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COMPUTER ASSISTED LEARNING FOR BASES OF ELECTRONICS. FROM LAN TO HYPERMEDIA IMPLEMENTATION

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Abstract- This paper presents the implementation of a Computer Assisted Learning system, from Local Area Networks to Hypermedia environment. The user Professor is endowed with authoring support for tutorials and multiple-choice tests, with knowledge data-bases managing facilities and with access to complete records of students results. The user Student can attend a tutorial or take a test on a self-initiative base or during a session managed interactively by the Professor. The LAN system, implemented in C++ language, creates a cost effective teaching/learning environment. The rapid evolution of communication technologies and the advanced data networks enables the integration of multimedia information processing in the education process. Implementations at the Technical University of Cluj-Napoca for a LAN and Web-based learning/testing environments for Bases of Electronics are described.

I. Introduction

The main aspects of a learning and evaluation system based on a computer network are [1], [2]:

- the actual network, including its hardware and software characteristics;
- the authoring facilities - that allow the non-programming professors to develop teaching material;
- the learning environment provided for the student.

The LAN networks usually are small size low cost/performance networks, connected through Novel and/or Windows NT. Many out-of-date networks can be still useful for training purposes, but require careful and optimised programming. Our own developed software MeDIAC [2] accomplishes these requirements; it is written in C++ and includes some low-level procedures.

Hypermedia is a way of organising multimedia information by linking media elements, called nodes. The entire assemblage is a hypermedia Web. The learning environment consists of learning materials as hypertext, videoconferencing, Web Agents, and collaboration tools for working in-groups (share documents or chat sessions). It is

important to give equal opportunities to access educational material, no matter where are you living, and the Web offers this opportunity. Distance learning is independent from time and place, so learners can study when they have time for it. Of course, a good infrastructure of telecommunications is needed.

The WWW (World Wide Web) is now the most widely used hypermedia platform. It is based on client-server architecture being simple to use and well documented (*http://www.w3.org*). The learning environment is implemented as a WWW-server, a collection of tools in that server computer, and Client computers running browsers. In addition to classical Web servers, several new techniques were used to allow hypermedia education.

The authoring facilities allow the user **Professor** to develop various teaching materials using integrated and/or external editors. Courseware, tutorials and tests can be edited. In both implementations - LAN or Hypermedia – there exists a good support provided for the post-processing of the tests results: the **Professor** can trace the time evolution of an individual student/group or year of study and some basic statistical factors can be determined. For further analysis an interface with specialized software may be used.

The user **Student** can choose between running a tutorial or taking a test; besides, the interactive system implements a method of progressively testing the students' knowledge within a "learning" session and in a "testing" session it may make reference to the course material. The usual HELP and navigation facilities are also provided. The network connection allows the **Professor** to organize the learning environment and supports bi-directional communication between **Professor** and **Student** during the training sessions.

II. The LAN Implementation

The LAN implementation consists of two basic subsystems: the authoring subsystem and the training subsystem, corresponding to its two main types of users: the **Professor** and the **Student**.

The authoring subsystem comprises four integrated editors and their data-bases - a general-purpose drawing editor; a multiple-choice questions editor, a test editor and a tutorial/courseware editor - a communications manager - necessary for this network-based system - a system manager - which deals with the access rights/passwords assignment - data-bases inspection module and a statistical analysis module which includes records of the students test results. Figure 1 presents the main facilities supplied by this subsystem.

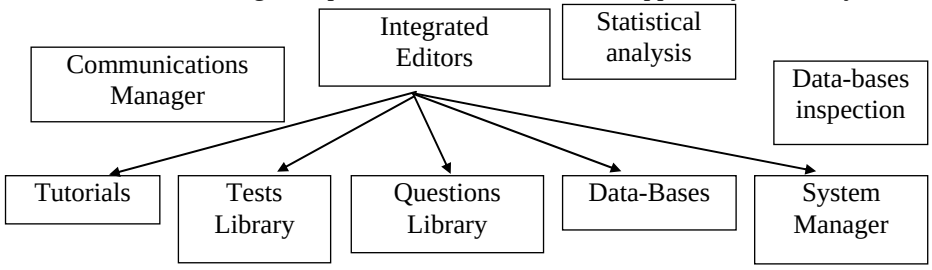


Figure 1. Authoring utilities in the LAN implementation

The integrated drawing editor is optimized in terms of quality-per-speed ratio but external editors can be used, as well: the system accepts the usual .BMP and .TIFF formats.

A special attention has been paid to the electronic schemes specialized editors as ORCAD; most of these editors use the .DXF vector format, which is entirely accepted by MeDIAC.

A figure can be included into a tutorial or question file - in a so called Extended Save Format - or can be stored in a separate library, in which case the tutorial/question file contains only the location and zooming information relating to the picture. The former case implies serious space penalties, the latter has access speed drawbacks.

The question editor is designed for a multiple-choice format with enhanced didactic features: it allows the **Professor** to add HELP/References to a course paragraph and messages for the proposed answers; to set up different marks for each possible choice and to assign difficulty degree to a question. Time constraints can be activated during the tests editing.

The **Professor** has access to the records of students tests results and can analyse them both as a time evolution and from a statistical view-point. Some of these possibilities are: the time evolution of a year of studies/a group/a particular student; mark classifications; the average marks and the variances; the correlation between the automatic tests results and the classical evaluation methods ones.

The **Student** can choose the subjects/type of training session (if not set up by the professor) and the language. He/she is given with general information about the tutorials and tests in libraries (topic, duration, number of questions, difficulty degree, time constraints, previous results); during a session some information are also available, as number of answered questions, remaining time, etc.

The network connection allows specific interactive facilities: the **Student** can send messages to the Professor regarding any problem arisen in a training session (ambiguous questions, more information on a subject, etc.). If the **Professor** is available, a talk-like session can commence; if not, the message is saved for further answering. Also, the **Professor** has the possibility to send unidirectional messages (supplementary questions or helpful hints) both as text and as images. These messages can be sent to all the students or only to a particular one.

The system is implemented using C++, with some of the critical routines written in assembly language. Object oriented programming techniques have been used.

III. The Hypermedia Implementation

The authoring subsystem is built on the base of the BSCW (Basic Support for Co-operative Work) extension of the standard Web server. BSCW represents a shared workspace system, which supports mainly group management (*http://bscw.gmd.de/*). It was used for delivering and sharing information and educational material. Besides the fact that it appeared to be difficult to gain accurate insight in the state of the lessons by using BSCW only, the essence of tutoring itself remains mostly a private matter between the tutor and the learners. When strictly used for sharing information among the users BSCW turned out to be very useful. The reason being mostly because it is well integrated with E-mail and other information sources and can be learned fast and it is easy to use.

For communication purposes, chat-like services are available (EWGIE or CGI-Chat). EWGIE (Easy Web Group Interaction Enabler) is a simple collaboration service, very much like IRC (Internet Relay Chat) written in Java (*http://www.eit.com/ewgie/*). With EWGIE learners can follow the teacher in cyberspace without typing site addresses themselves. By clicking an icon corresponding to the teacher on their interface, the learners

start to follow the teacher. The only thing the teacher has to do is to type site addresses on their interface.

The Web Server used is *http://www.bel.utcluj.ro/* [3]. To allow an easy access to the databases, all the services were implemented at the server end. Efforts have focused on the development of interactive lessons and exercises for fundamental topics in electronics. The majority of lessons and questions were written using JavaScript, for not blocking the server activity if too many users are accessing the pages at the same time.

We have used in our learning environment the fact that the server can record user actions in log files. Based on the statistics realised using this information, individual teaching by considering previous actions can be done. By performing analysis of the marks and attempts of the files, we have used these results for evaluating and improving computer aided learning and testing applications.

IV. Conclusions

Both computer-aided knowledge systems were applied at the Technical University of Cluj-Napoca. Passing the test (mark ≥ 5) was a condition for the exam.

The developed multiple-choice questions-based system is both simple and effective. The proposed tests cannot evaluate all the abilities and taxonomic levels; they cover only a part of a complete and thorough valuation. They could be a complementary tool to classical valuation, very helpful for teacher, letting him free of some routine loads. Their main advantages rely on the self-evaluation capabilities, without a classical equivalent: the students' study time is better used and the scoring mechanism allows them to follow their evolution and to compete with their colleagues.

As it can run on low performance platforms, the LAN implementation supplies a cost-effective solution for training systems. The integration of the learning environment in Internet Network has led to a great interactivity and effectiveness. The Hypermedia implementation is more easy to be developed and more spectacular. Working with the well-known browsers – Netscape or Internet Explorer – it is more pleasant and easy for both **Professor** and **Student**.

The result of using the systems for education shows that the students enjoyed this way of learning/testing and they consider it useful in improving their skills. The systems structures are flexible, easy to adapt to other disciplines.

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