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ABSTRACT

Many United States institutions of higher education have established Web-based educational environments that provide higher education curricula via the Internet and diverse modalities. Success has been limited primarily to virtual classrooms (real audio/video transmission) and/or test taking (online form filing). An extensive survey was carried out that examined the course content offered by many leading private and public North American Universities and some colleges in the United Kingdom that offer full or part-time programs via the Internet. Four alternative methods that have been employed to place laboratories online include: videotapes, home kits, arrangements with local facilities, and software simulation. These are far from being "real" labs. In electrical and computer engineering and other technical fields, the challenge remains how students can perform real working lab experiments through virtual technology. The innovative concept of having a Real Lab on the Internet via Remote Lab Technology could provide a solution. (Contains 21 references.) (AEF)

Virtual Labs VS Remote Labs: Between Myth & Reality

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Abstract: Many US institutions of higher education have established WEB-based educational environments that provide higher education curricula via the Internet and diverse modalities. Success has been limited primarily to virtual classrooms (real audio/video transmission) and/or test taking (on-line form filling). Following the study of Net-based educational environments, the researchers found that most labs are far from being real labs. In electrical and computer engineering and other technical fields, the challenge remains how students can perform real working lab experiments as through virtual technology. Florida Atlantic University faculty members Drs. Bassem Alhalabi and Sam Hsu from Computer Science & Engineering and Khalid Hamza from Educational Technology & Research are working diligently on the design, development, and implementation of real lab setups to go on-line. Their success will set an innovative record in Distance Education to pioneer the development of the 'Remote Laboratory.'

1. Distance Education & The Current State of Art Technologies

As it is practiced today, Distance Education (DE) focuses on developing and supplying education materials via the Internet in the form of books, instructional materials, visuals, explanations, and other forms of traditional and modified DE materials. Course content is continually updated to increase the effectiveness of learning. Interactive group discussions, collaborative class projects, and on-line help are being offered to give the student the feeling of being in a traditional classroom [16]. The teacher assigns work in much the same manner as assignments are given in an on-campus to gauge the extent of learning by the student.

Fundamentally, the method of teaching adopted in virtual education can be classified as synchronous or asynchronous in that each approach offers a unique advantage (Gibbs 1997). Synchronous teaching contributes to collaborative learning through joint problem solving scenarios and can be used in threaded discussion through active participation of the guide or teacher. Asynchronous teaching frees students from the anxieties associated with group learning and permits self-paced study through repetition (Aotani 1997). Both modes are popular among the students and universities and are used extensively. This realization that distance education needs no on-campus facilities gave rise to virtual universities. The term "virtual" indicates that the university may or may not have an existing campus. These universities offer comprehensive degree programs and course materials that are delivered on line. In most cases, these universities effectively offer the same primary tools of learning as do established universities that offer distance education programs. Thus, virtual universities have emerged as an equally acceptable alternative to

conventional universities. If students and teachers maintain proper interactivity, the concept of the virtual campus is likely to be successful [6,16].

2. Distance Education, the Remaining Challenge

Despite the tremendous success in the development and marketing of distance learning and its anticipated future, one major challenge remains that leaves some specialized fields of education far from being ready to go on-line. In engineering programs where laboratory sessions are indispensable, students would not be able to complete degree requirements without attending real campuses that provide real lab facilities. The primary solution to this challenge has been software simulations. While the comprehension of study materials can only be a question of time for any student, the student can learn through easy-to-use tools. However, the problem is not so easily amenable when the student's understanding of the experimental concepts through the simulation software material is the paramount goal [2].

3. Survey of Existing Virtual Laboratories on the Internet

An extensive survey [21] was carried out by examining the course content offered by many leading private and public North American Universities and some colleges in the United Kingdom that offer full or part-time programs via the Internet. Most institutions have recognized the challenge of offering lab courses over the Internet and have spent significant efforts to overcome this weakness. Following are four alternative methods that have been employed to place laboratories on-line. Among these four schemes, Simulation Software has been identified as the best alternative, because it is highly portable and cost effective [8,13].

3.1 Videotapes

The Open University employs videotapes in Great Britain, which also uses the other distance education techniques. If the presentation of a simple experiment is sufficient in instructing the student in full measure, then the videotape showing the experiment is mailed to the student. Later, the comprehension of the student is tested by an on line examiner who asks probing questions assess the student's comprehension [2].

3.2 Home Kits

If hands-on experience is considered essential, then a custom designed home kit is sent to the student with relevant material required by the student for using the home kit. The Open University has designed several such kits for use by students [2]. However, when we refer to courses like Logic Design, Microprocessors etc., the possibility of providing a home kit becomes nearly cost-prohibitive. Further, the student may not have the accessory facilities needed to use the kit at home. Geographical distances, which will add to the delay in receiving the material, may deter the student from accepting these course offerings.

3.3 Local Arrangements

The third and, perhaps, the best choice is to make available the real laboratory facilities near the student locale. Accredited colleges in the vicinity of the student locale may offer such lab facilities for a week or two. Alternatively the University itself can make available the laboratory facilities for a week or two on their campus. Intensive laboratory activities during this period helps the students to finish the requirements needed by the course or may help them to finish the remaining part in their homes in a satisfactory manner [2]. However, this alternative is by far the most satisfactory from the student point of view, yet it suffers several disadvantages in that the distance between the student locale and the University can be a major draw back. This inconvenience adds substantially to the cost of the course and, for the majority of students, makes it more unaffordable. The university staff may also have difficulty in opening its laboratory facilities for a short duration, which will affect the on-campus students.

3.4 Software Simulation

Simulation Software is designed for the purpose of bringing the laboratory facilities to the door of the student [8]. Constant improvement is made in the software to make the whole experience nearer to reality

[13]. During the past few years, the Multiverse Project [18] has involved the efforts of developing student-friendly software, which is designed to guide a student step by step allowing more time and explaining the results. The software available in WEB/JAVA has, to some extent, attempted to meet these requirements, however, they are not without imperfections. Simulation software is seen as one way of imparting practical knowledge by allowing the student to conduct experiments on the computer simulating all the steps, which a student would take in real laboratory while performing the experiment [13]. It is yet to gain wider acceptance, although some universities offer them because not all obstacles in the system have been removed.

4. Remote Labs: The Ultimate Solution

A real laboratory experiment etches firmly on the mind of the student for which there can be no substitute. The mistakes that a student makes during any experiment helps that individual to more clearly understand the concepts behind the experiment. These mistakes become valuable lessons that are unlikely to be lost with the passing of time. Involvement of body and mind in a real experiment yields rich dividends of knowledge gained by the experimenter. Teaching a student all through the course by simulation studies can, perhaps, make the student meet the requirements of the course and enable him to complete it satisfactorily from the point of view of the university that offers the course. At the conclusion of the course, however, we only have a student who is completely incompetent in repeating the experiment in a real laboratory. Regardless of the diligence that goes into to software design, the element of reality will be missing, which will causes the student to become a spectator, not a learner. In the field of practical studies, there can be no prominent position for simulated environments. The knowledge so gained in no way compares to the knowledge gained in real experimental studies.

5. Remote Labs On-line

To illustrate our idea, we will use Logic Design Laboratory as an example, although the concept extends to any engineering or science lab. In the actual real lab, students use breadboards to mount a few logic chips, some AND and OR gates, and connect all the chips by wires. Then, they connect the board to the power supply and verify if the circuit is functionally correct. If it is not, the student will rewire the board and run it again. If we replace the wiring part of the experiment with a programmable interconnect network interfaced to a host computer so that wiring (and rewiring) is done on-screen and downloaded to the interconnect network, students will no longer have to be in the lab. The Logic Design lab that is available over the Internet complete with real logic chips allows absolute freedom to construct any circuit. Therefore, a physical setup in the actual lab with a breadboard has all the necessary chips to make all possible connections available via a programmable interconnect network. The use of a host computer here should not be confused with software simulation because students are still dealing with real working electronic parts and still have the freedom to make any connections. The computer is simply used to lay out the connection on the screen and simply download it the breadboard. Once this is done, the remaining part of the project is to design the wiring interface to be connected to the Internet.

6. Conclusion

Distance education for courses where there are no experiments involved like mathematics or history, might do a justice to the needs of the student at a distance. However the scenario is entirely different when experiments form an integral part of the course content. While simulation packages have a role to play in distance education they can never replace the need for real and practical laboratory knowledge. Hence, this innovative concept of having a Real Lab on the Internet via Remote Lab Technology could be the beginning to a contemporary era in the history of on-line education. The researchers of this work invite you to feel free communicate any questions, concerns, or ideas.

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