VLE: A Remote Education Paradigm with Temporal and Spatial Flexibility

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Abstract

This paper discusses a virtual learning environment (VLE) for teaching engineering courses. The courses are offered using the World Wide Web on the Internet as the delivery medium. The virtual learning environment is an integrated system of tools that will help the administration, students and professors in offering courses using the Internet. We have developed (VLE), where a student can apply for admission, register and take courses on the Internet. VLE provides a flexible and interactive learning environment for students, as well as people with special needs such as disabled persons, full-time employees and people living in remote places with Internet access. The Admission and Course Registration modules developed in this paper can be used in any education system to provide online admission and course registration facilities to the students. Students can also monitor their admission process online, using the Admission Status Monitoring module of the VLE system. The implementation of VLE is a n-tier client/server system with worldwide web as a front-end and the MSQl (mini SQL) relational database package as the back-end, which manages the VLE database. The middleware used to interface the worldwide web with MSQl database is the w3-mlsql scripting language.

I. INTRODUCTION

A. Statement of Need

The mode of instruction has changed from the century old one-to-one instruction to the present day typical classroom one-to-many instruction. The evolution of new computers, telecommunications, and multimedia technologies has provided the infrastructure to explore new methods for delivering quality higher education [1,2,5]. There are several factors that behoove us to develop a new instructional mode by using the current communication and multimedia technology.

Due to rapid changes in technology, companies are laying off people with experience in old technology. Most companies today are under pressure to cut costs to be competitive. This cost-cutting process has resulted in the loss of a large number of jobs in past decade. Sweeping changes in the economic system need a very flexible and cost-effective infrastructure to retrain and re-educate a large population segment so that the workers can acquire new skills. In the present learning environment, the interaction between students and instructors is constrained by time and location. The traditional learning environment is not very suitable for people who are employed full time and want to further improve their professional status.

Furthermore, more and more universities are under budgetary pressure. In almost all states, the state funding for higher education is under critical review. This budgetary pressure on our universities will most likely continue into the Twenty-First Century. Engineering educators must explore various options to provide cost effective education while maintaining a high quality learning environment to serve the nation’s engineering manpower needs.

In this paper, we have developed a new and flexible instructional mode called the virtual learning environment (VLE) that uses current computer and communication technologies, namely the Internet and World Wide Web, for delivering instruction to a widespread student population [6].

B. The Existing Instruction Modes

The development of the information superhighway and multimedia system extend the digital interactive capabilities to homes, offices, and schools. In order to achieve full use of these capabilities, universities and educators must formulate new educational paradigms to reach a wider audience at a lower cost, higher flexibility and better quality. The existing teaching environments are discussed below.

The traditional classroom environment is one in which the teacher and student meet at the same place (in a classroom) and at the same time (according to a schedule). Here, the instructor can use any presentation style, such as on a blackboard or with an overhead projector, to teach the students. One of the limitations of this approach is that students must adjust to the time and location requirements of the course.

The distance learning method in which the course is offered at one location and the students could take the course at geographically different places is also very
popular. This method is achieved by using video, fax, phone, and data interaction between the students and teacher. For example, North Carolina’s VISTA net was developed for providing a means to transmit courses offered at the University of North Carolina, North Carolina State University, and other universities to all the areas of North Carolina [11]. One of the restrictions of this approach is that the student must meet the time requirement for the class. Moreover, the students will have to go to a particular location to take such a class due to the elaborate requirements of the audio visual equipment.

Another approach is based on interactive CD-ROM technology for computer aided instruction (CAI). In this approach, the students come to the classroom for studying but interact with the instructor at different times by using e-mail, phone, or direct contact. In this paradigm, the main issue is to build the software such that it provides an active learning environment for the student. The teaching software usually includes materials based on hypertext, multimedia, and an interactive problem solving environment. Some of the limitations of this approach are as follows: 1) any modifications in the course are difficult and expensive to implement because for new course material a new set of CD-ROMs must be created and distributed and 2) there will be a long lead time needed to implement changes in the course.

We reviewed many sites over the Internet for existing educational material. Almost all the existing sites have their material in the form of classes notes and their goal is provide information to the user as reference material. They are not intended to be an alternate or substitute to the traditional learning environment. They are also very limited in their capability of audio and video presentations and do not provide administrative, as well as technical, tools for building a course in their environment.

II. THE VIRTUAL LEARNING ENVIRONMENT (VLE)

A. The VLE Delivery Medium

In this project, the Internet will be used as the delivery medium for the virtual learning environment functions. The popularity of the Internet is growing at a very fast rate and it is estimated that there are millions of computers connected to the Internet [3]. Based on current projections, most households in the U.S. will be using the Internet for one purpose or another by the end of the next decade. This popularity is due to the user friendly access to the Internet as well as the availability of useful information such as free software, library access and weather forecasts.

The VLE software system will use the World Wide Web (WWW) as the delivery medium. There will be software tools and support for the administration, students and professors. The VLE developed in this research will be accessible from any computer that can access the Internet. In the VLE, students can learn the course contents (lectures and study material) at their own convenience. The VLE provides complete spatial (location) and temporal (time) flexibility for students to take a course.

B. The VLE Shells

The VLE is a complete university environment where the students can apply for admission over the Internet. After getting the admission, they can enroll in the class offered by the VLE. The students can access class materials and interact with the professor. There are also VLE tools and support for the administration and professor. The software system that provides tools and support are called shells. There are three shells in the VLE:

- Administration Shell (ADSHELL)
- Student Shell (STSHELL)
- Professor Shell (PRSHELL)

The ADSHELL of the VLE implements all the functions of administration in a university environment. The ADSHELL is responsible for student admission, course registration, grade management, administrative report generation and all the other administrative functions. It has the following modules:

- ADSHELL Admission Module
- ADSHELL Course Registration Module
- ADSHELL Control Module

The STSHELL of the VLE implements all the functions for a student to take the course over the VLE. This shell allows students to access the course contents which are in text, audio and video form. The VLE allows students to view lectures and access the study material for every topic of the course. In the VLE, the assignments will be given at a specified time for a specific duration. The students will also take tests at specified times and answers to the questions will be transmitted to the professor automatically. This component of the VLE will also have an e-mail facility, chat facility and a multimedia teleconferencing system for the student-teacher and student-student interaction. It has the following modules:

- STSHELL Courseware Module
- STSHELL Assignment and Testing Module
- STSHELL Communications Module
- STSHELL Feedback Module
- STSHELL Multimedia Conferencing Module

The PRSHELL of the VLE contains all the tools and instructions for a professor to develop the material for a course to be offered through the VLE. It also includes all the day-to-day procedures that a professor has to follow once the course is ready for delivery to the students. It has the following modules:

- PRSHELL Course Preparation Module
- PRSHELL Daily Activity Module
- PRSHELL Assignment Posting and Grading Module

III. DESIGN OF THE ADMINISTRATION SHELL (ADSHELL)

The design of the Administration Shell (ADSHELL) includes all the functions of administration in a university environment. It has the following modules:

- ADSHELL Admission Module
- ADSHELL Course Registration Module
- ADSHELL Control Module

All three modules have been completed and tested.

A. ADSHELL Admission Module

The ADSHELL Admission Module includes an interactive application form on which a student provides all the relevant information for admission to the VLE program. The ADSHELL Admission Module mimics the actual admission process at any university. It has the following submodules: 1) VLE Application Form Interface and 2) VLE Admission Status Monitoring Module.

The VLE Application Form Interface was built by using the HTML forms as the front end, a w3-nsql as the cgi-bin middleware and a nsq database as the back end. The form takes the data from the students and stores it in the data base after performing some validation checks. The VLE Admission Status Monitoring Module is useful to both students and the admission office staff. They can communicate through the front end provided by this submodule and get their questions resolved quickly. This method will reduce not only the paper work but also the processing time significantly. The sample application form is shown in Figure 1.

B. ADSHELL Course Registration Module

Once the students are admitted to the program, they can register for the VLE courses through the ADSHELL Course Registration Module. This course registration module allows a student to add or drop a course or check the status of the current registration.

C. ADSHELL Control Module

The ADSHELL Control Module is a very extensive module that oversees the functioning and operations of the entire VLE system. It allows the Admission Module to initialize the system, review applications, ask the applicant to submit the missing material and generate various administrative reports. The complete details of this module are given in [6,7]. This module is organized into four submodules as follows:

- System Related Administration
- Admission Related Administration
- Admission Status Related Administration
- Course Registration Related Administration

IV. DESIGN OF THE STUDENT SHELL (STSHELL)

The design of the Student Shell (STSHELL) includes all the functions for a student to take the course over the VLE. The STSHELL has the following modules:

- STSHELL Courseware Module
- STSHELL Assignment and Testing Module
- STSHELL Communications Module
- STSHELL Multimedia Conferencing Module

The first two modules have been completed and partially...
The existing educational software largely mimics the traditional teaching style. Moreover, most educational software programs have a "page-turning architecture" [9]. Programs with this type of architecture typically present users with a screen of text and allow them to "press a button for the next page." This type of learning is very passive for the student and is not very effective.

Most existing multimedia educational software fail to provide a good learning medium because they simply add video and graphics to the page-turning architecture. Creating educational and effective multimedia courseware involves taking seriously the idea of learning by performing. Good educational software is active, not passive. This type of software provides the users with various options to do things and not just simply watch. Multimedia systems should be designed for compatibility with people's powerful natural learning mechanisms. When people learn in the real world, they adopt goals, generate questions and finally (in most cases) find answers.

In this project, the VLE courseware will have two components: 1) lectures and 2) studyware. The lectures will include the actual discussion by the teacher, and the students will be able to view them on their monitor. In order to view a lecture at the student's own pace, there will be some basic features provided to pause the lecture, do limited rewind, and do limited fast forward. This capability will give students the flexibility for understanding the material according to their needs [10].

The VLE studyware will have the following features:

- It will provide a framework for learning by experiment and will focus on performing the task that requires the skills and knowledge needed to be taught.

- It will provide an application first, then instruction, because it has been shown that students respond best to instruction if they can relate the subject matter to problems with which they are struggling. Moreover, this method will teach students to associate the correct solution with a problem they may encounter in the future.

- It will provide learning by illustration because most students react positively to compelling illustrations. The multimedia courseware will have interesting and informative cases that relate to the students' problems.

- It will provide multiple learning paths because most students want to control the educational process. The recommended learning sequence will be marked, but students would be allowed to determine the next step.

- It will have advisory features. If in cases when students do not know what questions to ask, they should be helped by the software to navigate through an informational base to easily discover its contents.

There will be extensive study material associated with each lecture. This material will provide more detailed information about the lectures. Thus, the students can directly learn from this courseware. A brief comparison of the VLE studyware with a standard textbook is given in Table 1.

Table 1. Comparison of Textbook with VLE Studyware

<table>
<thead>
<tr>
<th>Features</th>
<th>Standard Textbook</th>
<th>VLE Studyware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic learning material</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Sample solved problems</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Exercise for practice</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Animated explanation</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Help (on demand)</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Access to references</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Student feedback mechanism</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Hyperlinks</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Ease of revision</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

B. STSHELL Assignment and Testing Module

The duration of a VLE course will be one semester as in traditional teaching but the students will have the flexibility to assimilate the material at their own pace as long as they can cover the material needed for taking the quizzes and tests. In the VLE, students will be given quizzes and tests at a fixed time on a particular day. The complete quiz and test schedule will be made available at the beginning of the semester. All the students will have to take the test during that specified period. Moreover, the assignments will be posted with the course one week (or as needed) before the due date so that students can complete
the assignments and can submit them electronically, by mail or in person to the instructor on or before the due date.

C. STSHELL Communications Module

In a virtual learning environment, the students and teacher do not necessarily have to be at the same location at the same time. They can communicate remotely by using computer communication technology and also can meet in person. Thus, the VLE provides the flexibility of personal communication as well as remote communication with the instructor. The following basic schemes are used to provide remote student/teacher interaction: 1) VLE E-Mail and 2) VLE Chat.

VLE E-Mail is a simple e-mail tool but customized for the VLE so that student and professor can communicate with each other with a click of a button. The VLE E-Mail provides one-to-one communication. VLE Chat provides one-to-many and many-to-many communication for group discussion. This method is limited to interaction by text. It is a customized Internet Chat.

D. STSHELL Multimedia Conferencing Module

We are in the process of planning to built an extensive Multipoint Multimedia Conferencing (MMC) system developed by us in an earlier research [4,8]. The MMC system will allow users to have a many-to-many communication facility with the capability of transmitting text, video, voice and graphics. In this environment, users can create two type of conferences, 1) restricted in which only an invited party can participate in the discussion and 2) open in which any one can join the conference during the discussion.

The MMC system does not require extensive audio-visual equipment for its operation. This MMC system only requires a user to have a personal computer (PC) with an audio and video card and a desktop camera. The multimedia data are transmitted over the Internet between the users, so there is no need for a special type of network. Moreover, the VLE MMC system is based on the concept of distributed control for MMC management which allows it to operate even if some servers in the MMC environment fail.

VI. CONTRIBUTIONS AND BENEFITS OF THE VLE

The proposed VLE will provide a basic framework for offering a wide range of courses to large audiences over the Internet. This would be the first step toward offering various degrees over Internet. The proposed virtual learning environment will not only be useful to the students, but industry, universities and educators will also benefit from this project. A summary of the benefits is listed below.

A. Benefits to Students

1. It will provide an active learning environment for the students because they participate in every step of the learning process.

2. Students can learn at their own pace.

3. More emphasis will be given to clearly illustrate where a particular concept can be used in real-world problem solving. The students will be shown various examples to clearly identify the application domain. This feature will help the students understand the reasons for studying this course.

4. It will provide an advising environment when a student makes a mistake. Thus, students will not hesitate to try new and unusual lines of reasoning.

5. Students can take these courses from any remote geographical location as long as they have access to the Internet.

6. Students with disabilities, special needs and restrictions can also actively participate in the learning process.

B. Benefits to Engineering Educators, Universities and Industry

1. The research investigates innovative approaches to improving the learning process. Development of new material and methods for delivering this material will facilitate rapid and widespread transfer of knowledge. This benefit will be reflected in better comprehension of course materials and the opportunity to teach more students with the same teaching resources.

2. It will be very easy to modify the courses implemented on the WWW with minimal additional cost. Moreover, the revised course will be immediately available to the students.

3. The VLE courseware will provide universities with a basis for offering a large number of advanced courses that may not be possible now due to a limited number of faculty members with the appropriate expertise.

4. A virtual learning environment provides an effective means for full-time employees at various companies to enroll in various degree programs as well as special courses. They do not have to go to a
university to attend classes after work but can participate from their office or home.

5. Universities will benefit from higher enrollment because of the active participation of full-time employees from companies in a large region.

C. Cost Effectiveness

The cost factors in developing and delivering the VLE courses are as follows: 1) communication network, 2) hardware and software, 3) student cost for Internet access, and 4) personnel for development. Because the proposed research will be using the Internet as the main communication medium for delivery of the VLE courses, there will not be any major cost for developing a high performance network to offer these courses. The hardware and software for PCs are inexpensive. Internet web browsers and many plug-ins and add-ons are free of charge. The major cost in offering these courses will be in terms of developing them for the first time. This cost will involve the development of text, image, video and voice capture from various sources. The investment in equipment will pay off quickly as more and more VLE courses are developed.

The most expensive part of the course development is the skilled person needed to put all the components of courses together. However, as more and more courses are developed, this expertise will be readily available and at lower rate. The cost of the hardware and software will go down as multimedia products become more popular. Moreover, the cost of developing higher level courses will be about the same as the lower level courses.

The VLE will increase the total student enrollment and graduate more students at the universities because more students with special needs and restrictions can participate in the learning and retraining processes. Overall, in the long term, the VLE will provide a more flexible and cost-effective means for delivering education.

BIBLIOGRAPHY