Web Mediated Design Courses: Challenges and Realities in Teaching Electronic Collaboration

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Abstract

During recent years, computer media and networking have become more and more popular among educators. Within this technological emergence, the World-Wide Web (WWW) has proven to be a valuable tool for design education in terms of connecting students to each other, an extensive fund of information, and for delivering various multimedia learning materials. Experience from Web-mediated Virtual Design Studios (VDS) suggests that learning approaches taken from face-to-face design courses need to be reconceptualised to take into account the unique opportunities offered by distributed computer media. This paper presents the techniques used to teach students about communications technology through a project-based design experience and explores the results from web-mediated design log books and presentations.

1. Computer mediated and supported instruction

In recent years, educators have faced the proliferation of computer media and networking. This turn of events has opened the way for fundamental changes in the methods and techniques employed to educate and train design students. Overcoming time and remoteness to reach learners, the networked computer has become an active dynamic force in distance education, providing a new and interactive means to decrease the gap between conventional and distance learning methods. Both methods include two major components: (i) *course materials* to be delivered to the students; and (ii) *communication* between students and educators. When implemented via networked computers these techniques are referred to as *computer mediated and supported instruction* (CMSI) and are being integrated both in basic and distance educational methodologies.

It has been demonstrated [5] that generally there are *no significant differences* in achievement between:

- students in traditional classes and students in distance-delivered classes; and
- distance students at remote sites and distance students within organisational sites where the instructor is present.

These results support the development of a *unified CMSI method* for both types of education. Further research [8] supports this idea and specifies some criteria when unified methods will work effectively. Comparing distance education to traditional face-to-face instruction, it has been shown that teaching and studying at a distance can be as effective as traditional instruction when:

- the *method and technologies* used are appropriate to the instructional tasks,
- there is student-to-student *interaction*,
- there is timely teacher-to-student *feedback.*

The majority of courses available on the Web are following either the flowchart of conventional paper-based courses or are organised as hypermedia sources of information [see, e.g., 14, 15, 16, 17]. The courses have a common structure which includes administrative material, internet resources, and three units. Distance education web sites usually provide a list of intended activities [10], self-instructional programs [11], and one-way courses, either as a set of slides of the lecture presentations or as a complete lecture in HTML format.

A considerable drawback of the current approach in the design of distance education Web mediated courses typically provide a single direction of information flow and result in a loss of interactivity. Thus the academic community has begun to explore the potential of the WWW as an *educational media space* and *environment* [1].

We have developed and applied the concept of a *Web-mediated Virtual Design Studio* (VDS) as an environment for teaching students about computer-mediated collaborative design [3]. The experience of the development of learning materials for the studio series was evidence that the design and management of Web-mediated courses involves much more than merely converting lecture and exercise notes to a collection of linked web pages. The VDS emulates the components of a real world design environment: workspace, design tools, information

access, and communication channels. Such a model aims at joining all participants in an active *problem-based* learning process that overrides one of the problems confronting distance education; i.e., *passive participation*.

We extend the VDS approach to a general Web-mediated project-based course structure, suitable for distance and local education. The model has been applied in a course on computer-based design and has the following compulsory components:

1. *Course materials and information*—lecture and tutorial notes, project assignments, submission details, time schedule, glossary;
2. *Course communication*—asynchronous (e-mail within the course group, bulletin board), synchronous (videoconferencing with shared whiteboard, on-line chat);
3. *Information search and access*—within the course materials, the outer web space;
4. *Student participation*—bulletin-board archive, videoconferencing whiteboard files, student log-book.

Even with this course component guide, putting together a computer mediated and supported (CMS) course in design is a difficult task. In the next sections we discuss the premises and resources that, on the one hand, make such a course as painless as possible and, on the other hand, provide a means for analyses of course effectiveness and student acceptance of the WWW as a teaching and learning environment.

2. A web-mediated design course

The Computer Based Design (CBD) course at the University of Sydney is project-based and does not require on-line testing and examining of the students. The CBD course is an elective course for architecture and engineering students that introduces the use of the WWW, networking and electronic communication as the means for project coordinating, developing and documenting the environment. Students work in teams to design, develop, and deliver a complete Web description of the product.

The aim of this course was to provide a broader exposure to computer-based design than an individual department provides. The students learned both multi-disciplinary collaborative design and the supporting technology: CAD, 3D modelling, image processing, electronic communications, information and database management, and the use of the Web for collaboration.

Projects covered a wide span of design tasks from guitar and ergonomic chair design to a touch screen information system and bus stop design. The variety of projects reflects the disciplinary spectrum of participating students. All design information is presented in electronic form on the Web. The project teams used e-mail and a hypermail implementation of a bulletin board to synchronise their activities with the tutors and the other teams. They held scheduled videoconference sessions to discuss current developments in the design. Each individual kept an online log book of his/her weekly activities and design ideas. Each design group produced a Web-documented design project. The final grade was based on the following components:

- *homepage design* (10%), which is the entrance to the labyrinth of technologies involved in the course and to the variety of Web documenting styles;
- *videoconference attendance* (20%), through which course participants learn the techniques of computer-mediated collaboration;
- *logbook submission* (35%) declares the way the student has spent the course time during the week and their ideas towards different aspects of the design project;
- *group web presentation of the final design* (35%), which shows how students learned to document a design project on the computer, i.e. on a web page.

Students were organised into interdisciplinary design groups of 3–4 members. The students had 13 weeks to complete the task; 12 weeks of semester interspersed with a one week mid-semester break. The course homepage included basic tutorials on networking technologies, the WWW and HTML. There were also occasional scheduled lectures on computer-mediated technologies in design.

3. Student designers' logbook — a feedback to educators and a source for analysis

Since much of the design activity and the collaboration occured through electronic communication, we needed a way to track student activity electronically. Access counters on Web pages was not a significant representation of design activity. We used the idea of a diary or logbook. Students were asked to submit each week a log of their activities and ideas via a Web form. The time log submission describes how much time a student spends on different course activities. These activities have been grouped into four major categories as shown in Table 1.

While the time log describes *how* the time was spent, the design project log submission roughly describes *what* was produced during the week. It gives more details (working notes, ideas, sketches, references, etc.) about the design development. The design log differentiates the content of student activities related to the project into the following streams: design problem and intended function; market analysis and product research; alternative design concepts; design development; and performance analysis. The design logbook was intended to help the groups keep track of design evaluation which could be used in the development of the final Web documentation. However, students were not very strict with the use of the design

log, partially due to hesitation about what to include in each record. The results of the time and design log can be found at the course home page [19].

Table 1. Classiffication of student activities in the time log book.

Category	Subcategory
communication	· asynchronous (via e-mail)
	· synchronous (via videoconferencing)
learning	· technological issues
research	· Traditional (e.g. based on conventional information sources, like books, journals)
	· Web surfing
design developmen	· individual
	· collective
	· Web documentation

3.1. Communication

We analysed the use of student time and present the results in Figures 1–5. Figure 1 illustrates the comparison between the two types of communication. With minor exceptions, the level of asynchronous (e-mail) communication is almost constant throughout the course with an average of about 22 hours a week. Towards the end of the course, students focused on design development and documentation with more intensive face-to-face communication. However, we expect that in a fully distance education course the intensity of the asynchronous communication would increase as the deadline for course work submission approaches.

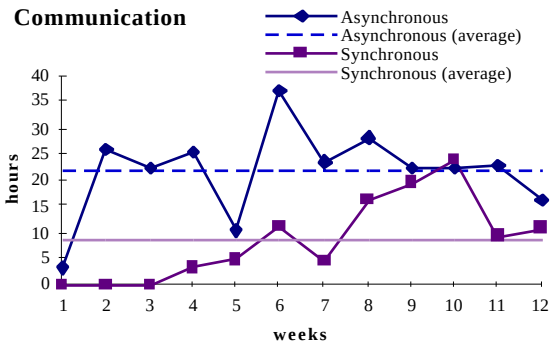

Figure 1. Time spent on each sub-category of comunication activities.

The synchronous (videoconferencing) communication, introduced in the third week, was part of the assignment. The assignment required each student to participate in at least four sessions of at least 30 minutes per session. The actual amount of time spent by each team was more than the required minimum. In general, it was a rare case when all members of the team were available for a scheduled conference so many team members had more than four sessions. Usually each session was 2–3 times longer than required, due to the amount of work on the agenda, or to technical problems and interruptions.

3.2. Learning

Figure 2 shows the time spent spent learning to use the various communication and presentation technologies and displays the initial "struggle" with technology. The maximum is rather "sharp" — only a week (the third one) was spent mainly on learning the computer media. After that the time spent each week for learning is almost always less than the average estimate. This means that after the initial "hill climbing", students acquired sufficient skills to continue to progress the collaborative design project without acquiring more technical skills. We consider that this is a result of the use of the Web as a course media. The Web browser integrates the information structure, content and context, enhancing understanding and usability beyond other type of browsers (e.g., an FTP or Gopher browser) that give access to similar material. Its simple platform independent interface makes it easier for students and teachers to exchange material. The browser allows document sharing, e-mailing, and other collaborative tasks with little cognitive overhead required of the student, saving more mental energy for student creativity.

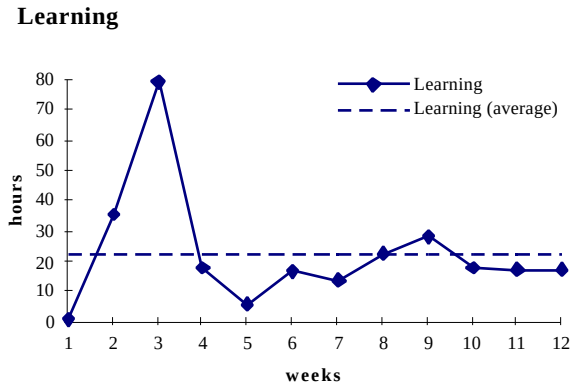

Figure 2. Time spent on learning efforts.

3.3. Research

We observed a significant shift towards doing research on the net rather than in the library. These results, shown in Figure 3, are confirmed also by the analysis of the video-conferencing whiteboard files. When discussing a particular idea, its illustration, or the pros and cons, someone always

asks about the source of the information which is put forward. In most of the cases students referred to the net.

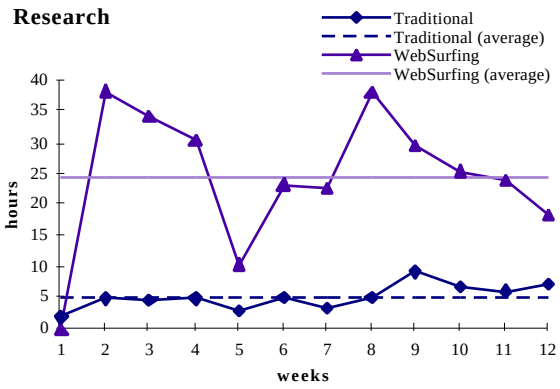

Figure 3. Time spent on each sub–category of research activities.

This result adds more support to the concept of Web-mediated courses. There are a few basic considerations when using the electronic media for developing course materials for distance education. The first deals with selecting the media for transferring the information. This means selecting the software platform (e.g., courses in multimedia design are usually oriented towards the use of Macromedia Director with an emphasis on the presentation). When the emphasis is on the contents with a reasonable presentation, the ability to process multimedia content, and standardisation across platforms and sites makes the Web an ideal course media. Another consideration is the need for different representations of a design using a variety of modelling tools. The plug-in (or helper) techniques implemented in the Web interface minimizes the efforts for displaying different representations.

3.4. Design development

The design development was tracked using the the project information recorded in the logbook. The design development, with the exception of Web documenting, was divided into individual and collective activities, which are obviously exclusive categories. Web documenting was counted separately, as it is an individual activity when considering the editing of the file, and collective activity when considering the design of the document.

3.5. Comparison between categories

Figure 4 shows a remarkable “parallelism” between the individual and documenting activities throughout the whole course. Consequently, for project-based courses the Web environment allows students to avoid the typical cycle of initial development with the post-development documenting environment, when it is necessary at the end to recall some information on the design which may be either undocumented or just lost. This on-line documenting feature leads to a relatively low time spent in building the final multimedia documentation. On average, students spent about 50% less time for the preparation of the presentation than for the design development.

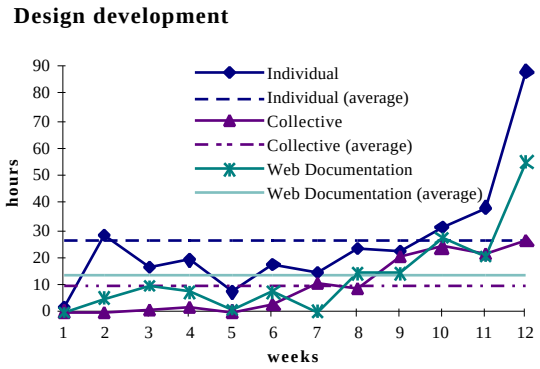

Figure 4. Time spent on design development.

One of the aims of this study was to determine if the course was balanced with respect to its different components. Figure 5 shows the weekly time spent for each of the four main categories. Except in the first few weeks, the time spent on learning technological issues was less than the time spent on the design subjects and communication of ideas. Moreover, students spent a valuable amount of time for research. These are positive results supporting the technological basis of the course.

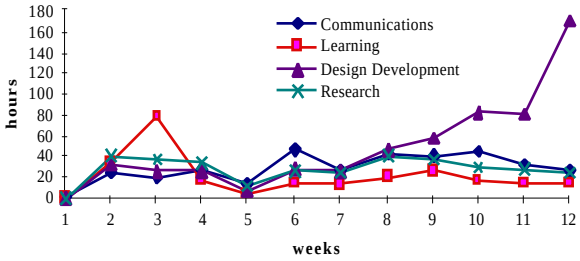

Figure 5. Time spent on activities

During the active design period, starting from the sixth and seventh week, the focus shifted towards project design and documenting. The final crest reflects a typical “end-of-semester” syndrome.

Students spent almost triple the amount of time in individual efforts than in collective work (Figure 6). This fact does not necessarily mean that they did not cooperate and collaborate effectively. A series of experiments on computer-mediated collaborative design [2,4] observed different collaborative design styles. When one design team worked the entire session to achieve consensus on design decisions, the other team worked independently on

two parts of the design, checking with each other only at the interaction of the corresponding parts.

An expected result is the high percentage of Web surfing. The course had very few formal lectures and relied on students to find material on the Web in order to complete the projects. Looking at the communication aspects, asynchronous e-mail communication remains preferable, which coincides with the higher amount of time spent in individual design activities. Thus, if we exclude the videoconferencing, the course schema has low demands on network bandwidth.

Only 10.5% of the time was spent for documenting the project, which is a relatively low percentage. This result supports the further use of the Web as project documenting media in distance education.

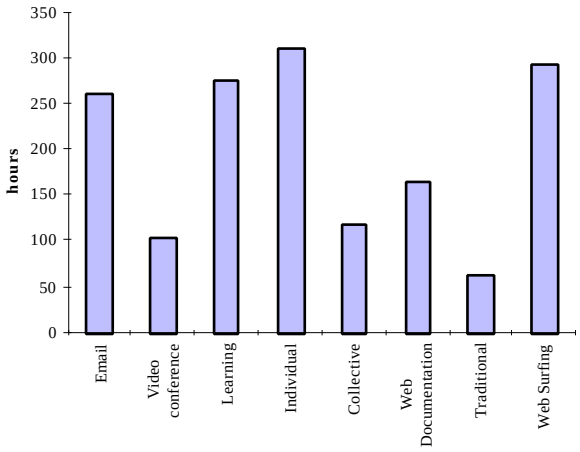

Figure 6. Total time spent per subcategory.

4. Learning to collaborate in a video-conferencing session

At first glance, it seems that collaborating in a videoconferencing session is no more than a telephone conversation. However, experimental studies in computer-mediated collaborative design [2,4] have revealed that knowing videoconferencing techniques is essential for successful design collaboration. On the other hand, even comprehensive guides about videoconferencing [18] discuss mostly technical details. Thus we present some working ideas whose efficiency has been proven by student practice.

The initial videoconferencing sessions demonstrated that students had faced several problems. In each session, due to the asynchronous entrance of the participants, the connections at the beginning were done in an anarchical manner and usually led to a crash of the videoconferencing software. The lack of synchronisation between the different media (audio, video) caused more disorientation for students. The delay with the update of the shared whiteboard was a source of additional distortion and misunderstanding. Without preliminary agreement each of the students tried to put some information on the whiteboard, using arbitrary colors, placing the text and drawings wherever possible. During the next session, students had difficulties with the interpretation of the content of the whiteboard records from the previous session. Taylor and O'Connor [7] report similar observations in using a shared whiteboard, without mentioning a way to override them. Maher *et al*. [4] alert that due to the intensive information exchange via the audio and video channel, a valuable amount of the design semantics is left undocumented.

At this point we introduced a *communication documenting protocol* and a template whiteboard file. In every session each designer had to use only one distinguishable color. This *color key* information is displayed in the header of the first page. The header also contains information about the group, session number, date, time and the student name that correspond to the color key. The first page also accommodates the agenda of the session. The header of every other page includes the color key, and list of topics discussed on that page.

For improving the organisation of the students during the session and to decrease the technical problems due to the lack of management, we decided that in each session one of the participants had to be appointed as a *session manager* (who was acting always with a blue color). The session manager was responsible for keeping up with the agenda, for synchronising the information exchange, keeping everyone on the same page, and checking whether everyone was using the assigned color. Another function of the session manager was to document the session.

The tracking and evaluation of student participation is a difficult issue in teaching and using videoconferencing in distance education. One source of information is the whiteboard file. Following the color key the tutor can estimate the participation of each student in the discussion on the whiteboard. This does not take into account the audio and video exchange. However, due to the low quality of these channels, the whiteboard remained the main "battlefield" of ideas. A typical whiteboard file from a course session contained an average of 4-5 pages. The development of quantitative measures, based on documented sessions, requires the creation of a coding scheme, similar to the one presented in [4]. Currently we are working on the development of a coding scheme for capturing and categorising the information that lives behind the scene during a videoconferencing session.

5. Conclusions

Von Wodtke [9] has expressed his experience and observations of creative thinking in a quite original way —

in the form of syndromes. Following his style we have compiled the results of our qualitative observations of student behavior during videoconferencing sessions and from the evolution of group project pages.

Analysis with futher paralysis: Improving access to information, the Web simplifies the student's effort and decreases the time spent for the initial but the vast amount of information simply cannot be processed. Consequently a Web-mediated design course has to include a separate section about *selectivity in information retrieval*.

Can do everything by myself: Groups where students separate the tasks with respect to their competence, perform much more successfully compared to groups where there was an overlapping of the work.

This idea is my idea. Entering a collaborative session with a particular design proposal, students become very protective of "the idea", even if it is difficult to defend it.

Too many ideas around. Some students were quite fruitful in generating or finding and collecting ideas. The Web should be used to document these ideas which makes it easier to employ them at a later stage of the project development.

Half-cooked ideas: Normally in collaborative sessions the ideas presented by students were half-baked. This was an advantage from a collaborative point of view.

The balance Content/Presentation. Some students put considerable effort into developing ideas or models, but did not put enough effort into communicating them to others. The final result was a misunderstanding with other members of the group.

Captured in a cage. This syndrome can occur during the research stage. This stage was necessary for market analysis and avoiding the "reinvention of the wheel" but it encapsulates the student's mind within an already existing paradigm. Consequently, electronic media valuable, allowing students to work with *erroneous or even unrealistic initial assumptions* and to experiment with possible outcomes for different values of these parameters.

The experience of Web-mediated collaborative design courses shows that students were able to integrate learning how to use technology with learning how to design collaboratively. As students become more familiar with web tools before entering the course, more effort can be given to learning how to effectively use the resources of the internet and to gaining experience in collaboration.

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