# DISTANCE LEARNING USING WEB-BASED MULTIMEDIA ENVIRONMENT

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## ABSTRACT

The "schooling industry" is faced with an inescapable demand to redefine its endeavors in terms of producing learning, rather than providing instructions. We propose a hybrid learning model to attract distance as well as traditional students. One of the major components of this model is the web-based learning and interaction. We review the available avenues of distance learning and offer a model that we prepared as an example of web-based distance learning and training. This model combines video-conferencing, interactive classroom, web-based lectures and traditional instructions in an optimized way to achieve the goal of high quality technical education. The availability of lecture notes and other course material on the web makes it a 24x7 hours classroom. Conducting classes via videoconferencing ensures student participation from all locations and optional interactive conventional teaching strengthens student-teacher relationship and reinforces the concepts in the minds of students. Therefore, we believe this model offers one of the best opportunities in web-based distance learning. This paper presents the hybrid learning model and discusses the opportunities and challenges of the web technologies in the education of Computer Science and Engineering. Through this hybrid model we have already successfully offered several courses in the Computer Science program at SUNY Fredonia with students registering from across the New York State.

## 1. INTRODUCTION

With the changing times, our economic and social structure is changing. Both men and women are continuously forced to improve their academic and vocational know-how in order to gain economic stability and progress. These individuals often preferred attending traditional schools and desired them (schools) to offer evening, continuing education, or vocational programs at their own available time. To compromise between job and family responsibilities, these individuals need flexible and not so rigidly structured ways of instruction and learning. With the introduction of web-based software, we see new players such as software vendors and commercial organizations entering the education business. Their primary outlook is to profit, and we consider this to be a sacrifice concerning the educational integrity. We, the educators, in the real “schooling industry,” are thus faced with an inescapable demand to redefine our endeavors in terms of producing learning rather than providing instruction.

Another demand on instructors, particularly in engineering and science education, is to include additional topics in the courses as industry and the scientific community introduces newer material to their respective fields. This is especially true for computer science. This field has witnessed tremendous growth in recent years. We need to revise existing courses every calendar cycle and add more material into the courses or introduce new courses. Due to the large number of topics in subjects like computer networking, software engineering, operating systems, problem solving using programming etc., it has become difficult to keep the students focused during the lectures. As a result, classroom management has become more demanding. Also, given the large size of classes, it is very difficult to detect plagiarism and the use of other unfair means. We are faced with the challenge of assuring ourselves that students learn the key concepts, and that they are able to apply those concepts to discover the details of implementation.

The recent information explosion is also challenging the teaching process that has been the same for centuries. The only aspect that has changed over time is the way we store the information – writing on stones, leaves, and cloth was changed to using slates, blackboards, books and now the electronic media. In the traditional teaching process, the learning process is often overlooked. Web-based technology is fostering a shift from a teaching to a learning paradigm. The hybrid model that we are proposing provides a smooth

transition between the two paradigms and in fact, complements the traditional classroom.

The composition of the student body and the structure of the classroom is also changing with time. The technologies of videoconferencing and web-based education have made it possible to offer classes in a virtual setting. Thus time, distance, and location restrictions are disappearing. A student who cannot travel to the campus can take the course through videoconferencing and the internet from any institution of choice. Similarly, a student who cannot attend the class at the designated time can logon to the course site on the web and attend the lecture interactively through the posted lecture notes and online delivery and interaction with instructor and classmates. Therefore, there is a growing interest in combining the evolving web technologies with the traditional classroom in order to make the learning process more interactive and effective without undermining the necessity for human touch.

We discuss this hybrid learning model in this paper. We focus on two approaches to make Computer Science education more effective without sacrificing quality. First, we define the distance learning in terms of evolving technologies in Section 2. We review the conventional classroom model in Section 3 and discuss the techniques to enhance the learning process in this setting. Section 4 presents the hybrid learning model and shows how instructors can take advantage of the new web and multimedia technologies in offering distance learning classes. Section 5 presents the program that we developed at SUNY Fredonia to offer a specialized track in computer science. We conclude the methodology in Section 6 and present our limited experience with the new paradigm.

## 2. DISTANCE LEARNING REDEFINED

Traditionally, distance learning is defined as a means of providing access to educational courses or programs for students who are separated by time and physical location from a teacher. The courses or educational programs are packaged as a collection of lecture notes, exercises, assignments, and examinations assembled in the form of either a binder, a set of cassette tapes, or CD-ROMs, or a set of video tapes that an institution ships out to a distance student. The student who is an isolated learner, meeting certain predetermined deadlines, sends back the course work and completes the course with little or no interaction with teacher or course monitor. Unfortunately, this perception of distance learning still prevails. Today's information technologies and web-based software packages such as LotusNotes provide resources to simulate a classroom in a virtual setting allowing a rich interactive distance learning experience, which in some cases can surpass the interactivity of a traditional classroom.

Considering extensive use of information technology we, thus, define or rather redefine distance learning as "interactive distance learning" that provides a virtual classroom using interactive technologies such as web, internet, multimedia, etc. Instead of teaching, it promotes learning experiences based upon a variety of interactions including teacher with students, students with other students, students with other experts in the field, students with resources such as posted lecture notes, reference books, other web sites, etc. Through the use of technology, these interactions can occur at any time or place providing a 24X7 hours learning environment.

## 3. TRADITIONAL CLASSROOM MODEL

Traditionally, academic institutions have focused on teaching and generally promote excellence in teaching (almost every institution has a best teacher award). The curricula design and lecture-based delivery method reflects a dedication to the art and science of teaching. The infrastructure of institutions also supports the traditional teaching methodology only.

The teaching process has been very much the same for centuries. The only aspect that has changed over the centuries is the way students communicate and store the information. Centuries ago when mankind learned reading and writing, we started with writing on stones using sharp tools. The progress led to other media that changed from leaves and cloth to using slates, blackboards, books and now the electronic media. In the traditional teaching process, the conditions of learning and the individual learning patterns are often overlooked.

The traditional classroom is mostly a one-way street, with the information and discussion being delivered and led by the instructor alone. Often it is difficult to make students interact with the instructor. Although instructors apply different ways to foster learning, experience has shown that the students remain passive participants in the classroom most of the time.

The web-based technology is fostering a shift from a teaching to learning paradigm. The hybrid model that we are proposing provides a smooth transition between the two paradigms.

## 4. THE HYBRID COURSE DELIVERY MODEL - ACTIVITIES INVOLVED

The hybrid delivery model for courses that we proposed here is a composite of at least two components -- traditional classroom and web-based internet technology. Additional components will be added as the model evolves. To correlate the two paradigms, i.e., the proposed hybrid model, suitable modifications in the classroom component have been made. The classroom and web components are combined to complement each other. The contributions these components make in structuring a class are discussed in the following sections.

### 4.1 Improving the Traditional Classroom

For generating interest and excitement in the classroom various methods have been tested and found useful. One such method is called the "mini-lecture" technique [1]. Using this method, the class time is divided into two or three slots. At the end of each slot, students are asked one or two questions about the material covered so far. Students discuss their answers and opinions with their classmates and make any revisions before they are asked to submit the answers. In this way, participation from the students increases because those who are afraid of being proven wrong in public can see peer reaction before presenting their answer to the whole class. Depending upon the nature of the questions, the instructor can sometimes pose short questions directly without allowing any discussion.

Another way to encourage participation and feedback is to provide the students with multiple channels of communication. The question-answer session in the classroom is very formal to many students who are afraid of public speaking. What is needed is a candid and informal forum where everyone can participate at any given time. It is here that the internet and the web helps in traditional classroom. The mini-lectures are available on the internet as well. We create discussion groups, for example, newsgroups, chat sessions, and on-line project partners. The newsgroups for the class are created at the start of the semester and each student is asked to subscribe to the group. Instructor sets the agenda of the newsgroup by declaring it to be an informal link among the students taking the course. Topics to be discussed can range from problems or concerns about the course to personal hobbies, and results of the latest football game. The instructors sets aside a portion of the grade towards participation in this newsgroup. Whether graded or not, this activity helps keeping interest in the course. Another channel of communication is the problem solving sessions in an informal classroom setting. In such sessions, the students are free to choose the questions that are to be solved by the instructor in the class. It is advisable to get the list of problems ready before the actual session so that the instructor can plan on explaining and solving the problems in a particular and optimized order.

### 4.2 Hands-on Experiments

There is no alternative to the hands-on experiments that go with a particular course. Experiments and assignments reinforce and strengthen concepts covered in the class. Due to the rapid developments in computer algorithms and systems architectures, simulated experiments are now common to many courses in a wide variety of fields. Computer Science is also rich in this aspect as well. Instructors use a large number of simulators to supplement their courses. Examples include language translators, network modeling tools, computer architecture simulating tools, computer aided software design and engineering, and tools that run various algorithms. A large number of Java applets have been created for educational purposes. Some of these tools simulate several mathematical and engineering concepts [2]. Other examples include dining philosophers problem [3], comparison of bubble sort and quick sort [4] and many other algorithms. Some authors have included full logic level simulators such as Bill's Gates [5] in their books. These tools can be put to use in the classroom and assignments can be given based on the use of these tools. As new tools become available, we will use them in the classroom and assignments will be designed based on those tools.

### 4.3 Web, Video, and On-line Resources

The World Wide Web has become the largest reference library in the world with hundreds of online publications, discussions and tutorials posted on various web sites every day. We take advantage of these information resources on the web in the proposed CS program. Using the course management software (or HTML, or Javascript) we create a course homepage on the web and assemble links to additional sources of information about the course. As the course progresses, more links are added. The students are given assignments to explore these links and complete the assigned tasks from time to time. As an example, in the introductory level courses, the Abacus simulator [6] was explored and the students were asked to use Abacus simulator in performing arithmetic computations. In courses with assembly language programming, Intel's programming manuals [7] can be downloaded and specific programming exercises can be designed around the manuals.

We have been using SUNY Learning Network (SLN) – a SUNY wide course delivery and management environment to create on-line courses [11].

To review an example of the use of World Wide Web in developing exercises for classroom, the reader is referred to the URL in [8]. This module was developed by one of the authors while participating in a NSF sponsored educational workshop for teaching ethics in computing. Additional modules developed in an earlier workshop can be found in [9]. The modules provide preliminary discussion and present several web links for more reading. Later the students are asked to complete a worksheet that contains questions related to the module. Also refer to the URL (http:// www.sln.suny.edu/sln) for a sample course completely run under internet methodology using the LotusNotes course management software.

In order to further strengthen the concepts covered in the classroom, video resources related to the material is used. A typical video session lasts for about three-quarters of the lecture time. The remaining time period is devoted to the discussion about the video. The instructor leads the discussion with a review of the video and the students then express their opinions.

### 4.4 Detecting Plagiarism

It is difficult to detect cheating in various computer science and information technology assignments submitted by students. It becomes more difficult if the number of students is large or there are many assignments in a semester. In programming assignments, some students go to great lengths to change variable names, function names and order of appearance of functions in their source code to make their program appear vastly different from the original. Also, they may insert or delete spaces, comments, and indentation. One of the commendable efforts to overcome the malaise of cheating in programming assignments is the MOSS tool, developed by Professor Aiken of University of California Berkeley [10]. This tool is useful in detecting similarities between the source code files submitted. Similarities in the range of 80-90 percent are tagged as cases of possible plagiarism. MOSS is regularly being used at some schools [10] achieving good results in reducing plagiarism.

## 5. PROPOSED PROGRAM INCLUDING DEGREE REQUIREMENTS

The Computer Science division of the Department of Mathematics and Computer Science at SUNY Fredonia is planning to offer a Bachelor of Science Degree in Computer Information Systems, referred to as BS (CIS). The program will be offered using the hybrid learning environment discussed above. The model combines intranet/internet, virtual classroom, inter-active television, and traditional classroom setting. The objective of the program is to serve students residing in the southern tier of the Western New York area.

The BS (CIS) degree is structured as a four-year program and requires at least 120 credit hours. According to existing requirements of the university, a student must complete 36 credit hours in the General College Program (GCP), minimum 52 credit hours in course work in Computer Science core and Software Design & Applications, and 18 credit hours in Business Administration. Several courses in each area may be used to fulfil the GCP requirements. The remaining credit hours which are necessary to complete the minimum requirements of 120 credit hours may either be completed by taking electives at Fredonia, at a collaborating institution or elsewhere.

The courses included in the core requirements of 40 credits are listed in Table I. The CIS concentration requires 12 credit hours of courses from the area of "software design and applications (see Table II)," 18 credit hours in Business Administration (see Table III), and 6 credit hours of electives from a list of four courses (see Table IV). A student may transfer up to 75 hours from any other accredited institution.

**Table I: Bachelor of Science in CIS - Core**

| Courses | Cr |
|---|---|
| MA 120: Survey of Calculus I | 3 |
| MA 121: Survey of Calculus II | 3 |
| MA 210: Discrete Mathematics | 4 |
| CS 120: Computer Science Overview | 4 |
| CS 121: Computer Science I | 4 |
| CS 221: Computer Science II | 4 |
| CS 231: Systems Programming | 3 |
| CS 311: Computer Systems Organization | 3 |
| CS 321: Paradigms of Programming Languages | 3 |
| CS 341: Data Structures | 3 |
| CS 431: Introduction to Operating Systems | 3 |
| CS 451: Introduction to Files and Databases | 3 |

The students registering at a community college, may structure their BS (CIS) program as a composite of two degree programs, Associate Computer Science (ACS) and BS (CIS) – starting at junior level. Initially, a student may register for an ACS program at a participating community college. Upon successful completion of the ACS degree, if a student is interested

in pursuing the bachelor degree, she/he may register for SUNY Fredonia BS (CIS) program. A majority of courses taken as part of the ACS program will be transferable to the program. The students having no prior college-level course work or from other degree programs may directly join the BS (CIS) program. The length of their programs is determined individually. Considering the growing demand for the information technology, a set of courses that may be used as electives towards fulfilling the 120 credit hour requirements are listed in Table V.

**Table II: Software Design & Applications**

| Course | Cr |
|---|---|
| CS 223: COBOL Programming | 3 |
| CS 351: Business Systems Development | 3 |
| CS 425: Software Engineering | 3 |
| CS 456: Information and Decision Support Systems | 3 |

**Table III: Business Administration Requirements**

| Course | Cr |
|---|---|
| AC 201: Financial Accounting | 3 |
| AC 202: Managerial Accounting | 3 |
| EC 200: Fundamentals of Statistics for Economics and Business | 3 |
| EC 202: Principles of Microeconomics | 3 |
| **Business Electives (6 hours)** | |
| BA 300: Statistical Analysis | 3 |
| BA 321: Management and Organizational Behavior | 3 |
| BA 364: Management Information Systems I | 3 |

**Table IV: CIS Electives**

| Course | Cr |
|---|---|
| CS 435: Data Communications and Networks | 3 |
| CS 455: Relational and Object Databases | 3 |
| CS 461: AI and Knowledge Engineering | 3 |
| CS 499: Computer Science Project | 3 |

**Table V: Courses in Information Technology**

| Course | Cr |
|---|---|
| CS 104: Introduction to Software Applications | 3 |
| CS 105: Visual Basic Programming | 3 |
| CS 106: C++ for Scientific Programming | 3 |
| CS 205: Visual Basic Applications | 3 |
| CS 107: Introduction to Internet and WWW | 3 |
| CS 207: Internet and Web Programming | 3 |

### 5.1 Program Delivery

The hybrid course delivery model discussed above has been planned to use with a little modification. The model combines the SUNY Learning Network, an interactive TV classroom, a virtual classroom using a local server (running LotusNotes) and conventional instructional model. Using this model, we will divide the class into three groups of students:

1) The first group consists of on-campus students. These students will benefit from the techniques discussed in Section 4. In addition to the traditional classroom experience, these students will also be able to take advantage of web-based learning material maintained by the Instructor.

2) The second group consists of the students who enroll through a distance college. These students will be attending the interactive classes through videoconferencing. Also, the Instructor will be visiting the distance campus biweekly to provide the students a chance to have tutorial or question-answer sessions depending upon the nature of the course.

3) The third group consists of students who will be taking the course only through the web. For this group the course web page will be the only location where they can "take" a class. Instructors are expected to prepare highly interactive lectures on the web with a monitoring system to assure that the students go through the complete lecture within the allowed time limit. Besides using available interactive software, several new web-based delivery mechanisms will be used to ensure the success of the course. Instructors are expected to be continuously monitoring through their lap-tops and "virtual office hours." During these hours, registered students will be able to open a chat session with the instructor and conduct the conversation via microphone or keyboard.

We have been offering a selected set of courses through the hybrid model for the last one year. To date only the first and the third group of students were included in the study. The focus of the courses remained providing a result-oriented quality teaching.

Initial results show promise for the success of the methodology. In the current semester we are offering eight different courses through the hybrid model. Approximately 200 students have registered in these courses among those 25 are distance students. For the most students this has been their first such experience. They are enjoying the virtual nature of classroom that

does not sacrifice the quality and provides them enormous flexibility in organizing their work round the clock on day to day basis.

## 6. CONCLUSION

The rapid development in engineering and science fields has resulted in an increased number of topics to be covered in classrooms. In order to educate students effectively with the necessary concepts, active learning techniques need to be explored. Instructors can adapt discussion and interaction techniques in the classroom and supplement such efforts with the use of newsgroups, world wide web resources and instructional video material. Some suggestions are presented in this article with the goal of effective engineering and science education without compromising the quality. A sample academic program in computer information systems is developed which is being implemented as a distance program at SUNY Fredonia.

Through distance learning model that we developed, one can create a virtual classroom for students of all ages and situations – from youngsters to doctoral candidates, from corporate workers to military personnel. The result of course, instructor can reach across distances more economically and effectively than ever before.


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