

A COLLABORATIVE LEARNING SYSTEM BASED ON A SHARED INTERACTIVE LABORATORY NOTEBOOK

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Abstract *¾ This paper deals with ways of further developing and using innovative tools for teaching purposes in the field of science and engineering. Recent breakthroughs in communication and information technology, along with strides made in scientific education, have yielded new training approaches. In this paper, we present the utilization of HiQ, a computing and visualization tool from National Instruments, as a remote collaborative learning tool based on the concept of a shared interactive laboratory notebook. Within the networked environment, geographically scattered participants can access distributed resources and carry out laboratory experiments or prelab presentations interactively. One or more servers manage the real or simulated data. We will also discuss the pedagogical aspects involved as well as the system validation process.*

Index Terms *¾ collaborative learning system, information technology, interactive laboratory notebook, and virtual environment.*

environments, the research centre of Télé-Université that has been working for many years on putting together a virtual campus and on developing resources for facilitating remote learning. Our efforts in this area have been directed towards proposing a model of a collaborative learning system, assisted by technology.

More precisely, the objective of this article is to show how we can use the HiQ environment, a National Instruments application (<http://www.ni.com/>), to produce a collaborative remote learning environment, based on the concept of an interactive laboratory notebook. With the interactive laboratory notebook, the various participants can access distributed resources via the network and carry out collaborative laboratory experiments that bring together professors, tutors and learners.

This text is divided into five parts: an explanation of the concept of an interactive laboratory notebook; a presentation of the MISA method, which was used for the implementation of this interface; an overview of the system environment; presentation of a scenario using the interface, and a conclusion describing the prospects for such research.

INTRODUCTION

The recent breakthroughs in communications and information technology, along with strides made in scientific education, have yielded new training approaches. First, multimedia capability was included in learning systems for computer-based applications to facilitate better learning. Now, we wish to use certain telecommunications services for more effective transmission of knowledge. This led to a re-examination of learning tools and more in-depth thinking about knowledge, and especially how knowledge is transmitted. With the significant progress that has been made in technology, it becomes possible to combine technology and computer sciences to promote new tools, techniques and methodologies for modelling and distributing unconventional content in order to produce applications for collaborative learning. This paper presents an effort to integrate technology into these applications with the support of computer sciences. The tests of this study were conducted as part of the remote laboratories project of the LICEF laboratory of cognitive computer sciences and training

THE CONCEPT OF AN INTERACTIVE LABORATORY NOTEBOOK

Before describing the features of the system, it behoves us to explain what we mean by the concepts of a virtual laboratory and an interactive laboratory notebook. With the Internet revolution, remote learning has made great strides in the last decade. Thus, many of the models developed elsewhere, based on the concept of a virtual campus, presented the fundamental attributes of a virtual environment in the sense of a computerized and distributed environment offering a coherent and integrated grouping of pedagogical and communicational functionality intended for synchronous or asynchronous remote learning activities.

However, very few have stressed the concept of a laboratory, much less that of an interactive laboratory notebook. But the possibility of carrying out practical experiments is the very basis of engineering studies. The virtual laboratory is therefore an important element for the

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promotion of remote training in the engineering field. It should be seen as "a learning environment based on New Communications and Information Technology, whereby learners and professors can interact with either simulators or actual equipment, with no regard for constraints of time or geography [1].

The laboratory notebook is an extension of this research. By interactive laboratory notebook, we mean a tool that would make it possible to exchange and process information to improve understanding of a problem. It is a tool for collaboration in the sense that it facilitates a common decision-making process involving the key people and groups concerned with a given problem in a specific field. It is also an interactive process with a shared, transmutative objective [2]. In effect, partners with different points of view regarding a problem can explore their differences in a constructive way, seeking solutions that go beyond their own limited vision of what is possible. In other words, the notebook will facilitates teamwork built on a mutually beneficial relationship amongst several learners or between learners, the professor and the laboratory manager. From this perspective, the interactive lab notebook supports the work of geographically isolated individuals, who are thus able to gather in the framework of a virtual campus to learn together, and especially to learn from one another [3].

THE LEARNING SYSTEMS ENGINEERING METHOD (MISA)

In a virtual environment, it is essential to make the tools needed by the various participants accessible by means of a coherent interface that favours learning. To accomplish this, it is necessary to adhere to certain standards. In our work, we took the MISA learning systems engineering method as our starting point. This method was the brainchild of our colleagues at the LICEF laboratory of cognitive computer sciences [4]. In compliance with this method, our work was based on four models: a knowledge model representing abilities and skills, a pedagogical model, a media model and a distribution model.

- a. The knowledge model is a way of graphically illustrating the relationship between skills, knowledge, abilities and learning needs, making it possible to address cognitive, emotional, social and psychomotor domains in integrated fashion. The relationship between things known is highlighted by means of directional links identified by letters: *C* is a composite link, indicating that the composition of the thing known includes another thing known. The link *I/P* signifies input or product, according to the direction of the arrow. A procedure often has an input concept and a product.

In addition, it can be governed by a principle (represented by an *R* link), which establishes the conditions. The link *S* is used to indicate that a thing known has the same characteristics as the thing known with which it is associated.

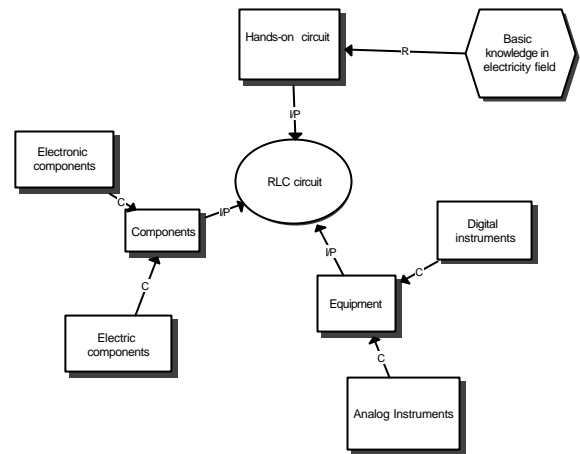


FIGURE 1. KNOWLEDGE MODEL

- b. Next, we looked at learning units. In effect, we worked out a learning scenario that allowed us to define the role of the various participants in a remote collaborative project.

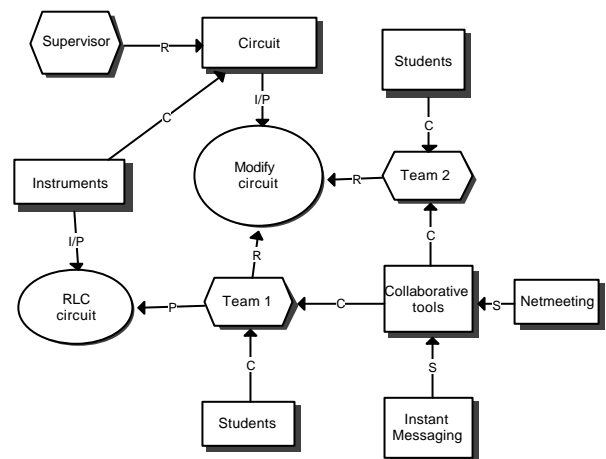


FIGURE 2. PEDAGOGICAL MODEL

- c. During the third stage, we established our media model by means of which we were able to produce a macro-design of the system.
- d. In the last stage, we prepared distribution model, which clearly addresses, based on media considerations, the matters of access to the learning system, the

infrastructures needed for distribution and the tasks of managing the training.

SYSTEM OVERVIEW

The interface that we propose is developed using HiQ, an application of National Instruments. The idea of using HiQ to develop a learning environment is a way of seeing how the technology incorporated in a pedagogical approach can help to produce new results from an online learning perspective. The HiQ notebook combines the capabilities of interactive analysis, data visualization and report generation in an integrated environment. It offers all the traditional features usually associated with a real notebook, such as pages, dividers and tabs. As a container of ActiveX controls, HiQ provides the possibility of integrating other ActiveX controls directly in the notebook. To make these controls accessible, scripts were programmed. By using the extendibility capabilities of ActiveX controls, we were able to associate a chat utility with the notebook to favour communication in real time and provide learners with a means for sharing their thoughts during a lab session. The environment is important insofar as it is the place where knowledge is constructed on the basis of exploration, initiative and freedom of choice [3].

To generate signals, access peripherals and share data, we used a system built with the application Measurement and Automation eXplorer (MAX), made by National Instruments; the DataSocket communication protocol, and equipment such as a data acquisition board (PCI-MIO-16E-4) and an arbitrary function generator (NI-5401 for PXI). Distribution is via Internet [5] [6].

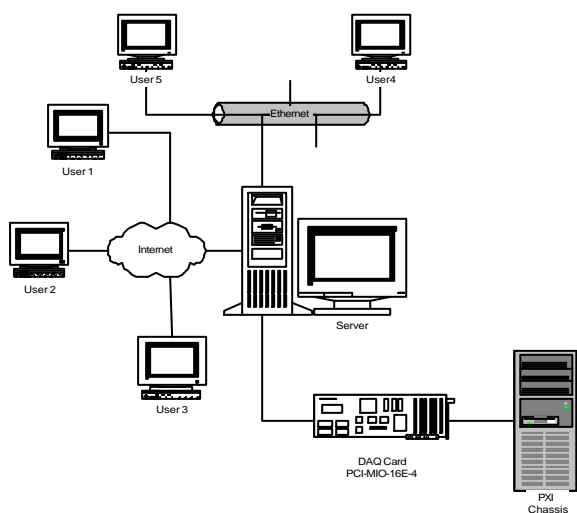


FIGURE 3. SYSTEM OVERVIEW

COLLABORATIVE LAB WORK

Within the framework of collaborative lab work using the interface, our experiments involved three types of participants: professors or trainers; tutors or managers, and learners. The trainers prepare the theoretical content necessary to carry out the lab work correctly. The tutors or managers have, above all, a supervisory role. The success of the lab sessions depends in large part on their expertise. They intervene in all aspects of the experimentation process, from preparation of sessions through drawing up reports and supervision of activities. They define the user groups, their privileges and the objects that can be shared during a session. As for learners, they access the graphical interfaces, work with the application, carry out necessary exchanges and contribute to writing the lab-work reports. All of this is accomplished via two interfaces: a client interface that learners can download and a server interface, which remains on the site. Partners connected via the same local area network or accessing the data server via Internet can come together to conduct collaborative lab work from different remote sites [2].

To test the interface, we came up with the idea of a laboratory on resonant circuits, requiring collaboration amongst learners. Each learner has the HiQ Reader, which can be obtained, free of charge, from the National Instruments Website. Learners decide who will take on which role, and control can change hands according to needs.

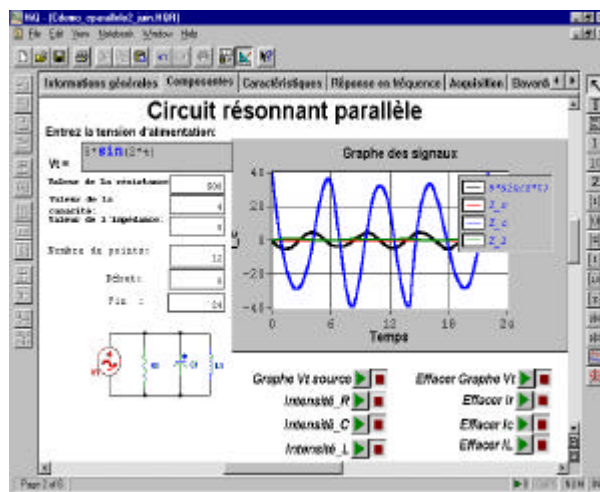


FIGURE 4. USER INTERFACE

The modifications made by a learner are shown on the screens of the other clients by means of the DataSocket Transfer Protocol (dstp). On behalf of the data server, the

DataSocket server handles reception of data to be transmitted to the clients [7].

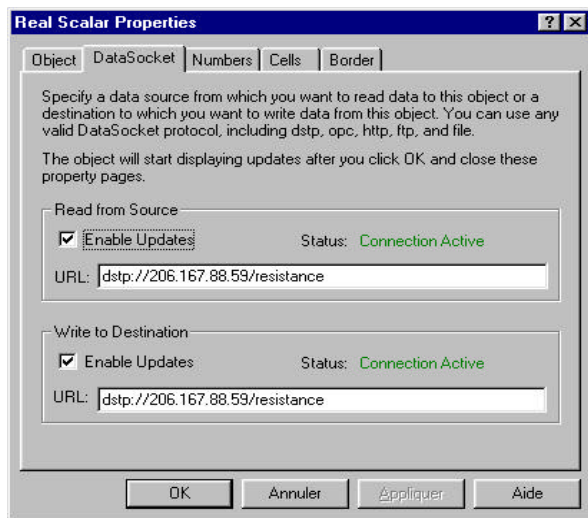


FIGURE 4.
USING THE DATA SOCKET TRANSFER PROTOCOL

Remote collaborative learning is often considered difficult because it involves building on different perspectives in an electronic world in which the personality of the other must be apprehended using appropriate electronic tools. For this reason, we introduced a chat tool to allow learners to maintain constant communication. All observations can be compiled directly in a word processor for purposes of analysis or evaluation

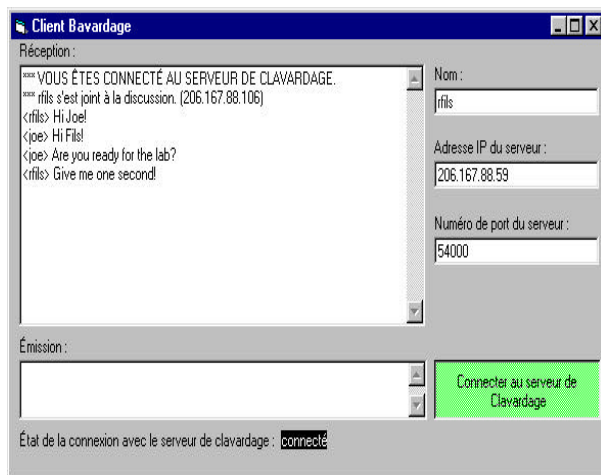


FIGURE 5.
INSTANT MESSAGING TOOL

More complex scenarios, requiring other forms of processing, can be set up by using the combined functionality of Labview, ComponentWork and HiQ [8].

CONCLUSION

The need to work on real facilities is a particularity and foundation of engineering studies [9]. However, in developing countries, there are many barriers to this. In the emerging context of information technologies (IT), it is thus important to reflect on how technologies might contribute to learning systems and, in particular, laboratories. The virtual laboratory could prove to be an interesting alternative for remote training, insofar as it offers learners immediate or delayed access to various learning resources, such as new content and costly hardware, then goes beyond simulations by letting them interact with real or virtual instruments. What is more, the use of existing applications is a cost-effective way of doing this. Using ActiveX controls, we are able to bring to HiQ the complementary functionality necessary to implement an interactive and user-friendly learning environment. ActiveX technology made it possible to make an infinitely extendible instrument from a dedicated product by providing the possibility of adding as many external components as needed to meet the new training needs of cognitive society.

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