

# From Theory to Practice: An Example of Computer-Supported Cooperative Learning

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## Abstract

*Since the year 2000, the authors have been teaching Basic Optics to engineering students in a partially web-based course, which lasts ten weeks and is offered twice a year. The information gathered over the period from 2000 to 2003 allowed us to plan certain changes, which were implemented last year (in 2004). This paper presents the information that was considered of relevance and our rationale in making necessary decisions in transforming the web-based course. We present the main features of the new course structure yet place a special focus on the group activity that we have introduced and is supported by BSCW (Basic Support for Cooperative Work) software. The process followed was based on six critical points for designing computer-supported group-based learning: learning objectives, expected interaction, task type, level of pre-structuring, group size and computer support.*

## 1. Introduction

The course evaluation performed over the course of four years [1][2] revealed that, while the course structure as a whole received a positive assessment, there were some aspects related to the way that the learning process was guided that needed to

be improved. Those aspects basically comprised the following:

- *The formulation of learning outcomes.* The students must be constantly aware of the purpose of the activities they are engaged in.
- *The assessment must be designed in such a way as to complement most of the learning activities.* The course evaluation revealed that most of students paid no attention to learning activities that were not relevant to the assessment.
- *The learning activities must be designed in such a way as to foster the learners' active participation in their personal learning processes and to allow them to acquire skills in 'learning how to learn'.*

These skills and strategies [3] will help students to manage their individual learning processes and study time.

Bearing these considerations in mind, a number of improvements have been made to the individual web-based activities (Section 2) and a group activity has been introduced that is supported by BSCW software (Section 3).

## 2. The web-based activities

The improvements to the web-based learning activities comprised changes made to the structure of the web pages of the different blocks and learning activities [1].

The list of learning outcomes for each block that appears on the corresponding block web page has been reduced from ten or twelve to a maximum of four or five. Each activity web page includes the aims of the activity at the bottom, which should number no more than four, and the tasks that have been designed as resources for learners [4]. Figures 1 and 2 illustrate the block and activity page structure as it stood prior to these changes (Figure 1) and the new format used from 2004 on (Figure 2).

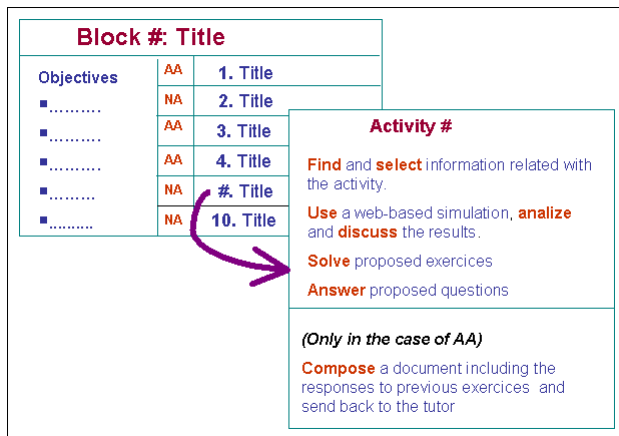


Figure 1. Block and activity web pages. 2000-2003.

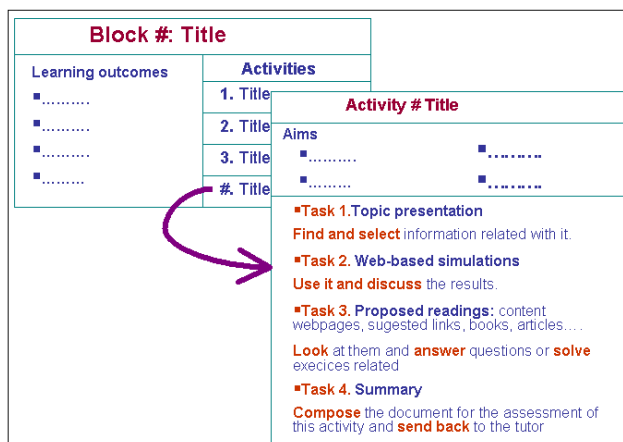


Figure 2. Block and activity web pages from 2004 on.

### 3. Group activity using BSCW

Along with the changes made to the web-based structure, further changes were also aimed at improving one of the weak points of the course: interaction and communication between tutors and learners, as well as between individual learners. We

agree with the argument put forward by Jones and Asensio [5] that:

- People learn *collaboratively* by articulating and sharing their ideas, experience and expertise through discussion and dialogue;
- 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.

The goal is thus to design learning activities based on tasks that combine collaboration between learners with an active process of reflecting on one's own learning process, and a way to achieve that is by introducing group learning activities.

Until 2003, as was stated, our web-based course lacked a real social connection between learners when they were called on to perform learning activities. As the students focused on in this study are in fact on campus students, they probably meet at times to work on their assignments, but there is no evidence of the way they collaborate once they hand their assignments in to their tutors to be assessed. They also collaborate when they meet in the laboratory for two-hour sessions, where they have to work in pairs using lenses and instruments, although this only occurs once in the semester. These laboratory activities contribute to the assessment as well as the web-based learning activities, the final examination and an essay that must be presented at the end of the course. Until last year, the students wrote the essay in pairs or in groups of three. While they worked on their own, however, we did not monitor the group activity and for the assessment we considered only the final essay. Last year, however, this activity was replaced by a web-based group activity that was supported by BSCW software.

Our aims in introducing this activity were firstly to introduce a group activity in which the students would be encouraged to cooperate in order to achieve specific objectives, and secondly, to guide and monitor this cooperation. We decided on specific software that would offer web-based support to cooperative projects, as this was well suited to the design of the course. As has been mentioned on different occasions, our course has a hybrid format: the learning process is guided using web-based learning activities along with on-campus face-to-face sessions.

It is worth highlighting some of the differences between cooperative work and collaborative work. This has been the topic of a number of publications [6], and the result has been that many researchers associate cooperation with the division of tasks and collaboration with an equality between contributors in finding the solution to a problem. If we adopt this terminology, our group activity would be considered a cooperative activity.

In [7], the authors present a six-step process-oriented methodology for designing computer-supported group-based learning, which we use to identify the critical elements affecting interaction. Subsequently, we present these elements and the manner in which they have been applied to our proposal, in order to show our rationale in coming to the solution we adopted.

### 3.1. Learning objectives

The group activity is proposed during the last third of the course, at a point at which most students have handed in the assignments that make up the main content of the course. By this stage, the students have grown accustomed to using the Internet as a learning environment, and they have already solved numerical and graphical exercises in which they were required to apply the fundamentals of geometrical optics. The main learning objective for this activity was for the students to apply the

knowledge they had acquired in solving a specific problem.

After considering a number of possibilities and analysing how the course had evolved over time, we realised that we had a candidate for the group activity: the essay that students wrote in groups using web-based bibliography and resources. Once that had been decided upon, what we then had to do was to provide them with an online environment that would enable them to cooperate. As before, in the group activity the students would be asked to design a hypothetical optical instrument, which would then have to meet specific requirements.

### 3.2. The expected interaction

Many sources would have it that any tool that foments interaction between users will yield positive results when the tool in question is implemented in a web-based environment. This, however, is patently wrong—there are countless websites whose chat rooms are always empty, or discussion forums that elicit all sorts of ridiculous contributions. Indeed, interaction does not take place spontaneously, but rather requires some sort of motivating factor, and if interaction between learners forms part of a learning activity, it must be guided properly to avoid frustrating situations.

During the planning process for our group activity, we first had to decide whether the communication between learners would be synchronous or asynchronous; both present advantages and disadvantages [8]. Synchronous communication offers the advantage of allowing fluent and active communication, though most of these chat tools allow only text input, and when sound or video is included then the communication speed goes down. We designed a chat tool that, in addition to text, allows for the synchronous transfer of images [9], but in the end we did not use it in the group activity.

The main reason behind discarding synchronous communication was that it

requires all the members in a group to log on simultaneously at a specific time. This feature is very useful in getting groups to interact in distance learning situations, but does not apply in our case, as a number of face-to-face activities are already included in the schedule. However, asynchronous communication offers the advantage that each member of the group can organise his or her learning time as he or she so chooses—in other words, students have to practice their planning and study skills in order to complete the task at hand. Another advantage of asynchronous communication is the ease with which documents and individual contributions can be stored to the discussion spaces.

Thus, the group activity we propose is an asynchronous activity that takes place over the final three weeks of the course. Group members will be required to interact when they meet to assign tasks. Upon finishing, each member then has to upload the results of his or her work to the group space.

### 3.3 Task type

The tasks were selected based on the learning objective and the expected student interaction, and are of the same type as those that constitute the web-based learning activities. As the group activity is proposed as a process of cooperation between the members of the group, the tasks are designed so that each member has specific responsibilities in order for the group to achieve the expected result. There are four tasks:

- Task 1: Bibliography
- Task 2: Geometrical design
- Task 3: Numerical application
- Task 4: Report: final essay

At first, they are given a few days to discuss the assignation of tasks, and they can then start working separately yet taking into account what their peers are supposed to contribute. The students have to coordinate their work to make sure that their geometrical and numerical designs are

related to each other, and all must take into account the bibliography compiled in Task 1. Finally, Task 4, in which one of the group members writes an essay to summarise the material compiled, represents the final product for the assignment and is done at the end of the process.

### 3.4. Level of pre-structuring

We have learnt from our experience in face-to-face situations that cooperation or collaboration occasionally occurs spontaneously, but in most cases it does not. The same is true with online activities, which is why it is necessary to structure activities well in advance. Thus, we had to decide how we would promote precisely this sort of interaction. We were faced with a number of proposals ranging from a high pre-structuring or jigsaw with a rigid task division to a low pre-structuring closer to a 'progressive inquiry' methodology [7]. With regard to the way we designed the tasks, our proposal took on a jigsaw format but added further elements to smooth the pre-structuring level. The resulting proposal could not have been made just by putting together the results of isolated tasks: it also required some degree of correlation between them. An important factor in making this viable is the virtual environment for supporting group work.

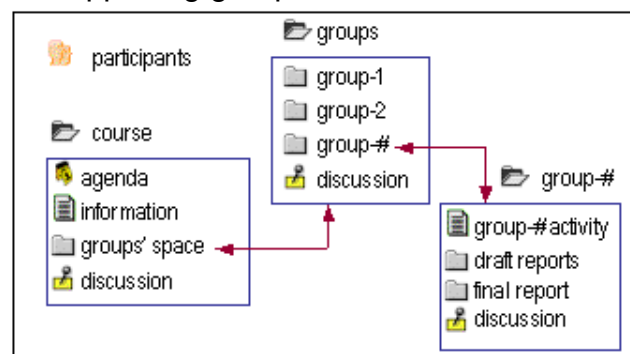


Figure 3. CSCL environment structure

Previous experience in participating in online group activities showed us that virtual spaces created by tutors or designers are welcomed by learners, and that this makes

their participating more likely. In such a situation, it seems as though there is an implicit agreement on who owns the authority. The structure of the shared space for the course group activity is described in Figure 3. As is shown, the discussion space serves different purposes depending on the environment in which it is used: whether it is for a course, groups or a single group.

### 3.5 Group size

There is no general agreement regarding what comprises a suitable group size in order for a group activity to be effective. For two reasons, however, we decided to divide our pool of students into four four-person groups. Firstly, we chose this number due to the number of students on the course—last semester there were sixteen—and the fact that this solution enabled us to design groups that would have an identical number of members. Secondly, four groups of four suited our purposes well, as there were four proposed tasks, which meant that in a four-person group each member could be responsible for one task. The performance of each member in the group space would then be determined by assessing his or her completion of whichever task he or she is responsible for. That is, there are no specific roles (moderator, compiler, reporter, etc.) assigned in terms of the group activity.

### 3.6. Computer support

The decision to adopt one solution or another for computer support cannot be made independently from the other critical elements described above. In 3.2, we point out that the group activity was planned as an asynchronous activity, and that we then had to search for a suitable tool. We considered the technical support received from the Technical University of Catalonia (UPC) as an essential factor in the process of arriving at our decision. We, as teachers/tutors, were thus able to concern ourselves exclusively

with educational aspects, and could leave technical questions to technical departments. Bearing this in mind, the decision-making process was as follows:

•*Firstly, we considered the UPC virtual campus.* In 1998, UPC's Information Service had already designed a virtual campus, based on Lotus Notes, which students and faculty members can access online and which offers one single environment that encompasses every school and every subject. It was designed by connecting intranets (including the intranet for the Basic Optics course), each of which encompasses a number of tools (discussion forums, agenda, etc.). Furthermore, we analysed reports that discussed the pros and cons of virtual campuses, and we met with a group of engineering students. The information we gathered regarding the way in which they used virtual campus resources showed us that the environment was too rigid to guarantee the level of interaction that we desired for our group activity. This led us to discard the possibility of using the course intranet as the web-based environment for the proposed group activity.

•*Secondly, we looked for a tool that had already been tested.* At UPC there were already teachers working in cooperative/collaborative learning in both face-to-face or online courses. Most of the teachers using computer activities to support group activities used BSCW software, whose server is managed by the technical staff at the Institute of Education Sciences. Therefore, this tool had the advantage that it had already been tested by educators the world over, but more importantly, we had colleagues close at hand who had already dealt with the specific problems that implementing web-based environments in particular situations could bring about [10]. Their comments and recommendations were very useful to us in the process of defining the critical elements presented in this section.

## 4. Conclusions

The information compiled in the annual course assessment until 2003 was useful to us in transforming the learning activities of a partially web-based course.

Nevertheless, we have not yet been able to perform an accurate evaluation of the course. We must continue to assess our results in the light of information compiled from different sources (such as BSCW historical and daily reports, students' responses to a paper-based questionnaire and the evolution of students' qualifications, etc.), select whatever information is relevant and then go on to analyse it.

For the present, we can only evaluate the last semester taught from a qualitative point of view. Still, despite the changes that have taken place, we can affirm that these changes seem to have had very positive consequences for students' acquisition of knowledge, as has been reflected in the students' web assignments, laboratory exercises and examinations.

With regard to learning activities, a key tool in achieving this improvement has been the distinction between learning outcomes and aims, along with a much clearer definition of individual tasks. As a result, the way in which tasks, activities and virtual environments interconnect is much clearer.

As concerns the proposal for the group activity, the use of the BSCW environment introduced a shared space that did not exist before, which has enabled learners and teachers to establish other forms of communication besides e-mail. In general, the students gave a good appraisal of the use of BSCW software in the group activity. Most of them participated actively, respecting the structure of the CSCL, and each group distributed the tasks amongst its members by discussing their preferences and without wasting the entire week assigned to this task. They looked at other groups' web spaces but without disturbing

their work, and all the groups had the assignment ready before the due date.

## 6. Acknowledgments

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