Document Management in a Computer-integrated Classroom

Nelson Baloian[1], Alexander Berges[2], Stephan Buschmann[2], Katrin Gaßner[2], Jens Hardings[2], Heinz Ulrich Hoppe[2], Wolfram Luther[2]

[1] Universidad de Chile, Departamento de Ciencias de la Computacion, Blanco Encalada 2120, Santiago, Chile
{NBaloian}@dcc.uchile.cl

[2] University of Duisburg, Institute for Computer Science and Interactive Systems, Lotharstr. 65, 47048 Duisburg, Germany
Alex.Berges@uni-duisburg.de, {buschmann, gassner, hardings, hoppe, luther}@collide.info
www.collide.info

Abstract. This paper reports on a work in-progress scenario of a computer-integrated classroom (CiC) with a focus on document management and document sharing. Following a brief introduction on the topic of distributed (distance) and non-distributed (face-to-face) learning, the system´s functionalities and architecture are being described, as well as the file structure to be found in the document archive. The system uses a unique type of XML document that can be created and edited by the FreeStyler application. The paper then concludes with a short description about the future work on the project.

1 Introduction

Traditionally, most of the research efforts in Computer Supported cooperative Learning (CSCL) areas have been dedicated to develop distance learning scenarios (for a good covering of this issue see [4]), still most learning activities take place in the traditional classroom, i.e. in a face-to-face learning scenario. It is still an open question if future learning will take place in the more de-personalized way of "virtual learning" or continue in the traditional style. Meanwhile, there are still classrooms, and there are people, namely teachers, whose responsibility it is to organize classroom learning. Accepting this reality, we can still ask what could be gained by using new information and communication technologies in classrooms. Motivated by the fact that innovative hardware and software has made its way to the classroom, some systems supporting in classroom learning scenarios have been developed [5, 9]. In this paper we present a system supporting teacher and student sharing learning documents in a computer-integrated classroom (CiC). The original idea of a computer-integrated face-to-face classroom was exemplified in the COSOFT environment [2,3]. Recently, the CiC idea was adapted to "early learning" in a primary school classroom [10] as well as to academic lecturing [7]. We share the

same principles which are behind the development of systems like Classroom2000 [1] and the electronic classroom used by ITM [13] about ubiquitous computing in the classroom [12]. However, Classroom2000 is oriented to capture the lecture and store it in files and the ITM classroom is oriented to remote lecturing. In our project we address the problem of document management (distribution, collection, sharing) inside (and outside) the classroom. It differs from the traditional courseware creation and managing systems in that it combines traditional face-to-face lecturing with computer supported collaborative learning. In a CiC setup the teacher presents the learning material (multimedia documents) on an electronic blackboard. Every student has a notebook or PDA, while the technical system provides the functionalities of interaction among the multiple computers. A wireless LAN connects the student's computer with the electronic blackboard, and there is a server (outside the local network) which provides and stores learning material. A CiC also includes systems which help teacher and students to recover, manage and share learning material.

The CiC combines positive aspects of the classical chalkboard approach, particularly its flexibility in the spontaneous elaboration of ideas, with the potential of modern networked multimedia. The value added lies in the avoidance of discontinuities in representations ("media breaks"). In the CiC approach presented here, re-use and exchange of results, either synchronous or asynchronous, is easily possible. The full spectrum of basic representations, ranging from freehand input to sophisticated simulation and animation is available.
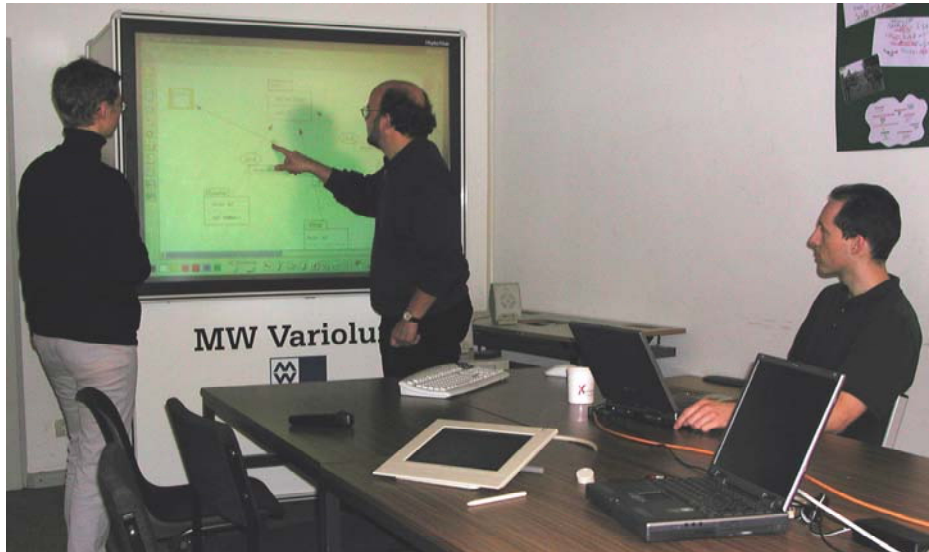

Fig. 1. The computer-integrated classroom scenario.

The work presented in this paper was motivated by concrete experience from a lecture about programming in distributed systems held at Duisburg University. Many problems occurred which could have been avoided by having an administration system for the learning material of the course. The same group is now designing and

developing the CiC system for this particular case. The work reported here focuses on the teacher's work-plan (in a classroom).

Although the CiC is still work in progress, most functionalities have already been implemented. The next chapter will introduce the use cases, that have been extracted as important needs. Chapter 3 will deal with the implementation of the system presenting its architecture, modules, and implementation of some important functionalities. Chapter 4 will briefly present some characteristics of the documents which are administrated by the system and the tool used to present and manipulate them. Chapter 5 will present some conclusions and future work.

2 The System Functionalities

The basic functional requirements for the envisaged CiC scenario can be broken down into the eight items listed below, each corresponding to a typical "use case":

Registration of teachers, courses, and students. In order to facilitate the document handling and management it is necessary to first register teacher, students and courses to the Document Manager. This module also maintains information about what courses are taught by each teacher, and the students that participate in each course.

Login procedures for students and teacher. Teacher and students have to login to start a teaching and learning session. The teacher can establish a classroom session which the students may join. The username and password credentials determine access rights to files and directories within courses' and students' files, inside as well as outside the classroom.

Distributing/collecting documents. During a classroom session the teacher can distribute and collect documents of any type to and from the students. Documents can be located on the Document Manager or in a local directory, either at the teacher's electronic blackboard or on the students' computer.

Sharing documents. By sharing a document we understand many people viewing and modifying the same document at the same time. This can be used when the teacher asks a student to present his/her work to the rest of the class. Discussions can be supported by allowing other students or the teacher to use the document being shown, adding notes and drawings to further explain their idea.

Monitoring the students' work. During a classroom session, a teacher can look at student's work within a document, for example to examine the progress made on an assignment or to verify the correctness of work in progress. A teacher is also able to collect parts of documents from the students, increasing his ability to monitor the work by comparing different approaches.

Questions and answers. A module named "Questions and Answers" allows students and teacher to interact in a chat-like manner. The conversation details can be saved for a later analysis of the written interaction inside the classroom.

Working outside the classroom. Users should have the possibility to create and modify learning material wherever they are. For this reason, we have implemented an interface that enables the user to access and edit the learning material via the internet. However, the tool does not include a synchronous remote learning environment via video or audio conferencing, it solely enables users to continue and edit their work started in the classroom environment.

Logging the actions during a session. We will provide mechanisms for keeping track of relevant information about the actions taken during the lectures by the teacher and the students for a later analysis. Conclusions can then be drawn about how the lecture was organized. For example, it is important to record which documents were opened during a session, how many times they were opened during the whole course, and how many times they were modified. This can provide us with valuable information about which files need to be replaced, complemented, or deleted.

3 The System Architecture

As a result of our practical experience we assumed the system should consist of at least one classroom local area network (Classroom Environment), desirably secured by a firewall which is again connected to a Document Manager (see 3.1). Adding to this we wanted to present the users the ability of asynchronous and distributed work on their documents, i.e. via an internet connection outside the classroom. The component developed for this purpose is situated in the Home Environment.

3.1   The Modules of the System

The System is organized into different components, placed into three environments: classroom environment, server and home environment. The functionalities of the components shown in Figure 2 and their interaction with each other is described below.

Session Control. The first component of the classroom environment is a supervision tool for the teacher: the Session Control. It is to be run by the teacher only, either on the electronic blackboard or on a separate computer. It includes mechanisms for synchronizing the instances of client interfaces in the classroom environment, for giving and taking rights to or from the users, and for logging session information. As the central component for the teacher it also includes file handling functionalities. This enables the teacher to use the Session Control as a stand-alone interface on the blackboard or in combination with the File Handler (run on the blackboard). Not only

can any document from the Document Archive or inside the classroom environment be sent to a selection of students, any document that is currently being worked on by any user can also be displayed on a selection of students' File Handlers.
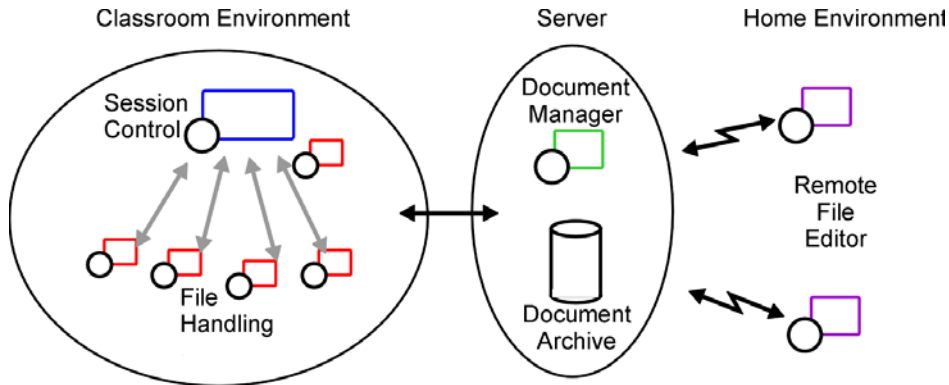

Fig. 2. System structure and environments.

File Handling. It is used in the classroom environment by the students and the teacher to open, edit, create, transfer and display the user's files or course files. Adding to this it allows direct communication with the Session Control Interface via a questions and answers dialogue.

Remote File Editor. The home environment consists only of the Remote File Editor, that enables the users to view, create, edit and transfer their files located on the Document Archive from a remote location. This is implemented by an internet connection and the document editor FreeStyler. It does not include synchronous collaboration with other users.

Document Manager. The Document Manager is part of the server environment and provides authentication to all users in either the classroom or home environment, including the individual's rights inside the whole CiC system. Adding to this it controls all file transfers from and to the Document Archive and keeps track of new and existing sessions and courses.

Document Archive. This repository is the second part of the server environment and stores all documents of the users, courses and sessions, all personal information of the users and all logged information. The Document Archive is controlled by the Document Manager.

3.2 The File Structure at the Document Archive

The Document Archive consists of a hierarchical organization of files containing all the necessary information to administrate the CiC. This includes information about the teachers and their files, the students and their files, the courses and the learning material associated with them, the information about which students are in a certain course, which teacher is responsible for a certain course, as well as the rights for teachers and students to create, modify, and/or read certain files. The next figure shows the directory structure and the information contained.

The root of the repository is divided in three directories: Courses, Teachers and Students, which contain the corresponding home directories. The home directories of Teachers and Students contain personal information, a Logs directory to store the actions history and a Files directory which is the only visible to the clients. The courses have the same structure, but the Files directory has another name as its use is oriented to share documents rather than store personal files. Also, each course may have another directory intended for uploads of e.g. homework prepared by students.
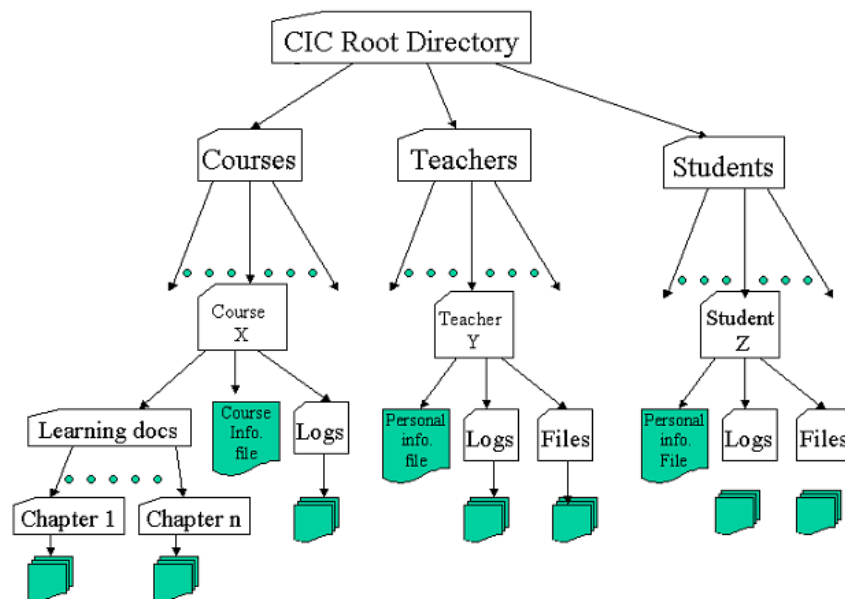

Fig. 3. The file structure at the Document Archive.

3.3 Permissions Management

The access rights are managed on the Document Manager, which assigns some default settings that can be changed later on. By default, each user controls the visible part of the home directory (he/she can perform all the available operations), and can grant or deny "read", "write" and "delete" access rights within this hierarchy.

The enforcement of the rights is done at a lower level, using a custom Java SecurityManager which is automatically invoked before operations like opening files are attempted within the JVM. Using this scheme, it is not necessary to audit every part of the server code, since the code itself is not trusted to perform every action.

3.4   Implementation of Login Procedure

The login procedure consists of several steps, including authentication from the data stored in the Document Archive. To start a new Classroom Environment Session for an existing course, the Session Control sends login parameters to the Document Manager and receives all available course information accessible to the given teacher. When a new session has been created, any File Handler can now access the running session by sending user parameters to the Document Manager, which authenticates the user with information stored on the Document Archive. Only after having received a unique session ID, the File Handler can perform a login to the Session Control (via RMI) and is then signed up to the Classroom Environment.

3.5   Implementation of Document Distribution and Sharing

During a classroom session the teacher can distribute and collect documents or parts of documents to and from the students. Files are first downloaded from the Document Archive (Fig.4, arrow 1) and can then be distributed among the multiple users (Fig.4, arrow 2).

For the sharing of content (i.e. part of a document) in the classroom situation, we use a synchronization server called MatchMaker [11], which allows the sharing of objects. This sharing is accomplished by maintaining a copy of the FreeStyler document model on the server, and sending the modifications to all clients that share the specific object being edited. It is important to note that the model exists in distributed copies on each client, so an application or communication failure does not imply loss of data, since the model will be available from any copy.

3.6   State of Implementation

All Modules have been developed and tested in collaboration with each other. Some functionalities are still missing, though, which will have been implemented and tested by the time the paper is being printed. A restructuring of the whole system, including the specification of standard actions evolving in a learning situation and the implementation of these is to be undertaken at that point. At the same time we will work on the strengthening of the interaction between the FreeStyler document editor and the individual CiC tools, which implies that certain actions or user inputs can be implemented in the FreeStyler directly, rather than repetitively in each CiC tool.
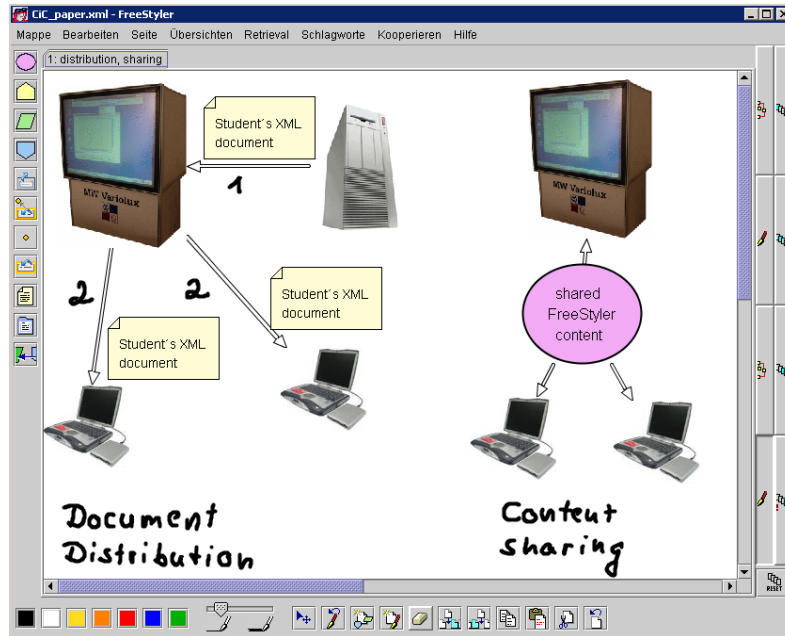
Fig. 4. Distribution and sharing of documents displayed in the FreeStyler model.

4   The Documents

For creating, manipulating and viewing the documents, the primary tool will be the FreeStyler [8]. It can be used during multiple working phases as preparation, creative meetings, presentation, postprocessing or wrapping up information Therefore, is serves also as an interface between face-to-face discussions and the documentation process. This is enabled by a cooperative visual language which offers a set of content objects to structure information. A content object combines a symbolic view with predefined interactions. It can be characterized as a template for a special type of information as ideas, concepts, decisions, addresses or internal and external links. Whereas several content objects rather define the category of information, others, i.e. the links, provide additional structural information and interaction features. Together with these content objects users can add handwritten input flexibly. Methods as concept mapping, mind mapping or MetaPlan are easy to perform with the FreeStyler. The external representations both enrich and influence the communication.

The documents may include a workflow description about how and when they should be distributed to the students, collected, where they should be stored, etc. This allows the system to offer useful default alternatives to the user, minimizing the input required to perform each task and keeping the focus on the session.

FreeStyler files are stored in XML format. Beside the advantages of a standard format in general, XML makes it easy to retrieve information. In order to exchange

the maps an integrated mail functions converts the maps to a picture format and send the content as attachments or the original XML files. FreeStyler-internal filters allow for separating types of information in order to focus on special aspects as decision or ideas.

The system will provide an interface to query the XML documents, both in their current state while being edited and off-line in the repository. This way, the teacher can monitor the work of the students over the document as well as grade the work or analyze the result of past sessions. The structure of the documents will help the teacher to look whether certain part of a assignment has been finished by all students, or if some keywords appear in the answers.

5   Conclusions and Future Work

We intend to use and evaluate the system in various scenarios, one of which will be a sample classroom setup in AccessNova at the University of Chile, another will be a comparison of lecturing using this system to the traditional way of teaching at the University of Duisburg. The evaluation of the results will be on the level of system usability (with surveys for teachers and students) and effectiveness (with tests about the issues being learnt/taught for the students and comparing them with results of the same test taken on a control group).

The CiC architecture and functionality share certain features with currently available "course management tools" such as Blackboard CourseInfo, WebCT, Luvit or TopClass (for a comparison, cf. Hazari, [6]). The specific issues addressed in our work are:
- The services provided have been designed with a primary focus on in-classroom work as opposed to remote scenarios.
- The application focus is more on the intra-course perspective with a smaller granularity (although multiple groups and courses are supported), not so much on the administration of courses in a bigger institution.
- The system is deeply integrated with the document data model used and comprises a XML-based query interface for teacher supervision as well as for intelligent support and analysis.
- The components in our modular architecture can also be used in other contexts or as special purpose services.

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