about consensus on a model of learning we mostly refer to primary and secondary school, at university level science teaching and learning research is almost an unexplored field, but despite this, previous studies are useful for reflecting on university teaching-learning practice. It is worthwhile mentioning proposals for
adopting a constructivist approach in some technical disciplines [5], problem based learning models [6] and co-operative learning [7], which are being adopted by some technical universities.

3. Key points in designing learning activities for CSCL

Co-operative and/or collaborative learning has been introduced as an innovation topic in higher education institutions since the 70s and the 80s, and one would say there is a general agreement on their effectiveness from the learning point of view [7]. Since the 90’s the possibility to use CSCL tools has extended the possibilities of co-operative/collaborative learning from face to face situations, where the learners meet at the same time and place, in online environments where the group members do not share space but meet at the same time (synchronous communication) or time or place (asynchronous communication).

Jones and Asensio [8] give us a useful resume of the essential points on how people learn that we have quoted here:
- people learn collaboratively by articulating and sharing their ideas, experience and expertise through discussion and dialog;
- people learn by linking ideas from the literature, online contributions and their own practice and experience;
- people learn by doing, by engaging with the activity or task;
- people learn from experience, either positive or negative and from exposure to different tutoring and learning styles.

There are several words that refer to the social character of the learning process along with others that refer to the learning as an active process which takes place working through phases that constitute what is known as the learning cycle.

Then the goal would be to design learning activities based on tasks that combine the collaboration among learners with the active reflection in one’s own learning process and encourage learners to work through the successive phases of the learning cycle [9].

![Learning cycle](image)

When designing learning activities there is another aspect that must be taken into account. When we use the web as an educational resource, we deal with a new environment from a learning point of view. Nowadays must of students are used to using the web in social communication contexts (chats, discussion forums, etc), they have become skilled in using such technology and they have been improving their own strategies in using it for their own purposes. Nevertheless, when they face these environments in learning situations to attain specific learning outcomes, the skills required to make a constructive and effective use of the potential of the web and its resources are different. Collis and Meeuwsen [10] say that they need to acquire 'learning to learn' skills and give us a list of the core components of learning to learn:
- Articulation and reflection. Becoming aware of one’s own thinking and thinking patterns.
- Planning skills. Becoming a better planner and a better self-regulator of one's own planning.
- Study skills. Developing better study habits as well as developing related meta-skills.
- Finding and applying relevant examples and models and applying them to one's own problem.
Self-Evaluation. The ability to anticipate areas of improvement in one’s work thinking and looking ways to improve it.

We have noticed that the requirements for effective learning are almost the same in any context, face to face or web-based, therefore the question is: What must we do to design effective CSCL environments?

An actualised and critical review of the literature about ‘collaborative learning’ and ‘co-operative learning’ can be found in Strijbos’s work [11]. Instead of CSCL, they talk about computer supported group based learning (CSGBL) and present what they name ‘a process-oriented methodology for designing CSGBL’. It consists of six steps:
1. Determine the learning objectives.
2. Determine the expected interaction.
3. Select the task type with respect to the learning objective and expected interaction.
4. Determine whether and how much pre-structuring is needed.
5. Determine which group size is best suited
6. Determine how computer support is best used to support learning and expected interaction.

This proposal does not have empirical evidence that the proposed design methodology will improve the CSGBL because it is only based on literature analysis. Despite this, it offers a framework to adopt a more systematic approach to CSGBL, and, quoting the authors: ‘to further CSGBL design that focuses on the heart of the matter: interaction’.

4. What about science and technology?

Ten years ago, the expectations concerning e-learning and computer support systems in general were very high [12]. Some of these expectations were:
• Students will use the web as prime mode of study.
• Virtual campus environments would provide both lecturers and students with an integrated environment.
• Synchronous tools as chat rooms would be used extensively.

To date we know that those predictions have not been accomplished. The web and their associated resources are being widely used for social purposes but there is a short use of them in formal educational situations. Nowadays, the situation is more stable in relation with use of web-based resources and Information and Communication Technologies (ICT). In education, the challenges we have to face include both technical and pedagogical aspects.

During the last five years a lot of papers have been published based on research on computer supported instruction, in relation with the use of electronic synchronous and asynchronous discussion as learning activity, and group-based learning [13][14][15][16]. However, this research is mainly focused on humanist and social sciences disciplines. There is still a lack of research in implementation of CSCL in relation with specific disciplines and in particular in the context of science and technological education.

Hammond and Bennet [16] have been working in a cross-disciplinary project exploring the use of educational technology to support small-group learning and teaching activities in the Physical Sciences, Psychology and disciplines within the Humanities. The aim was to identify the different ways in which ICT can support small group work and identify similarities
and differences between the disciplines. Fig.2 presents a summary of the relevant factors.

The evidence from their survey and case studies supports the view that a range of factors contribute to discipline differences in the use of ICT: epistemological differences between curricula, forms of discourse, text language and notation used in text-books and lectures, established procedures. Moreover, the perception of the relevance of collaborative networked learning in a specific discipline will depend on whether learning through dialog is relevant or not.

5. A chat tool prototype

Along with our reflection on all the items that have been pointed out above: model of learning, collaborative learning, use of computer support for communication, the relevance of discipline, and so on, we designed a chat tool to allow synchronous discussion over Physics contents.

Since 1996, we have been investigating the use of web-based resources in Physics education. We designed an educational environment for Physics teaching and learning [17]. One of the design requirements has always been that the resources must be compatible with the use of mathematical language and the presentation of equations and formulas. This was also one of the constraints for the chat environment.

The majority of CSCL is based on asynchronous communication, which is suitable for some purposes, but we consider that their possibilities can be empowered by enabling simultaneous interaction. The advantages and inconveniences of computer supported synchronous communication have been analysed by different authors [13][18], we considered their results when we design the prototype of the chat tool that we will present here.

The tool is sustained by a MYSQL database, and the languages used are: Java for the application, SQL for server and users management, and html for the webpages. The design requirements were:
- Different user's profiles: administrator, learner and tutor. Each of them has their own priorities.
- There is only one chat room always open: the corridor. In the corridor are all the users that are logged in.
- Chat rooms are only available while a scheduled discussion session is taking place. The tutor is who is able to open or close a chat session. They decide how long the session lasts either before, using a tool that enables them to plan the chat sessions, or just as they log in.
- Students can only log in to those chat rooms to what they are authorised to.
- The tool does not allow having private communications between two users.
- The chat interface has four areas:
  - Users and rooms area. This allows access to other rooms showing who is logged on, and in the case of the tutors and administrator, using the menu options to which at they authorised to.
  - Text area. It consists of a standard text window.
  - Image area. Allows the user to share images, such as formulas and equations. It contains upload and download functions.
  - Url area. The url typed is automatically loaded in the user's browser.

When the session ends, as a result of tutor decision or because the time assigned has expired, the content of the discussion is automatically recorded in a text file format. These are the technical features but the key point would be to use it in a suitable way for discussing science contents. This would be the moment to apply everything we have discussed in previous sections.

We plan to introduce it next year in a hybrid web-based course [19], designing learning activities based on guided synchronous discussion to attain specific learning outcomes.

There is also the possibility to use it during the Dissemination Phase of the
THEIERE, if the European Commission approves it.

6. Conclusion

To design effective networked learning it is necessary to reflect on pedagogy, differences between information and knowledge and models of learning and teaching. Skills and strategies required will depend on the learning approach adopted rather than the media used. In the transition from face to face to web-based environments, we do not have to put aside our classroom experience. Our chalk and talk background as specific content teachers would be very useful in designing effective learning activities.

Meaningful knowledge construction is an active individual process but in collaboration with others, and CSCL would be a suitable framework to design group activities to attain specific learning outcomes. Collaboration either synchronous or asynchronous has to be supported by technical environments taking into account each specific disciplines particularities.

7. Acknowledgements

The authors would like to thank Dirección General de Investigacion of the Ministerio de Ciencia y Tecnologia for financial support (reef: SEC2002-04254-C02-01)

8. References