NAVAL POSTGRADUATE SCHOOL
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THESIS

ENHANCEMENT OF LEARNING PROCESS IN WEB-BASED COURSES USING COMBINED MEDIA COMPONENTS

By

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September 2002

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Web-based courses are a popular form for applying distance education today. The development of the educational environment for applying these kind of courses is often considered an art form. Two approaches were studied for the development of a part of a web-based course. The first is the instructional design approach and how an instructor will implement the best course possible applying the more suitable instructional strategies. The second is how these instructional strategies will be adapted to the web for the creation of an educational environment that will enhance the learning process. Combined media components were used, animations and movies, to study the added value of these components to the instructional strategies. The course was delivered to a number of students who evaluated the result. The evaluation assessed the course for both the instructional quality and the web site design and usability. The scope is to study how to develop a high quality web-based course and to determine if the combined media components added value to the educational result. We believe that this study will help us to create the knowledge base for the planning and development of web-based courses for the personnel of the Hellenic Navy.

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ENHANCEMENT OF LEARNING PROCESS IN WEB-BASED COURSES USING COMBINED MEDIA COMPONENTS

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ABSTRACT

Web-based courses are a popular form for applying distance education today. The development of the educational environment for applying these kind of courses is often considered an art form. Two approaches were studied for the development of a part of a web-based course. The first is the instructional design approach and how an instructor will implement the best course possible applying the more suitable instructional strategies. The second is how these instructional strategies will be adapted to the web for the creation of an educational environment that will enhance the learning process. Combined media components were used, animations and movies, to study the added value of these components to the instructional strategies. The course was delivered to a number of students who evaluated the result. The evaluation assessed the course for both the instructional quality and the web site design and usability. The scope is to study how to develop a high quality web-based course and to determine if the combined media components added value to the educational result. We believe that this study will help us to create the knowledge base for the planning and development of web-based courses for the personnel of the Hellenic Navy.

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I. INTRODUCTION

A. PROBLEM STATEMENT

Distance education is a very popular practice of delivering educational services. During the last decade we have experienced the phenomenal growth of this educational practice due to the increasing availability of computers and innovative technologies, the access to web-based technologies and because of economic and demographic factors. The spheres where the distance education expands at a remarkable speed include colleges, universities, continuing and professional education, and government, corporate and military training.

One result of distance education growth in a parallel way with computer technology advances, is that the most common practice for delivering distance education today is through computer applications. That means educators in all educational levels have to become familiar with new computer technologies.

During our academic and professional years we have experienced a lot of computer-based distance education cases. In the most of these examples a common observation was that the developers of the courses did not take full advantage of the computer technology as the medium for providing education. There are numerous examples where the developer made a translation of the material from the one medium (book) to the other (web page), instead of making the transformation from the one medium to the other, having always in mind how to deliver the content to the learner in the most pedagogical way. We also observed that a topic may become more understandable and attractive to the learner if the developer had implemented the course using a combination of media components, like graphics, audio, animations, simulations and video.

The educators often attempt to use the capabilities of computer technology in a wrong way concerning the educational goal. Recreating a classroom-teaching model within a computer-based learning environment is a common mistake. Computer technology designed to mimic the classroom becomes a restriction and a barrier to the educator's ability to impart knowledge. [Ref 1 p.3]

B. OUR MOTIVATION

Our motivation behind this research was based in two facts. First was the observation that the majority of the applied web-based courses could be developed in a more instructive way. Most of the instructors have failed to transform and apply the course content to the new web environment. Many of the concepts could become more clear and understandable to the learner, if a different approach was taken when the course was implemented. We believe that in most of the courses, the use of combined media components would improve the possibility of the learners to learn the concept easier, making the learning process a pleasant experience. Also educators would be more creative trying to impart the concept in a more interactive way, than just produce presentation slides or plain text from a book with the addition of some images.

Second was the intention of the Hellenic Navy to develop organized distance education courses. The advantages of distance education make the solution of creating computer-based courses a necessity for every organization's personnel professional education. The design and development of computer-based courses is a very important procedure, especially when this design and development are related with the armed forces. Also many of the concepts in the Hellenic Navy that may become a topic for a computer-based course, give the opportunity to the educator to use combined media components to present a more instructive version of the concept inside the computer-based course.

C. OUR RESEARCH QUESTIONS

The primary focus of this thesis is to study and apply the most appropriate pedagogical and technical principles in order to develop the best course possible. The most interesting part of the development will be the application of combined media components according to the learning model that will be followed. The author believes that the evaluation of this course will show that combined media enhancements can be applied in web-based instruction, giving the opportunity for a more useful and interesting learning experience.

This research sets out to answer several key questions. First, we have to learn how to teach. Whenever we plan to teach, we should first address the pedagogical issues of how best to teach our subject to the expected audience. [Ref 2, p.2]

Second, is the web the appropriate way to teach? There are many arguments about the quality that web-based courses offer to learners. Educators are concerned about the quality of web-based courses and whether these courses can maintain the same high standards of excellence as traditional classroom instruction.

Third, what courses are more appropriate for teaching over the web? As we can imagine not all the concepts can be presented in the same instructive way through a web-based course. Some of them have better performance when combined media components are applied during the development procedure.

Fourth, how we will develop the best possible web-based course? The instructional design for a web-based course is still an art form. [Ref 3, p.2] There are specific issues that we have to follow in order to develop a web-based course of an acceptable level.

Fifth, which kind of combined media components help the learning procedure? In many cases the usage of multimedia in a web-based course, has as a result long downloaded times or inconsistent content of a page.

Sixth, which tools are appropriate for implementing web-based courses? There are commercial solutions for the implementation of courses. These software products should have a number of minimum tools that ensure the quality of learning process.

Finally, do the combined media components enhance the learning process? We will estimate the results of the course assessment and we will try to conclude when the enhancement of learning process is due the use of multimedia.

D. ORGANIZATION OF THESIS

This thesis is organized into the following chapters:

Chapter I: Introduction. This chapter includes an introduction to the problem, our motivation and the basic research questions.

Chapter II: Background. In this chapter some basic concepts are analyzed like distance education, web-based instruction and why organizations use web-based instruction.

Chapter III: The Instructional Procedure. This chapter contains all the theories of how to teach a subject and especially how to teach on the web. Reasoning exists why we have to use combined media components in our course implementation. Finally we completed research on some of the basic tools we can use to create a course on line.

Chapter IV: The Course Development on the Web. In this chapter there is a detailed description of the course we implemented on the web. We developed this course following the course lifecycle (design, development, evaluation, teaching).

Chapter V: Course Assessment. This chapter contains a detailed review of the course assessment, the results of the assessment and the course modifications we will make after reviewing these results.

Chapter VI: Conclusion and Future Research. This chapter summarizes the final results and provides potential future work for web-based courses enhancements.

II. BACKGROUND

A. WHAT IS DISTANCE EDUCATION?

1. A Formal Definition

As we saw in the introduction, web-based instruction is the most popular practice of applying distance education today. Let's start with a formal definition of distance education. According to the American Council on Education, distance education is "a system and a process that connects learners with distributed learning resources. While distance education takes a wide variety of forms, all distance education is characterized by: (1) separation of place and /or time between instructor and learner, among learners, and/or between learners and learning resources, and (2) interaction between the learner and the instructor, among learners, and/or between learners and learning resources conducted through one or more media; use of electronic media is not necessarily required." [Ref 4, p.10]

The main characteristics of distance education as extracted from the formal definition are:

- Physical separatio n between the learners and the educators
- Physical separation between the learners themselves
- Physical separation between the learners and the learning resources
- The communication between educators, learners and learning resources is conducted through communicating media

2. Some History

Distance education is not a new form of education. We may divide the evolution of this form of education in three phases. [Ref 5, p.1124-1130] Education is always taking advantage of innovative technologies. So these three phases are very tightly related with the growth of information distribution through the last two centuries.

During the 19th century and the early part of the 20th century, mail services were the main way of communication and information distribution. Printing materials and

books were delivered via mail services, as correspondence courses were the main tool of distance education. Correspondence educators monitored learner's study by responding to mailed-in assignments. That was the correspondence phase of distance education, a method that is not totally abandoned in our days.

After analog signals were used in the early and middle of the 20th century, the barrier of physical distance was greatly reduced. New technologies, like telephone, radio, television and broadcasting, were widely used to provide distance education. This strategy gained more and more fans in the area of education. In the 1960's and 70's we are in the analog signal times phase of distance education. Some methods of that phase with some technological advances are still used very widely in our days.

Since we have entered the information age, the technology innovations provide fundamental mechanisms for distance education. The wide spread of computers, multimedia, fast communications and computer networks has driven the development of distance education. We are now traveling through the information age phase of distance education.

Due to technology progress, distance education has been growing during the last decades, acquiring an essential importance in education. Today the number of people studying via the distance education method is between 20 and 30 million, all but 10% of which are adults [Ref 6, p.1].

3. Modes Used For Distance Education Today

Three primary modes are used today for delivering distance education. [Ref 7, p.1-3] We will see that these modes have taken pieces from all the historical phases we discussed earlier.

In a remote classroom, instruction is delivered in a number of students who meet in a place physically separated from the organization responsible for the instruction (university or college). The material is presented to the students in a form of videotape playing in TV sets. Usually additional material is provided to the students, like books and

notes. The interaction between students and educators is done usually after class with telephone or e-mail.

In a virtual classroom, the instruction is delivered to individual students who have access to a personal computer and a computer network. This can occur anywhere, at home, at the office or at the campus. The students and the instructor have to be connected to the network at the same time. That is the reason why this mode of instruction is also called as synchronous online instruction. The instructor has full control over what the students can see and hear on their computers. He may present his material in many ways like slide presentations, video clips, live lecture, a whiteboard display or special software applications displayed on the student's monitors. There is almost full interaction among the different parts. The instructor can ask a question and the students can answer at the same time using their keyboard. Also a student can ask the instructor a question or make a comment with the same way or even present a material to the whole class. This approach emulates a classroom environment. The class is run electronically in real time like all the participants (students and instructor) were in the same place.

In anytime classroom, the instruction is delivered to the students working in a personal computer in any place. The material may be obtained by visiting the course home page in the Internet or the organization's intranet, or by a CD-ROM sent by the organization through the mail. The students may work with the material independently, any time of the day, anywhere, setting their own schedules. This "anytime-anywhere" feature is the reason why this mode of instruction is also called as asynchronous online instruction. The interaction between students and instructors or among students is done using asynchronous modes of communication like e-mail and sometimes using synchronous modes like chats, videoconferencing and telephone. This mode of distance learning is the most common approach to web-based instruction, where we will be focused next.

B. WEB-BASED INSTRUCTION: USING THE WEB AS A TOOL FOR DISTANCE EDUCATION

1. Main Characteristics

There are many definitions for web-based instruction. Khan [Ref 8, paragraph 4] defines web-based instruction as "a hypermedia-based instructional program which utilizes the attributes and resources of the World Wide Web to create a meaningful learning environment where learning is fostered and supported". Relan and Gilliani [Ref 8, Par. 4] give another view of web-based instruction as "the application of a repertoire of cognitively oriented instructional strategies within a constructivist and collaborative learning environment, utilizing the attributes and resources of the World Wide Web".

As a first notice to these definitions of web-based instruction is that this kind of instruction is a form of distance education. As we mention in the beginning of this chapter, the main characteristic of distance education is the physical separation between educators and learners. In web-based instruction, instructors, students and resources are separated from one another. The computers and communication networks are the media that provide interaction among all those people and resources.

Another notice is that although the different definitions of web-based instruction, a main characteristic that all agree on is that this form of instruction takes full advantage of Internet and World Wide Web in order to accomplish its functionality. That means anyone may have access to education, from anywhere and anytime he wishes.

There is a wrong impression by many educators about web-instruction. The general sense is that we use this technology to do the same old thing faster. The only thing we have to do is just publish our presentation slides, some resources and the homework on the course web site and web-based course is ready for use. Another impression is that we can use the web for publishing our notes or books in a cheaper and easier way. Of course this is not true. Students do not like to read large pieces of text through a monitor. They also wish to have available their reading material everywhere they need to (home, cafeteria, classroom), something that does not happen if this reading material resides in a web site. Experiments showed [Ref 9, p.49] that a simple book-to-Internet translation had not encouraging results. The students expect the web-course to

offer improved functionality. Books have the advantage of portability and familiarity over computers. What expected from web-based instruction are other factors to add some value to this innovating educational practice. Students expect a more flexible structure than this of a traditional book, interactivity that is not provided by books and easier access to information.

Web-based instruction appears as a practice for distance education, which makes an effort to offer to the students the same functionality as the traditional classroom, but attaining full classroom replication is not easy to accomplish. However, there are factors where web technology improves the learning process comparing with traditional classroom. A student enrolled in a web-based course, may have an easier and quicker access in resources, which will help to better understand a difficult concept. Also he can join web discussion groups, expanding his knowledge about a specific topic. A web animation or simulation may help for a better understanding of a concept's functionality, than trying to attend the instructor's lecture in the blackboard. The student is free to ask questions an expert on the web about difficult points that are not easy understandable. This functionality mainly helps many shy students that do not wish to ask question during the lectures. Of course, there are also factors that cannot be as good in web-course as in traditional classroom. A main factor that the web provides but not as successful as the classroom, is the face-to-face interaction between instructor and students and among students. There are tools in a web-based course that can approximate this interaction. But it cannot replace the personal interaction. In a classroom, a student has the possibility to ask the instructor as soon as he understands that he miss a lecture's critical point. This may also happen in a web-course but the instructor's answer will not be immediate. Students may interact among each other anytime during a traditional classroom session or outside the classroom during the study hours. This kind of interaction usually consists of questions in a specific topic, sharing of course's resources or cooperation for a course's team project. In a web-based environment this kind of interaction is possible with the use of synchronous or asynchronous applications among students. However, live interaction cannot be replaced with great success in the web environment using these methods. Face to face interaction is an aspect of the traditional teaching that is not covered well by applications used in the web-based environment. Finally, in order for a student to join a

course in a traditional classroom, the only thing needed is his physical presence and the reading material. In a web-course, the same student should be familiar with the necessary technology to obtain the learning material and interact with the other part of the learning process. The following table summarizes several important features of the two educational approaches [Ref. 8]:

	Traditional classroom	**Web-based course**
Source of information	Teacher and textbooks	Resources on Internet
Information format	Text	Multimedia
Presentation format	Linear	Hypermedia
Type of interaction	Synchronous	Synchronous/Asynchronous
Interaction space	Classroom	Networked world
Instructional emphasis	Acquiring knowledge	Building knowledge
Objectives	Specific, pre-defined	General, negotiable

Table 1: Summary of features of the two educational approaches (traditional classroom course - web-based course)

2. Types Of Web-Based Courses

When an educator or a student hears the phrase “course on the web”, he can imagine a lot of things. Usually when a faculty member informs us that he puts the course on the web, he usually means that he published on the web the course syllabus, some notes or required bibliography for the course. Considering the three major types of web-based courses [Ref.10, p.23] may help in better understanding of when a course is web-based in real.

The first type of web-based course is the Web Course. Its main characteristic is that it can be accessed anywhere, anytime via the Internet or an intranet and the use of a web browser. There is none or little synchronous interaction and generally the interaction and communication among participants are flexible and asynchronous. We may say that a

Web Course is a course that is fully available on the web, makes use of a web browser and the course experience begins and ends on the web. All instructional strategies are planned and executed around the communication capabilities and content resources available on the web. [Ref.10, p.24] Because of the full availability of the course to the web, the participants, instructor and students, can participate from anywhere in the world. Another feature of a Web Course is that it takes advantage of web technologies and web applications in order to complete the educational procedure. That means the use of electronic mail, chat rooms or online conferences to support communication among participants. The usage of web applications, like databases, search engines and digital libraries, helps students to better understand the course and supports discovery learning.

The second type of web-based course is the Web Centric. This type of course shifts the center of instruction from the traditional classroom to the web. There are many similarities with Web Courses. The educational experience is likely to begin and end on the web. The instructor introduces the course, specifies course objectives and the resources needed, all through web communications. The Web Centric course makes significant use of web technology and applications. The main difference with a Web Course is that a Web Centric course may have a number of scheduled synchronous meetings among participants. These meetings usually take place on campus or at a predefined place like a hotel or a conference center and generally take less than one third of the class time. In other words, classes of a Web Centric course correspond to a total of 15 hours comparing with a typical 45 hours class. So, class time is concentrated, reducing the number of times students have to gather in the classroom.

The third type of web-based course is the Web Enhanced. This type of course uses the web as a supporting tool to a traditional campus course. The instructors use the web to present the course syllabus, resources, course requirements, assignments and other administration components like office hours and phone numbers. Most of the times they use web technology to support the dialogue with the students using e-mail communication. This type of interaction also reduces the available office hours. The implementation of a Web Enhanced course may be the first evolutionary step of a faculty member to a new technology. Usually instructors start their journey to web-based

instruction by moving all their course's administration components to the web. Then they may start to experiment with technology.

Designing, developing and delivering a web-based course is not an easy duty. For most faculty members, deciding to develop a web-based course requires a realistic look at the time and the resources needed to use this strategy effectively.

C. WHY ORGANIZATIONS USE WEB-BASED INSTRUCTION

1. General

As we mentioned in the previous chapter, distance education has become a very popular form of training services. Due to technological advances, web-based instruction is today one of the most common ways of delivering distance education. There are many reasons why organizations, like large enterprises, government and military services, use web-based instruction for some or all of their training programs.

The Internet, as a communication medium and as the main delivery medium for web-based instruction, gives users access to information independently of where the information is held. The main advantages of the Internet are that it enables users to gain access to information whenever they need to, to access information from wherever they are located and to communicate with other users. Organizations, introducing web-based courses, try to take advantage of the web capabilities in order to reduce the training cost and increase the educational level of their employees.

Organizations use web-based instruction to reduce travel expenses. The students may complete a course or a seminar using their personal computer at home or at work. They may also work on training courses using their notebook computers when they are on the road. The main advantage is that they do not have to travel to a central classroom and pay for transportation, hotels and meals. The payoff in web-based instruction, for organizations having high travel-related expenses, is substantial.

In many cases there are students who cannot join a class. The reason may be, if the training is conducted in another city, the prohibitive cost of the course or because of travel expenses. But even if the training is conducted in the same city or even in the same

building, the student might be too busy to spend part of his valuable time to the classroom. In the worst case the student may have a scheduling conflict with his/her job some time during the training. Joining a web-based course, the student will be free from all these time and money restrictions and the organization will reach students who otherwise would never have the training opportunity.

Web-based instruction has many features that are not possible to be found in traditional classroom. In the traditional classroom the student sits back and passively listen to the instructor. In a web-based course the student must be active in order to take part to the learning procedure. He can learn at his own pace and his own style. He can expand his knowledge by reaching out the information and the educational resources available on the web. He also can be more productive by interacting with other students or the instructor and participate in projects specially developed for computer use. He can share his work and experiences with other students or the instructor and receive their feedback. Organizations offer web-based instruction not only for economic benefits, but because they feel that they will have better results in the learning procedure.

Researches have demonstrated [Ref. 7, p.4] that computer-based instruction using active, self-paced learning with individualized feedback has often reduced total training time by 30 or 40 percent. Web-based instruction has many similarities with computer-based instruction. That means it very possible to achieve similar time reductions when training is delivered online. Also there is a time reduction for the course content update. Course materials can be revised in just one place and the new version becomes instantly available.

Many organizations introduce web-based courses in order to boost their image and gain prestige in the educational or business community. They advertise their view to the new technologies and the 21st century innovations. At the same time they manage to reduce training expenses, attract new students and improve their training efficiency. The business and political interests of the organization are served simultaneously.

The situations in which the use of a web-based instruction program makes sense for an organization are:

- The organization has high expenses associated with the travel of people attending training programs
- Many of the organization's prospective students finds it difficult to break away from their work and attend a face-to-face training program
- All the participants of the program have easy access to desktop or mobile computers that can be connected to the organization's intranet or the Internet.

2. The Navy Perspective

The Hellenic Navy has the intention to develop distance education courses for its personnel training. [Ref. 11, p.2] The navy has all the characteristics of a large organization. A big difference with other large enterprises is its critical mission for the defense of a country. A very important factor for the success of this mission is the continuous and high standard of training for its personnel.

As we can notice, the navy completes all these situations proposed for a sensible development of a web-based instruction program. First, we know very well that when a specific training program is scheduled, the location is announced, usually in a training campus. The navy personnel who will attend this program have to travel from various locations around the country in order to be physically present in the classroom. That means huge traveling expenses for the navy. Second, due the increased operational tasks, the participation of large number of active navy personnel to traditional classroom seminars and courses is prevented. That happens because the student is more useful in his ship than going for a long or short period training course. Third, in our days every office located in a building or into a ship, is supplied with a personal computer or a laptop. The personnel are reasonably competent to use this kind of technology.

The situations for the development of a web-based instruction program were presented. What will be the benefits of applying this kind of program? Primarily, the reduction of traveling costs for the personnel's transportation. In many cases the development of web-based courses will reduce the physical presence of a student in a traditional classroom. Secondly, the student will have the opportunity to attend a training

program without break away from his duties. He can join the program during his free time, although he may be underway an operation aboard a ship. So the training of the personnel will be continuous, a basic factor for an assured improvement. Due to these advantages, it is necessary to find out the principles for designing, developing and delivering web-based courses.

D. RISKS AND DISADVANTAGES OF WEB-BASED INSTRUCTION

Web-based instruction is a new form of distance education. As it happens with all innovations, it has some early adopters, who are very enthusiastic about anything new. But there is also the other side, which claims that this form of education does not offer the quality of the traditional way of classroom instruction. Web-based instruction inherits many of the advantages and disadvantages of traditional classroom instruction but also introduces some new ones.

As we mention before, the development, design and delivery of a web-based course is not a simple task. The whole procedure most of the time is labor intensive. Researches have shown that for every hour of web instruction, the development time can reach up to 18 hours. [Ref. 10, p.30] Also, the collaboration of a small group of people is necessary for the production of a high quality web-based course. Many times the instructors receive a tremendous pressure from their institutions to develop and publish their courses on the web. This must be done as fast as possible. As a result the course's production chain -development, design, delivery- is not implemented in the right order, including all the necessary steps. The general sense is that the quality of the web course is not the one that was expected.

Many organizations and institutions find the opportunity, introducing web-based instruction programs, to reduce dramatically their operational expenses. The implementation of a web-based course is very expensive. The cost of a three-credit course averages around one million dollars. [Ref. 10, p.71] The administrators of some organizations, in their effort to reduce the expenses, introduce low cost web-based courses. As a result the quality of these courses is very low and the students are not satisfied with the experience.

Loss or decreased interaction between instructor and students is a serious risk. The greatest risk exists when the instructor does not realize that students do not understand what is being taught. This situation can happen if the web-based course has no interactive strategies or are very lousy implemented. In order to avoid this, the instructor or his assistant are required to be accessible online on a regular basis.

We have to take under consideration that not all the types of courses are suitable for web-based instruction. There is a possibility that instructors will try to implement web-based courses that are not suitable for delivering through the web. This procedure will take a lot of time, cost and effort with no guaranteed results. The course's quality will be lower than this of the traditional classroom course.

Courses that emphasize memorization or can be easily graded mechanically by evaluation software, are suitable for web-based instruction. But also this type of courses is highly susceptible to cheating, which is expected to occur when grades are the primary goal, used as a determinant for jobs and promotions. Unfortunately, except creating passwords and secure sockets, there is not much to do to avoid cheating among students. A good counter measure is to promote the idea of knowledge as the primary goal of education.

As we mentioned earlier, the implementation of a web-based instruction program is not a small investment. We presented in the previous section the situations in which web-based instruction makes sense for an organization. There are cases where some or all of these situations do not exist and the implementation of a web-based instruction program has no reason to be taken under consideration. A very detailed study must be done; including all financial criteria, to provide the stakeholders with the input if the investment will have a positive balance. The cost of the investment may be prohibitive and the organization will continue the educational and training tasks following the traditional classroom way.

III. THE INSTRUCTIONAL PROCEDURE

A. HOW TO TEACH

1. Pedagogy

The teaching process has very old roots dating to ancient times. Over the centuries the means for delivering education were changing, following every age's spirit and scientific innovations. The foundation of learning is always supported by pedagogy. As a Greek, I know very well the meaning of this term, which comes from Greek roots. The term in translation means " the art of teaching children". [Ref. 2, p.2] Pedagogy is the art of teaching. According to Ciavarelli [Ref.2, p.3], whenever an educator plans to teach, he should first address the pedagogical issues of how best to teach a specific subject to a specific audience. The most important of these issues that every educator should take under consideration when he develops a course are:

- The characteristics of the students he is going to teach
- The content of the subject that needs to be taught
- The best possible organization of the content
- The best strategy for content's presentation
- Keep course on specific sequence
- The best way to deliver the specific content
- Fulfillment of the teaching objectives

Pedagogy traditionally builds on four core components, the learner, the teacher, a task to be completed with the help of a teacher and the knowledge needed to complete the task. [Ref. 10, p.16] As we may observe these four components does not restrict the place and the time for teaching and learning. Pedagogy is something that happens almost everyday. It happens when we learn how to drive or when our fathers show us how to barbeque chicken or when a friend explains us how to buy CDs from the Internet. We have the picture that teaching and learning happen only during our academic years inside

a classroom. The fact is that we learn and teach everyday during our life and pedagogy is the most important reason for the human's brain evolution.

2. Human Learning Theories

Anyone who has been teaching for any length of time has developed his own theory about teaching and learning. This theory includes knowledge of his students, what brings the students in the task of learning and what the students will be able to know and do after they finish a particular course. According to Ciavarelli [Ref. 2, p.4] and Boettcher [Ref.10, p.17] there are three principal schools of learning theory, behavioral, cognitive and constructive. Some very important instructional design principles are derived from these three theories.

The behaviorists believe that the goal of learning is to shape a learner's response to a set of stimuli. Their learning approaches tended to focus on tasks and skills that could be objectively defined and taught through hands-on practice with feedback of performance feedback. [Ref.2, p.4] Under this theory, the instructor defines and controls the instructional environment under which the student interacts. Assessing of the student's progress is based on a demonstration of the target behaviors that the instructional environment is designed to elicit. [Ref. 10, p.18] An example of using the behavioral learning theory today is the airplane simulators used for pilot's training. But, a pure behavioral training method is difficult to use when teaching complex human problems solving and critical thinking skills. [Ref. 2, p.4] According to Boettcher [Ref. 10, p.19], three key instructional design principles come from the behaviorist theory:

- Identify the goals and objectives to be learned
- Create a learning environment that assists the learner in acquiring these goals. This new environment includes the stimulus or task that will engage the learner
- Review, examine and consider adopting or adapting existing materials before developing new ones.

The cognitive theorists believe that learning occurs when the learner processes information. In this theory, the input, processing, storage and retrieval of information are at the heart of learning. [Ref. 10, p.19] The instructor is responsible for the information input process, but the learner takes an active role in storage and retrieval of the information. The primary implication is the importance of structuring experiences that involve the learner as an active participant in the process. The more instructional design can incorporate activities that require deep-level processing, thinking and manipulating of content by the student, the more we increase the probability that effective learning will occur. [Ref. 10, p.19] The instructional design principles derived from cognitive theory are:

- The course must include problems that the student will solve in steps, taking advantage of the acquired knowledge in each step. Sufficient help and resources should be provided for the solution of the problems
- The instructor must be sure that the student is ready to learn the core concepts, principles and attitudes of a course. Establishing prerequisites for this course may ensure this.

Constructive learning theory appears as an extension of cognitive theory. The learner constructs knowledge for himself. He is the creator and processor of the educational experience. This theory emphasizes the student-to-student interaction as an important component of the educational environment. The instructor is no more the manager of the information input process, but the manager of the environment the learner defines. [Ref. 10, p.20] That means the instructor plays an important role in the learning process by arranging instruction to encourage students to engage in active learning situations in which students participate in problem-solving activities, sometimes working alone and other times working in groups. [Ref. 2, p.6] Instructional materials, problem-solving situations and assessments invite the interest of the students because the learning experience is directly applicable to real-world environments. The instructional design principles derived from constructive theory are:

- The students are setting their own objectives. The learning environment puts the students in charge for learning a set of objectives and skills.

- The course content should be well-structured in order to provide continuity of learning to the students
- The instructor has a role of mentor, manager and facilitator of the learning environment
- The interaction among the participants is very important element for the building of structured knowledge.

The key component of these learning theories is the interaction of the learner with the learning environment. There is no difference whether we use stimulus, information processing or construct knowledge because the learner is at the center of the learning process as an active participant. Today the traditional educational model presents the instructor as the center of knowledge and the learner is the passive receiver of this knowledge. The interaction among the participants is very small. The opportunity for interaction in an online environment is greater because the participants do not have to consider about time limitations and physical constraints.

3. Instructional Design Principles

> Attention to instructional design is one of the most critical factors in successful learning networks, whether course activity is delivered totally or partially online or in adjunct mode. All education, on a network or in face-to-face environment, involves intervention by an expert (the instructor) to organize the content, sequence the instructional activities, structure task and group interaction, and evaluate the process. [Ref. 12, p.125]

The basic principles of instructional design are derived from the learning theories we studied in the previous section. Instructional design is a piece of art that emphasizes how to put learning models and theories together. Boettcher defines instructional design as "the process of designing the environment, methods and resources for effective learning of specified goals and objectives by students." [Ref. 10, p.40] We are sure that we know more about how students learn in our days than we did in the past. That means instructional design becomes more critical in order to ensure the quality of the courses.

Here are some basic instructional design guidelines that usually help instructors to develop a course:

- The instructor should have a good knowledge of his students. He should know the reason they join his class and their background knowledge related to the course content. This factor is very critical for the designing of the course content by the instructor. The students, who have an established foundation in a related to the course field, can learn more and more quickly.
- Determination of the course's goals and objectives. This is a critical factor in the course development. The instructor must determine what his students will know and will be able to do after the course completion.
- The instructor should be able to imagine the environment where his students will be learning. This environment will be for example a classroom, a laboratory or their home. The visualization by the instructor of his students learning environment will help him in the planning of the educational media he will use.
- Planning of the instructional strategies that will be applied by the instructor. Instructional strategy is a communication activity used to engage the learner in a task and to assist the learner in acquiring the knowledge necessary to complete the task. Some examples of instructional strategies are lectures, discussions, reading assignments, study projects, presentations and tests. The planning of the instructional strategies is related with the learning environment.
- The instructor should know during the course delivery, if his students understand and learn the material he presents. The selection of the proper assessment procedures is also a part of the instructional design. These assessment procedures may be tests, projects or case studies and the students will be tested in periods of time according to the assessment procedure.

- Planning of learning activities that will help the learning procedure. These kinds of activities should be planned in a way that introduce, apply, reinforce and extent the course's content. The main activity of this kind is the interaction among the course's participants. The course should be designed taking under consideration that the interaction among participants enhances the learning process. This interaction cannot happen without planning by the instructor.
- The instructor should choose the instructional media that will use to deliver the course material. Usually this material can be delivered using more than one medium. The instructor should choose among a number of media and his decision is critical for the success of the learning procedure. He should choose this kind of media that are familiar to him and the students and also accessible by all of them. Simplicity is the best rule for this choice. Examples of instructional media are the books, course web site, computer based material, multimedia classroom or Internet resources.
- The instructor should know that the more hours of teaching he designs, the more time and resources he will need. The instructional design is directly related with the budget of a course. The instructor, who wishes to maximize learning with a reduction in the hours devoted for this learning, will increase the cost of the course's development. Well-design courses will take more time, money and resources to design and develop.
- The delivery time of the course should be known from the beginning of the course's development. In that way a better management and allocation of the human, infrastructure and financial resources could be planned.
- The objectives and goals that are set by the instructor for a course impact the whole design and development procedure of this course. In other words, a complex concept may take more time and resources to be implemented than a simple one that can be delivered with a simple lecture.

As we may notice reading some of these issues, instructional design is not a simple or straightforward task. There are many factors that should be composed in order to implement a well-structured course. These basic guidelines should be reviewed before the beginning of a course development.

B. HOW TO TEACH ON THE WEB

1. A New Pedagogical Model

As we observed in the previous sections, moving a course on the Web is not a simple task. The most important benefit that the Internet provides is the entirely new environment for teaching and learning. The physical and time constraints are removed either for instructors and students. The development of a course or an educational program for moving on the Web gives instructors a perfect opportunity to apply the basic learning theories into a new environment. In that way a new pedagogical model arises. Teaching on the Web is not as simple as creating and launching text documents with some pictures on a web server or publishing slides presentation on a course web site. The instructors do not have to translate their teaching material in order to fit on the new teaching platform. They have to transform this material and all their teaching strategies in order to be compatible with the new pedagogy.

Reviewing the three basic learning theories we may say that, a computer simulation software can be a part of a course that tries to shape the student's response to a set of stimuli (behavioral theory). On the other hand, designing a web-based course that will contain, among the other material, problems, assignments and resources on the Internet related with the solution of these problems, will give the student the opportunity to process information (cognition theory). Finally, the interaction between instructor and student and among students, using proper interactive tools like electronic mail, chat rooms and discussion boards, helps students to construct knowledge for themselves (constructivism theory).

2. Moving a Traditional Classroom To The Web

Traditional classroom education is based upon a paradigm normally called the "knowledge reproduction model". [Ref. 13, p.20] This model uses instructional strategies like live lectures, printed material (handouts, textbooks), assignments, tests, team or individual projects, structured classroom activities and instructor office hours. The basic idea is that knowledge is objective. Knowledge is transferred from its source (instructor, textbook) to the student who is the passive receiver of this procedure. Many problems arise from the fact that the instructor is the source of knowledge and due the physical and time constraints that occur. For example, a student who misses a class will have a gap in his knowledge concerning a lecture or instructions about an assignment, because the instructor cannot repeat the lecture or the assignment's instructions. Handouts or notes need a lot of time for production and reproduction for distribution, making their update a time consuming task. Instructor office hours are not always enough and convenient for every student. Class time is severely limited, making the interaction among the participants very poor. Instructors are always stressed in an attempt to keep on schedule. As a result of all these problems, the communication bandwidth between instructor and student is too narrow and the sources of knowledge are too limited. What is needed is an approach that has multiple knowledge acquisition channels and multiple knowledge sources, where the students can actively participate in the knowledge acquisition process. [Ref. 13, p.21]

Can we move all the functions of a traditional classroom in a web-based environment? First of all we have to summarize the classroom's basic functions and search for web-based equivalents. The instructor is a kind of classroom manager. That means he is responsible for syllabus distribution at the beginning of the course and any changes during the course period, he has to monitor the students participation during the class sessions, he provides notes to guide students in focusing on important areas of the lectures, he encourages class interactions between him and the students or among students assigning group projects and finally delivers and receives assignments from the students. In a web based classroom all these functions may happen in the course's web site. The instructor may distribute the course syllabus via the course homepage and update it very easily. He can make announcements and publish class notes in an

electronic bulletin board. There is a possibility for synchronous or asynchronous interaction among participants using chat rooms, e-mail or discussion groups. Also the instructor may assign tests and projects and the student can submit their work electronically. The instructor as the classroom's manager is also responsible for the course lectures and the media to present them. In a traditional classroom the instructor delivers lectures, using projectors for a visual presentation of his notes. Rarely he uses other media, like TV sets and sound systems, to enhance the classroom environment. On a web-based classroom, the instructor may deliver a lecture in a synchronous or asynchronous way. The student may watch and hear the instructor through his computer monitor in a live or videotaped lecture. He also has the opportunity to download the lecture slides and use them during the lecture. He may interact with the instructor during the lecture, either interrupting him during a synchronous session or sending an e-mail message during an asynchronous session.

We observe that the transformation of a traditional classroom into a web-based classroom is possible and already happens. Almost all functions of the classroom can be realized on a web-based environment. The critical point is the proper development of this environment and the means that we will use to adapt the traditional functions to the new environment.

3. How To Develop a Web-Based Course

Defining steps before the development of a web-based course is necessary because we ensure that the course's environment will be designed with the proper instructional strategies. Today the common practice for a classroom course is that the instructor is the main and only person who takes the responsibility for the design, development and delivery of this course. That happens because the instructor is recognized as the person who have the greatest knowledge of course content, structure and instructional strategies, and is probably the person who can most effectively and efficiently delivers the course. [Ref. 10, p.47] Today, in the physical place of the classroom, paper notes, books and a slide projector are the most common tools for a course delivery. The instructor may use the material he had from previous classes or the

borrowed material from another instructor. He also may create his own material even the night before the next class.

Web-courses that are delivered online need a more detailed design and development than traditional classroom-based courses. Building a web-based course means constructing a full teaching and learning environment. It is the same with the traditional classroom-based courses as building the physical classroom. But as it is not an instructor's work to construct a classroom and he needs some building construction experts, the same happens with the online environment. Web-based courses that are delivered in online environments require additional design and development support. The planning and development of such a course requires more coordination. This happens because this kind of courses make use of a variety of media, technology and resources, and include a variety of learner-centered instructional strategies. [Ref. 10, p.47]

We will try to discuss very briefly a systematic step-by-step process that an instructor can use to construct a web-based course. This process is based upon Boettcher and Conrad book, *Faculty guide for moving teaching and learning to the web.* [Ref. 10, p.47-58] When an instructor decides to implement a web-based course, he has to follow the steps that briefly are presented in Table 2 and discussed below.

First step is to determine the strategy that an instructor will follow for moving a course to the web. There are two approaches for this strategy. The team approach requires a team of experts who will contribute to the design and development of the course and during its delivery. This team may consists of various members, like a project manager for the tasks coordination, an instructor to maintain the content and the instructional strategies of the course, a web designer for the course web site design, a researcher who will assist the instructor to find and organize content resources available in digital form, a graphic artist who will be responsible for the visual design of the course material and web site, technical support staff to help prepare the organization infrastructure for the course delivery and help the other members to use this infrastructure, a course assistant who will interact with the students replacing the instructor when needed and an administrative coordinator who will assist in the marketing, recruiting and admission process of students

Step 1	Determine the strategy for moving a course to the web (Team or individual approach)
Step 2	Select course environment
Step 3	Redesign a current course
Step 4	Gather and prepare the course materials
Step 5	Define students activities and interactions
Step 6	Build the course web site
Step 7	Implement and manage the course
Step 8	Evaluate the course and make alterations

Table 2: Steps for web-based course design and development

for the course, and ensures that all the student services are in place to provide a stable, reliable and productive educational experience for them. This approach is recommended when the course is being planned for a long-term delivery and will be attended by a large student population. It is also recommended when planning degree or certificate programs. The individual approach requires only the contribution of the instructor. But the instructor who will design and develop the course should already have some basic skills and abilities to succeed in this task. He should be familiar with web-based software applications that will use in the course. He should be able to present the course material in such way to promote interactions among students. He should manage the course according to the software dictates. He should be able to create opportunities for collaborative learning and work among students and capable to serve more as a facilitator than a single source of knowledge. Finally, he should have a strong belief in the efficacy of web-based instruction. [Ref. 7, p.53] This approach is used for lower cost, when there is more time for course transition and when the developer will also teach the course. Generally, following this approach is not recommended unless you enjoy learning and working on your own.

Second step is to select the course environment. This step is also very important because the choice of course environment will be the key for the successful or not transition of the course to the web. You can choose to create your own kind of environment that will enhance the educational process. Many features should be contained in this environment. Some of them are the syllabus, course announcements, calendar, electronic mail, chat tool, timed online quizzes, capability to upload information easily, grade reporting, discussion lists and student management. Today there are commercial software products, called web course management systems, which simplify the process of creating a web-based course environment by offering ready to use course templates. Using this type of management system, many design decisions are made for you.

Third step is to redesign a current course. When you decide to move an existing course to the web, you have a great opportunity to reassess the strengths and weaknesses of this course. That means it is a good time to update the course and add new features to increase active student learning and collaboration. During this process of update and redesign, the course's various components, like goals and objectives, teaching and learning strategies, technology support and assessment, should be examined.

Fourth step is to gather and prepare course material. During this step you should start to search and categorize the online material that you will use to present the course content or as resources for student help. This duty is time consuming because the Internet provides an enormous number of resources, which will make your selection very hard and maybe will influence your decisions about the course content. Also it is possible for some material to require copyright permissions and subscription access arrangements before they can be made available to the students in an online environment.

Fifth step is to define the student's activities and interactions. In a traditional classroom course, face-to-face interaction happens with no special schedule or planning. As a result a pre-designed classroom activity may be redesigned if the instructor has the input that it does not offer the learning results he wished. On a web-based course the face-to-face interaction is not present. It is not simple for the instructor to change a learning activity or the way he interacts with the students or the students between each

other. Changes on a learning activity are possible but it is better to reduce them in order to avoid potential confusion for students. That means the learning activities and interactions should be designed and developed in detail before they released in the course's web environment.

Sixth step is to build the course web site. A web-based course usually consists of a course web site that serves as a guide to all educational activities, like course administrative tasks, course material and interaction among course's participants. This is the step where all different pieces, digital documents, online resources, multimedia components, interaction strategies, assessment tools and web course management tools, can be brought together. All these among the developer imagination and basic principles of web usability are tight together for the creation of a web site that will attract the student's interest and will provide him a enjoyable learning experience.

Seventh step is the implementation and management of the course. The instructor should by this time be ready to begin the online course delivery. He will introduce him self and will announce the course goals and objectives. He will explain that with the new environment the students are evolving in the educational procedure to a much more greater extent than they were previously. The course schedule will be released among the possible ways and hours for interactive activities. A very clear schedule should be posted concerning the instructor's office hours for synchronous interaction. Another duty for the instructor is the on time feedback he will provide to the students for their assignments and who they should turn to for technical assistance.

Eighth step is to evaluate the course and make any necessary alterations. You will spend a lot of time to design and develop the web-based course and you wish to know if there are some features that have to change. Your course evaluation may be done by your students, using their perspectives, or by your organization using an evaluation tool. Among others the basic course components that should be evaluated are the course web site organization, the clarity of course materials, the quality of the activities, the technical support, the level of communication and the overall course satisfaction. Finally we cannot ignore the cost impact of such a project. If we spend little, the course will be used by a small number of students and will have short lifetime. If we spend more, the

course might be able to be used by thousands of students over a longer period and the organization may have profits by selling the course to other organizations.

C. USING COMBINED MEDIA COMPONENTS IN WEB-BASED COURSES

1. Why To Use Them

How do we answer the fundamental question of how we learn? According to Sonwalker "In answering the question of how we learn, we look to the basic modes of cognition – touch, smell, sound, vision and taste – and to the primary educational modes of listening comprehension, ocular comprehension and haptic comprehension." [Ref. 1, p.3] In our days computers may deliver media components like text, images, photographs, animations, simulations, movies, live video and sound. These machines may create an environment that can virtually interact with all human senses except taste and smell.

Web-based instruction is not just the translation of the lecture notes or the book content on the new medium, the web. This kind of instruction, due to the absence of face-to-face communication among the participants, should encourage the student participation in the learning process. We may manage this kind of participation by designing different kinds of interaction during the web-based course development. We should avoid the model of distance education that was based on the instructional television. This kind of media provide image and sound to the student in order to enhance the learning process and make a concept more understandable, but they let him be a passive receiver of the information without any participation in the whole process. During the design of a web-based course the instructor should think about using a combination of media components that let him to present conceptual material that are difficult, perhaps nearly impossible, to present with text. This kind of presentation can be made either using interactive strategies or providing dynamic examples for learning. According to Sonwalker [Ref. 1, p.4], a list of potential combined media components enhancements for the learning process might include:

- Audio annotations to graphics

- Graphical visualization
- Audio annotations to video demonstrations
- Video demonstration of graphical elements
- Animated graphical frames (animated gifs)
- Audio annotations for animated graphics
- Animation of physical concepts
- Text annotations to video frames
- Animated simulations
- Numerical simulations for parametric studies
- Graphical simulation of mathematical equations

Recent developments in computers industry and computer networks field give the opportunity to apply this kind of media components and their combination in web-based courses, creating an educational environment which will enhance the learning experience. Of course this environment will depend on the learning model appropriate for the delivery of the course content. [Ref. 2, p.4]

2. Ways Of Presenting Information

A large part of a web-based course is dedicated to the course content presentation. By studying this content, the student will be able to use all the other functions of the course, like interaction with the instructor, assignments, resources, tests, etc. The course content is nothing more than presentation of information to the students. There are many media used for presenting information through a computer. Many of us use our computers every day to receive information and have a first hand experience of the media components and their combination provided for the information transmission. We will present a small review of the most basic of these media components:

Text

The most obvious and traditional way to present information on the web is with textual form. Like a text editor, we may use different font type, size, boldness, style or color. We also may underline selected words or phrases. We use all these tools to give our text special meaning or to emphasize some important points. We also may guide the student to resources concerning a term or to another point in the same document. It is very important to make sensible use of the fonts format in order to emphasize an important concept or force the student to pay attention in a specific part of the course content. We should be careful about the kind of fonts we use because the potential of some students do not have these kind of fonts in their systems is great.

Simple graphics

These are graphics in the form of simple geometrical shapes. They are sometimes referred to as low memory graphics because they do not require much file space. A compression technique called Graphic Interchange Format (GIF) is used to save simple graphics in order to make the file sizes smaller and easier to store and transfer. We use simple graphics to present a graphical representation of course content functionality and navigation. It is a more effective way to capture student's attention than simple text. Simple graphics files contain a maximum of 256 colors, which is not enough to truly represent photographs that normally contain up to 16.7 million colors. [Ref. 7, p.12]

Photographs

Another popular way to present information is the photographs. In this point it is useful to refer to the Chinese logo "a photo counts as thousand words", to emphasize the learning value of a photograph. We use photographs in our course content to demonstrate a concept that we describe in the text and make it more understandable. A photograph always captures the student's attention and is the first thing that he will look in his computer monitor. Reasonable choice of photographs will give to our course an attractive first impression and a curiosity for the student to study the content. The most popular compression technique used for photographs on the web is called JPEG, after the Joint Photographic Expert Group that created the format. Unlike GIF files, which represent graphic information in an 8-bit code, JPEG files can use a 24-bit code that can present the

16.7 millions colors necessary to faithfully represent photographs. However, keep in mind that for users to see all these colors, they must have 24-bit display cards and monitors in their systems. [Ref. 7, p.12]

Animation

An animation is a sequence of graphic images stitched together to form some kind of movie. Animations are used very often in web-based courses because are not static and may provide a great level of interaction between the student and the computer. An elegant designed animation may actively illustrate complex concepts. Animated graphs, for example, provide clear indications of phenomena. In a biochemistry class [Ref. 14, p.188] still figures cannot adequately demonstrate the utility of animation for conveying these complex concepts to students. In this case there is a complex sequence of events that is articulated during the overall process. While the sequence can be expressed in words and enhanced using conventional images, the animation adds clarity nearly impossible to provide by other means. There are two approaches for creating animations. The simple approach is the animated GIF, which consists of a series of GIF images stitched together using appropriate software. This is the equivalent of creating a series of simple graphics on the pages of a notebook and then flipping through them quickly to give the impression of motion. Of course the user's browser must be supported by the software's plug-in application in order to view the animation. The other approach for creating animation is by using a scripting language like JAVA that produces short programs that can be viewed by the most recent generation of browsers. The greatest advantage of this approach is that the animation may interact with the user. In this way we provide a truly interactive learning environment that student can explore, add to and compose in, enabling him to become actively engaged in the learning process. Street and Goodman [Ref. 15, p.94-100] developed a Java applet for demonstrating a complex algorithm used in computer networks routing. In their experiment, they chose students who have previously taught the algorithm. Their conclusions were that by using the applet for practice, students had an enjoyable experience that led to measurable gains in long-term information retention.

Movies

We use movies for visualization of concepts that are difficult or impossible to present using other media. Video is always a pleasant way for students to receive information. We all have experiences of interesting times when an instructor introduced a movie in the classroom trying to make a concept more understandable. Movies represent a great challenge for computer systems since the necessary network capacity is very large. As the bandwidth of the Internet grows, video on the web becomes more common. The quality of the movies, produced for the web, continues to grow as a result of improved hardware and software. Video must be compressed in order to work on the Internet. Uncompressed video takes so much bandwidth that accessibility would be restricted. There are several video compression standards commonly in use, like M-JPEG, MPEG and MPEG-2. All these standards compress video files with a cost of lost data. When these losses are large, the quality of the movie is not appropriate. There are two ways of providing video in a computer system. The first way is to download a movie file from the server. This approach may take a large amount of time depending on the file size, the network traffic and the user's connection to the network. Movie files are used when the instructor uses the video as a supplement to his course content. The second way is by using streaming video. The movie file is sent from a server and captured in a buffer but not stored permanently by the client's (the student) computer. As soon as enough information has been received, the movie starts playing. [Ref. 14, p.144] Again the network traffic and the user's connection to the network play an important role for the reliable video transfer. The instructor uses streaming video for delivery of live lectures. Also, discussion forums and other interaction sessions may be established among a course's participants using this kind of technology. Of course, we must be sure that student's browser applications are equipped with the proper plug-in programs that may play the compressed movies.

Sound

Sound is recognized as one of the emotionally most compelling media. It is the core means of human communication. [Ref. 14, p.148] There are different ways in which sound can be used in web-based courses. One way is earcons, sounds that indicate a

particular operation. Computers play sounds to indicate an event or an action, like when a process completed or e-mail arrives. These kinds of sounds are very useful when the student interacts with an educational action, giving him feedback when he is doing well or not. A second way is informational sound that indicates some special meaning about the data. The instructor may use this kind of sound to provide information about an image or an animation he uses in his course or provide a summary of the topic he analyzes in the web lecture. Another way is streaming audio, providing the same functionality as streaming video. It may be used, as streaming video, for live lectures or live communication among the course's participants. Also the instructor may record a lecture and provide the audio file to his students as a course supplement. We have to take under consideration that sound files can take nearly as long to be downloaded as movie files. Also proper plug-in programs are also needed by the student's web browser applications to play sounds.

3D Graphics

Three-dimensional graphics are appearing on many web sites. This kind of graphics are used to represent an object in such a way the viewer can choose the perspective from which to view the object. They are also used to support the creation of virtual reality worlds. The instructor can use this kind of worlds to present an animation of a concept. Also most of the simulation programs are using virtual reality environments. A special language, called Virtual Reality Modeling Language (VRML), is used to create web pages with this capability. [Ref. 7, p.13] Of course, a VRML plug-in program must support the student's browser, in order to be able to see the virtual reality environment.

3. Some Concerns

During our research in web-based courses we observed that the most common way to deliver the information is using text and images. We do not find that the majority of the courses use in great extent other kind of media or a combination of them. The truth is that there are some issues that make instructors to hesitate to use other media components except text and image to present their course's content.

The presentation of more sophisticated media components or a combination of them requires the use of a properly configured computer system by the students. That means the students should be equipped with systems that have processors with great speed, large memory, proper receiving and transmitting devices (speakers, headphones, digital cameras). Also their browser applications should have the proper plug-in programs in order to be able to receive all the information transmitted by the sophisticated media. The fact is that computer systems technology is far ahead. Today the most simple and cheap system is capable of supporting all this kind of sophisticated media components and any combination of them. Plug-in programs that allow the use of some media components are readily available on the web and are often free of charge. The instructor can provide the students with detailed guidance in locating, downloading and installing these plug-in programs.

We referred to the large files that contain video or sound data. As we understand the larger these files are, the more time we need to download them. If the course contains a lot of these files it would be very time consuming to download these files. This is especially true when the students are not connected to the network with high-speed devices. We believe that in future and due to computer network innovations, the download time will be decreased drastically. A solution to this problem is the choice of compression techniques for the media, which require much less memory space and therefore the transmission is done more quickly. We believe that in future and due to computer network innovations, the download time will be decreased. Today, the instructors should take under consideration the download times before they use videos or other media that need large file sizes to be stored.

Most of the times, enormous time and effort are required to design and develop the more sophisticated combined media components techniques. Also it costs a lot of money to program and deliver them over the web. The instructors and web-based courses' designers should always wonder if the combined media components that they are going to use, add enough value to the learning experience to offset their costs.

The instructor and the designer of a web-based course must be careful not to fall prey to all these weaknesses. They should take care to limit the applications of combined

media components to situations in which they will significantly enhance learning. [Ref. 7, p.14] The Internet has a long run and its capabilities will improve. Soon most of these arguments will disappear.

D. TOOLS FOR CREATING WEB-BASED COURSES

We referred to the previous chapters that there are a variety of tools and resources that help instructors and students with the task of teaching and learning in the new web-based environment. We will give a brief description of the most basic tools which help instructors to move course materials to the new environment more quickly and easily than in the past.

1. Web Course Management Tools

> A comprehensive web course management tool provides a framework or template for the three major steps of faculty work in offering a course: design, development and delivery of the course, including tracking, grading and assessment. [Ref. 10, p.61]

This kind of tools is very important and helpful for the faculty. We may say that are as important as word processing tools or e-mail applications. They are flexible and the instructors do not need to be expert to use them. These tools contain some of the functions that may be developed by the instructional designer and the course's web page developer. They serve as checklists for guiding faculty through the planning of a web-based course by providing a wide choice of application modules that support the teaching and learning activities in a course. The capabilities are already build in and the instructor may choose if he will use them or not. [Ref. 10, p.59] The web course management tools may be used for the development of any kind of web-based course, either a Web Course, a Web Centric or a Web Enhanced.

Hundreds of web course management tools are implemented every year, either by companies or by organizations. Also new versions of older products are produced, including new capabilities and trying to keep up with the technological innovations. The

most “up-to-date” tools covers the full range of basic course administration tools, like syllabus or class information, course design tools, content resources, students profile (tracking, grading, assessment) and a variety of collaboration and interaction strategies.

We referred to web course management tools as a template for designing, development and delivery of a web-based course. But which are the features that these templates offer? According to Gray [Ref. 16, p.18-23], there are four categories of features. The first category is related with the design features. The instructor gets a sense of what a web-based course might be. There are some ready to use templates that may provide a starting point. Of course some time is needed for redesign. The second category concerns features for collaboration, like e-mail, file sharing, bulletin board, synchronous or asynchronous discussion tools. The web course management tools should support the use of all three interaction strategies, instructor to student, student to student and student to resources. These features help all the course’s participants to collaborate and interact to each other and with resources on the Internet. The third category includes course management features, like student grading and tracking, assessment tools and quizzes. The instructor saves a lot of time using this kind of features because he has not to design and implement all these management features from scratch. The last category has to do with administrative features, like site security and technical support. Students will not ask the instructor for some strange behavior of the course’s web site and the instructor will get free from answering technical questions that does not know the answer. A central technical administrator will be responsible for technical questions that arise and to address the unpredictable things that happen.

The web-based course templates, which usually come with the course management tools as samples, contain the following common course elements: instructor introduction, syllabus, course description, course materials, lectures, online discussions, required material, recommended material, supplementary materials and resource sites, student home pages, student grading tools, e-mail applications, online discussion and communication features. [Ref. 10, p.61] In this point we can make a reference to specific web course management tools like CourseInfo by Backboard, LearningSpace Anytime by Lotus and WebCT developed at University of British Columbia. Before you decide which web course management tool to select, it is useful to investigate about the features of

each tool. The best way is to read current evaluations of the products that you are interested of. We found some reviews of current products on the web and we are sure that much more exist. [Ref. 17, 18]

2. Books Companion Web Sites

The publishers of educational textbooks have noticed a decrease on their sales during the last years. A reason for this decrease is the faculty choice to move on web-based courses in greater extent. That means the students are buying and reading fewer and fewer books. The instructors prefer to move from textbooks to other print, video and digital materials. They try to take advantage of the great power of the Internet, the availability of information resources. For example, students can access and search through the library holdings of a thousand universities.

Publishers try to face their sales decrease by expanding their business from print formats into multimedia and web formats. That means they create web sites or CD-ROMs that are provided as a textbook companion or individually. Most of these online textbooks share common features like links to resources, student's assessment tools, content animations, simulation programs, communication applications and instructor separate companion. The evolution of textbook's web sites started as an electronic copy of the original textbook, which was published on the web. The next step was to add some digital resources, like interactive tutorials, animations, simulations and video content. The most current step is to create a dynamic environment that includes content related web resources, hosted events, contests and virtual spaces for faculty networking. [Ref. 10, p.67]

Most of these textbooks web sites are free of charge when they come as a companion designed to support a specific book. The instructors should adopt the specific textbook, where they can find a great content for the development of their web-course. A search to the publisher's web sites might help instructors to explore how this new form of textbooks will help them to their move to the web. Some examples are Archipelago (http://www.archipelago.com/) by Harcourt Brace Company, Addison Wesley Longman

Higher Education Publishing Group (www.awl.com) and Prentice Hall (http://www.prenhall.com/).

IV. THE COURSE DEVELOPMENT ON THE WEB

A. WHAT WE ARE GOING TO TEACH

After studying all the principles of instructional procedure, either traditional or web-based, the time has come to develop our version of a web-based course. As we refer in chapter one, there are kinds of concepts that are more appropriate than others for web-based development. Web-based courses offer the opportunity to create an exciting and active learning environment and encourage important educational activities.

Our aim was to develop a web-based course, including all these techniques that simulate a real classroom. We tried to manage this by creating a web-based environment and manipulating the majority of the functions that a classroom provides. The functions we tried to transfer to the new environment were the course's overview, the instructor's lectures, the student's assessment, and the interaction between students and instructor, among students and between students and resources. Special consideration was given to the lectures functionality. We wished to design the lectures in such a way that the content would be more clear and understandable to the students. However, one of our motivations for this thesis was to improve the poor content implementation of existing web-based courses.

Having all these factors in mind, we were looking for a course that would be suitable for the new environment and would give us the opportunity to apply combined media components for the content presentation. The idea was given by a course we studied in Computer Science curriculum at the Naval Postgraduate School. The content was related with computer networking. We thought that some of the course concepts could become more understandable for the students. We had the idea that instead of trying to understand a concept through the textbook's figures, it would be easier if we create a computer animation explaining the same concept. The computer networks area and the Internet provide us with a great variety of issues to begin.

Of course, to develop a four-credit course would take a long time and will not make a great sense for the scope of this thesis. We decided to develop a part of a web-based course that provides an introduction to the Internet. Our aim is to provide students

with a general idea about the Internet's basic infrastructure and the basic hardware and software components that make the Internet work. We also provide students with an assessment tool to find out what they have learned and a variety of web resources for those who wish to examine closely the issues we describe in a more brief way. Our course could be taught to students with little or no experience to computer science and it will be totally web-based or a Web Course, according to the types of web-based courses.

B. OUR WEB-BASED COURSE IMPLEMENTATION

For our course implementation we decided to follow the eight steps for the development of a web-based course, as are described in chapter three.

1. Our Strategy Selection

We had to choose between the two strategies for moving a course to the web, the team approach and the individual approach. Although the team approach is the preferred strategy for integrated web-based courses, we took the risk to develop the course without the assistance of a team. Two reasons existed for taking this decision. First was the nature of our thesis that was an individual project. Second were the time and financial constraints that might occur during the implementation of the project. However, this approach is very common in the educational community because many instructors move their courses to the web by their own. The conclusion we made by choosing the individual approach is that we earned a lot of benefits. This was the first time we taught through the web, so we learned about instructional design principles and how to apply them in a new environment like the Internet. We also learned how to develop web pages taking under consideration design and usability principles. But we also learned that designing, developing and delivering a web-based course of high quality is a significant, difficult and time-consuming task.

2. Our Course Environment Selection

As we have mentioned the selection of the web-based course environment is one of the most important steps in the development procedure. During our course's design we

had the opportunity to use one of the existing web course management systems as our course template. We preferred to proceed by our own, designing our course environment. We tried to include in this environment all these features that would enhance the learning process.

We designed the course's environment in such a way that it will be very attractive and easy to use. We managed this by keeping it simple and providing the same template in each web page. The user may navigate anywhere easily and without being lost inside the course's web site. The student may study the course overview where the instructor describes very clear the course's objectives. He also may be informed about what he will be able to know after course completion.

The course environment also contains the lectures, where the student may study the course content. There are six lectures and these are organized in such a way that there is a sequence among them. The student may also navigate through the course resources if he wishes to study deeper into an issue.

The communication among course participants is ensured with two ways. The student may communicate and interact with the instructor or the other students with the e-mail application that provided by the course template. Another application, the synchronous chat, makes possible the online synchronous discussion among students or between a student and the instructor. Students may use this application to join a discussion concerning a common subject among stakeholders other than the course participants.

Finally, the students may check what they have learned by taking the course quiz. The structure of the quiz is multiple choice and contains questions from all the six lectures. Students receive immediate feedback when they answer the questions and after they are done, their score is presented with a comment about their performance.

3. Our Course Design

Following this step we tried to apply the instructional design principles we studied in chapter three. We designed a course for students with little or no background to

computer science. As a consequence, the course content was simple and some issues were not presented in a more detailed and complex way. Of course students with a background in computer science, have the opportunity to study these issues in more detail, navigating through the course resources.

The course goals and objectives were clearly stated from the beginning. The student may check the course goals and objectives from the course overview page. If he feels that they fulfill his expectations, he may enroll on the course.

The course is a Web Course, which means that the students should be equipped with a desktop or laptop, a browser and network connection. There is no need for live lectures or meetings. This may happen only for social purposes, for example after all students completing the course, a party may occur.

The instructional strategies we used are online lesson presentations, assignments through e-mail and assessment test. The lessons are delivered through the web in textual form and computer animations of the concepts are provided. In this way we tried to make more understandable issues that are very hard to be explained solely in text form. After completing the lectures, the students are able to watch a movie that gives another view of what they have learned. The instructor is able to know if his students understand and learn his material by surveying their questions that he receives by e-mail, quizzes and assignments they submit.

Finally we designed, as a kind of learning activity, a synchronous chat application used from the students for online discussions and ideas. Another form of interaction is the navigation through the course resources. The students will be able to find more information concerning the course content by navigating through the resources links.

4. Course Material Preparation

The gathering and preparation of the course content is a very important procedure. As soon as we decided about the course content that we would develop, we started to search for resources in textbooks and on the Internet. We had as a basic reference two textbooks that we studied and are having as main topic computer networks and data

communications. The first one, that was our basic reference for our course, is “Computer Networking” by James Kurose and Keith Ross. We studied this book and we tried to summarize the most basic concepts that describe how Internet works. Because the course is developed for students with little or no experience to computer science, we try to keep the whole content simple and understandable. The second textbook we used as reference was “Data and Computer Communications” by William Stallings. The content of this book is more scientific and complex, but provided to us a better understanding of concepts related with the Internet infrastructure. These two textbooks were our basic references for the course’s content implementation.

Our search on the web resources was really a great experience. We found a lot of web sites that were related with our subject. The variety of resources was great and was categorized according the simplicity or the complexity of the concept. Our concern was to choose web resources that provide a simpler view of the subject. However, we included some resources that provide a more advanced description of some concepts, like RFCs (Request For Comments) papers that provide the original development of a concept. This choice was made to help some students who wish to study deeper some issues. Generally our scope is not to provide a high level scientific course.

During the study and preparation of our course materials we had two concerns. First we were very careful to choose resources that were accurate and fit to the objectives we had for our course. We excluded resources that were out of date and were not representing our course’s view. The Internet provides a wealth of information that is out of control. As a result many of them are not accurate and of low quality. We have to be very careful of the resources we decide to use in our course content and as course references. Our second concern was about any copyright permission required for the usage of some resources. Due to the scope of our project, which was clearly educational and not commercial, we did not have any requirements for copyright permissions. Of course this is an issue if you wish to create a web-based course for a commercial organization.

The lesson we have learned during the gathering and preparation of our course material is that we should be focused on course objectives appropriate for our students.

We should start this procedure as soon as we have finished with the course design or at the same time. Our material selection should be accurate and from reliable resources in order to avoid student's confusion.

5. Definition Of Course Activities And Interactions

As we referred in chapter three we have to define ahead the course activities and interactions. This happens due to the nature of a web-based course and the absence of the face-to-face interaction among the participants. We defined clearly the activities and interactions during the development of our course. The activities are presented to the overview page of the course web site. They consist of lecture material in text form assisted by animations of the lecture's concept. In this way the students were assisted to have a better view of the concept presented by textual form. We hope that this strategy will make the concept more understandable and the learning experience more pleasant. The other course activity was the quiz. We implemented ten questions multiple choices quiz that covers the critical points of course content. The quiz was implemented with a Java applet that provides many capabilities. The students may take the quiz and see after answering each question if they were right or wrong. After completing the quiz, they have an immediate feedback of their performance, for example if they have to study more or if they have done a good job. Finally they can submit their answers to the instructor with e-mail. The instructor receives the results and has a feedback about his students' performance.

Our course's interactive functions were also implemented. We offer a course's resources page that includes some references, on the web or a library, in order to help students with their studying. So they have the opportunity to interact with the course resources. Another interactive function, the most classic and simple one in web environment, is the e-mail application. Students may reach their instructor anytime asking him questions concerning the course content and resources. Finally, a synchronous chat application was introduced. We used a server-client Java program that we coded when we studied the Internetwork Communication in Simulations class (MV3500) at NPS. The students may discuss with other students about the course and post their views.

They may also participate in discussions handled by other people who are interested in the same concept. Finally, they may interact with the instructor and discuss with him synchronously. For the realization of this session, the instructor should earlier announce his availability hours.

The course web site is not static. We mean that the need for changes in the content, the activities or the interactions may arise. These changes should be done but we have to inform the students about the content of these changes. The most proper way to do that is by e-mail or by creating a course announcement web page where the students will be informed about course issues.

6. Building The Course Web Site

This is the step of our web-based course development where we combined instructional design, web design and usability principles. Combining these two fields, we will create a good interface in order course content can be easily accessed, read and examined. We always had in mind during our web site design, that the computer is a tool used by someone to accomplish some tasks. If this tool requires more time, training, and effort to use than the tasks require without the tool, then it is a poorly designed tool.

During our course web site design, we followed Jacob Nielsen criteria for web site design, introduced in his book "Designing Web Usability".[Ref. 19, p.380] These four criteria are the foundation of good web site design, because they are the four things users want the most. These are high quality content, often updated, minimal downloaded time and ease of use.

High quality content

We tried to provide our course web site with high quality content. We designed an attractive template for the students and we separated the meaning and the presentation inside the web site pages. We make clear where the meaning of a concept is located and where the presentation of this concept. For the presentation we use animated movies, images and a video movie. We used compression techniques for the images and video files in order to reduce the downloaded time. We preferred to use downloaded than

streaming video providing better image and sound quality. For the meaning of a concept we use text with a standard font size of 10 pt. The pages headings become clear using larger font size. We tried to keep text as short as possible and we divided the pages into chunks. In that way we tried to prevent users from scrolling down the page to find its end.

Often updated

We offered our course for a period of two weeks, so there was no need to update the content of the web site. However, in web-based courses that go on for a long time, the update in their content is necessary. This update may concern the lectures, the resources, projects and assignments or even the course schedule.

Minimal downloaded time

We took as a fact that most of our student will use their home computers for accessing our course. That means a bandwidth capability of 56 kbps. We tried to keep the size of our files small. We have large downloaded time (up to 10 seconds according to Nielsen, Ref. 19, p.44) only in the presentation of the movie. We make a notice to the users about the approximate downloaded time according their Internet connection. We believe that comparing the quality of the movie, users will not bother to wait some time for download.

Ease of use

If a user has difficulties using a web site, he will not visit it again. We did not wish to make the life of our students difficult. We designed a common template for all the pages. Following such a technique, users become more familiar with the web site and they may navigate easily through the different pages. We use three different links, the first for sending the user to a different page of the same web site, the second for sending the user to a page in a different web site and the third for sending the user in another location of the same page. All the links were recognized with an underline. We did not use any frames while building the web site pages, in order to avoid problems when using different web browsers. There are clear titles in each page so the user knows where he is located all the time. The navigation is very easy and you can go anywhere into the site from any web page. The structure of the lectures' pages makes easier the learning

continuity of the concept. The student does not need to know which is the proper lecture to continue with because he may follow the links at the bottom of each page.

Our aim was to create a system where the students should have the chance for easy and enjoyable learning. But first we have to provide them with a system that its main characteristic is the ease of use. Of course it does not mean that a student may learn a subject through a usable system. We try to create usable systems that will help the students to accomplish intended goals of the course.

Our web-based course was systematically structured and labeled. Understanding and following this structure is very easy, either for the student, who wishes to navigate through the course material or the instructor who wants to locate an individual issue. Our web site structure is showed in figure 1. It is very simple but at the same time very flexible, because the template is the same in each page. That means the student may visit almost any page he wishes from anywhere is located into the course web site. The course home page describes the scope of this project. Next the user can go to the overview page where he learns about the course objectives and takes some instructions of how to use the web site and complete the course. This page drives the user to the lectures page, where the student may study the content of the course. There is a logical sequence among the lectures, so the student will not be lost with irrelevant issues. When the lectures are finished, the student may download and watch a movie that give a very interesting and understandable picture of the lectures' content. The resources page has links and references to related material according each lecture. The student may visit the resources at the end of each lecture to study more deeply the issues he just learned. Anytime during his study, he may collaborate with the instructor or other students using the e-mail application. He also may have a synchronous discussion of an issue with the other course participants, if he uses the chat application during the predetermined hours. Finally anytime during the course offering period, the student may take the test to evaluate his knowledge and provide the instructor with a feed back about his students' performance.

The course web site was implemented using the Macromedia Dreamweaver 4 platform, a professional HTML editor for visually designing and managing web sites and pages. The template we use in every page was designed and implemented using the

Macromedia Fireworks 4, a software solution for professional web graphics design and production. The animation movies were created using the Macromedia Flash 4, the industry standard for interactive vector graphics and animation for the web. Finally, the movie "Warriors of the Net" was an idea and production of Tomas Stephanson from Ericsson Radio Systems AB.

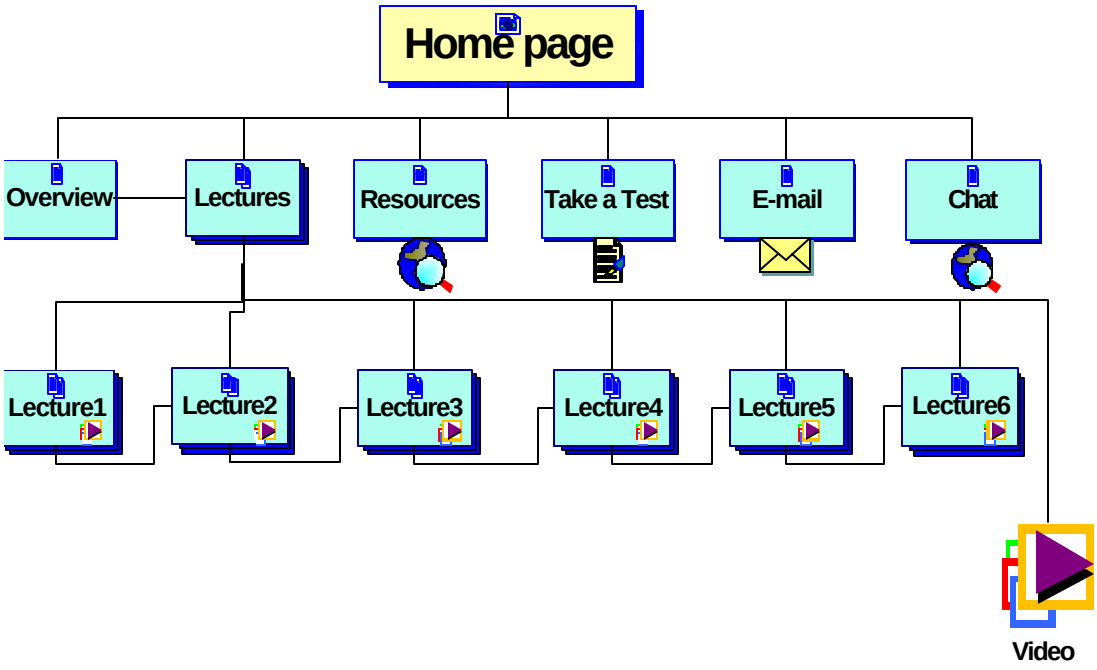

Figure 1 Course web site structure

7. Course Implementation And Management

We started our web-based course delivery on 20th of July 2002. The course web site material was reproduced in CDROMs and distributed to the students. Of course we may also upload our web site files in a web server. We preferred the CDROM solution in order to keep the project and the assessment procedure under control. Due to the nature of our project we set a period of fifteen days to the students to complete the course. We

provide some guidelines to students concerning instructor availability for interaction through the chat application. Other guidelines concerning e-mail messages, feedback on test results and technical assistance in case of problems were provided.

8. Course Evaluation

The evaluation of our web-based course is the last step of our implementation. We use the "Web Instruction Survey" evaluation tool that was developed by Professor Tony Ciavarrelli at Naval Postgraduate School. The procedure we followed and the results of the survey are presented to the next chapter.

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V. THE COURSE ASSESSMENT (RESULTS)

A. OUR EVALUATION METHOD

It is reasonable for the instructor to be able to receive a feedback concerning his web-based course after teaching it through the web. Although he has very carefully planned the course, he wishes to know how the students or other experts are doing with his material. He will probably receive very important observations and recommendations that will help him to improve his web-based course. This is the main reason for the development of web-based courses evaluation tools. These kinds of tools are focused in two main issues. The first is the assessment of the instructional quality of the course. The feedback from this assessment will provide the instructor with information concerning the instructional value of his course. Through the study of this feedback he will make all possible alterations that will change the instructional material and strategies in order to provide a better learning result. The second issue is the assessment of the design and usability of the course's web site. The instructor will receive very useful critique about his web-based course design and usability principles. This critique may be provided either from experts in the area of web sites development or from students who noticed some inefficient functions of the course's web site. The feedback will provide the instructor with a better view of his course's web site and he will make alterations that will improve the learning environment.

We made a reference to web-based courses evaluation tools. There are many kinds of these tools that an instructor may use. It is very common organizations, like colleges or universities, to develop their own evaluation tools. Also, there are companies such as E-Curriculum, which have developed evaluation tools for web-based courses. [Ref. 10, p. 57] Finally, a course designer or an instructor can build an assessment tool according to his unique bias, interest and requirements. According to Ciavarelli, it is really up to the developer of an assessment instrument to decide on the selections more appropriate to the purpose of the evaluation. He notices that an important point in developing an assessment instrument is to consider the evaluation of all components of an instructional system. These components include the quality and value of the instructional content, the instructor's performance, the instructional strategy used, the

presentation method, the delivery method, the appropriateness and reliability of the technology and media and the institutional support services. [Ref. 2, p.13]

The assessment tool that we use to evaluate our web-based course is the Web Instruction Survey that was developed by Professor A.Ciavarelli in Naval Postgraduate School. According to his view, he developed this tool having in mind that assessment should provide an objective or valid means to judge the educators educational and training accomplishments. Assessment should provide important diagnostic feedback to the student to improve learning, to the teacher to improve the instructional process and to the organization to improve its curriculum, support services and infrastructure. [Ref. 2, p.12] The Web Instruction Survey is a web-based course's evaluation tool that is delivered online. A complete form of this tool is presented in Appendix 2.

The Web Instruction Survey has three major sections. In the first section the participant should answer ten questions. The first three are related with the participant's age, sex and his/her primary position at the Naval Postgraduate School. The remaining questions try to give us an image of the participant's computer background, how often he/she uses a computer, type of applications he/she uses and for what type of activities, how often he/she uses the web, if he/she has taken a web-based course and what are his/her computer skills. These questions are very important in order to build the profile of the participants to our survey.

The second section of the survey is related with the evaluation of the web-based course instructional quality. The evaluation tool uses thirty-two statements that the participant has to grade using the Likert scale approach (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree). The statements are related with instructional design issues, like the role of the instructor, how clear the learning objectives were, the course content, the course's instructional strategies, the satisfaction the course offers, comparison with other web-based or in class courses and other. This section provides us with a feedback related to the instructional quality of our web-based course and which are the positive and negative points of our instructional material and strategies we use.

The third section of the survey has to do with the evaluation of the course's web site. The evaluation tool uses twelve statements that the participant has to grade using also the Likert scale approach as in the second section. The statements are related with web page design and usability issues, like how easy was the web site navigation, how often the user felt lost in the web site, how long were the downloaded times for media components, how easy was to read the text and other. The feedback provided by this section, gave us the opportunity to take under consideration some very important design and usability issues that we did not thing about during the implementation and have a negative impact to the learning environment. But we also receive a feedback about the strong points of our course's web site that enhance the learning procedure.

The last part of the Web Instruction Survey gives the opportunity to the participant, after completing the three major sections, to express his/her overall impression he/she concludes about the web-based course. The rating is made with the Likert scale approach as before and provides us with a feedback of how good or bad was our web-based course in general. Finally, the participant may answer three interview questions, where he/she can make comments about how easy or difficult was to use the course's web site, any difficulties he/she met through the web site and what he/she will change to the functionality of the web-based course. Some of these comments provide us with useful ideas about changing some of the course's issues and enhance its functionality.

B. THE WEB INSTRUCTION SURVEY RESULTS

1. The Participants

The same students, who have studied the web-based course, also completed the Web Instruction Survey. After they submitted the course's quiz, we provided them with the electronic form of the survey. They had a period of five days to submit the survey form. After we gathered all these forms and analyzed the input data.

Their age starts from 26 years old and the oldest is 38 years old. The participants consisted of eight males and two females. All of them are students, eight at the Naval Postgraduate School and two at the Community College of Monterey Peninsula. All of

them are using a computer either at NPS and College or at home. Figure 2 shows popular applications used by students.

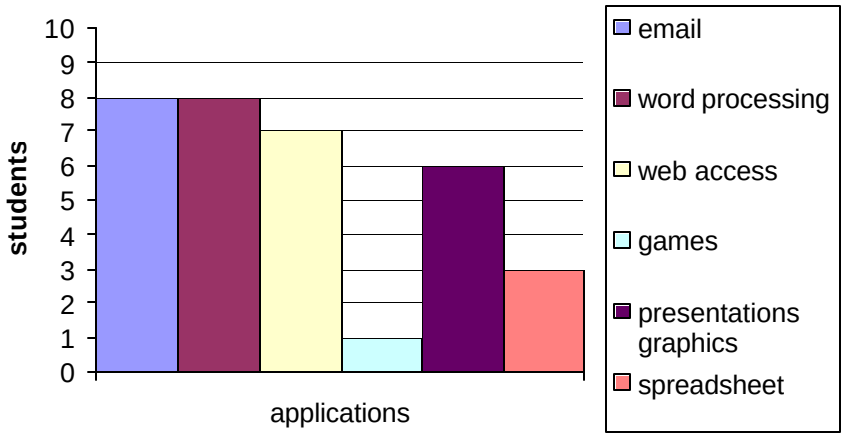

Figure 2 Popular applications used by students

None of them have ever taken a complete web-based course. Two of them have only participated in the experimental web-based course created by a former NPS student for his thesis study. Almost all of them have taken at least one course where the instructor uses the web as an assisting tool for the course content. Figure 3 shows the participants computer skills.

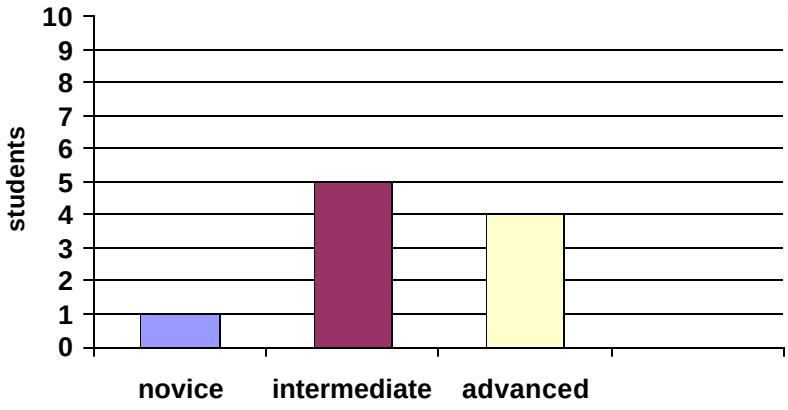

Figure 3 The students' computer skills.

All of them access the Internet daily and most of them several times daily, spending at least an hour browsing the web. Figure 4 shows the time is spend by the students browsing the web.

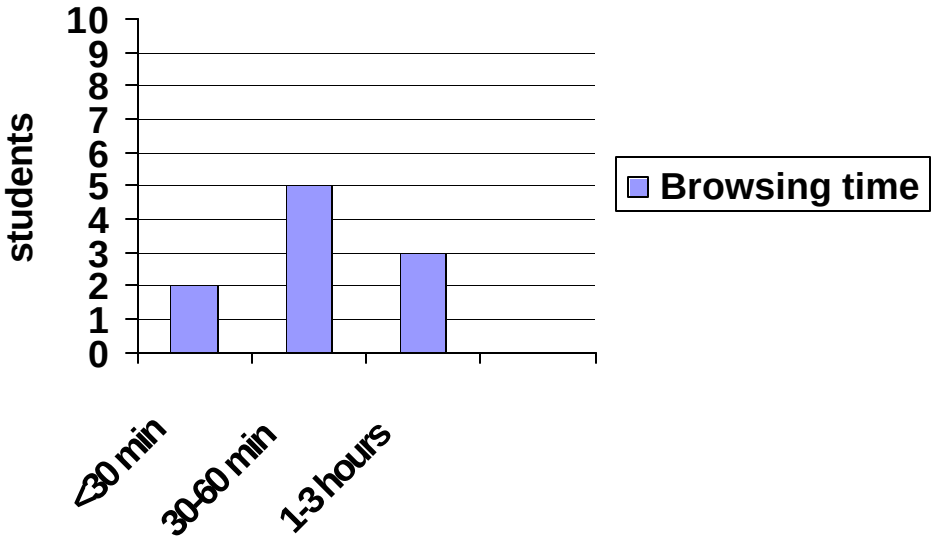

Figure 4 The time students spend browsing

We conclude that results from the Web Instruction Survey for our web-based course indicate students who participated in the course had medium-to-high experience with computer applications. They have a very little experience on web-based courses but they are visiting the Internet daily, spending at least an hour browsing the web. It was almost impossible for us to find some people who have taken online courses. We can give an explanation to that assuming that because of the participant's age, they are not so familiar with new educational technologies like the web-based instruction.

2. The Course's Instructional Quality

From the second section of the survey, we reach to many useful conclusions about the instructional quality of our web-based course. The students understood the purpose of the course and the learning objectives were clearly stated. The instructor does not define his role very clearly to the students according to their rating. The list of learning events is

posted on the course's web site. The students rate the learning activities as highly interactive. Course content is relevant to stated learning objectives. Some students believe that our course could make a better use of web resources. They also strongly agree that they received adequate feedback on their learning progress when they submit the course's quiz.

The content of the course was accurate, current with no outdated materials. The course's quiz is based on the learning objectives, although some students believe that it was not at the right level of difficulty for them. Instructions are provided for the quiz submission. The instructional material presented in a very organized way. The students believe that the course include interactive learning activities, although these activities do not include students collaboration. Due to the animations, some parts of the course required from the students to reflect on the subject. However, the course does not engage the students in problem solving activities.

It seems that the students have a clear view of where to get help if they have any questions about the course. Almost everybody had a timely feedback when posted a question to the instructor. The media we use, animation and video, made a great sense to the students. Figure 5 shows how students rated the course according to their learning improvement.

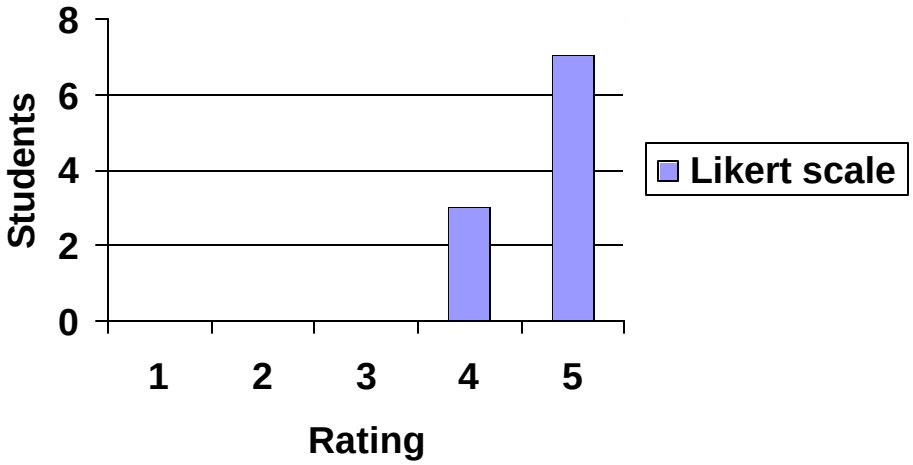

Figure 5 Students opinion that the combined media components improve their learning

According to the survey, the course follows a logical structure and that made the students to follow very easily the course content. Most of them rate the course as having the right level of difficulty for them, although they are not all studying the computer networks area. Figure 6 shows how students rated the course according to their expectations. They believe that the course met their expectations and it was a valuable learning experience, although they do not have any experience to web-based courses.

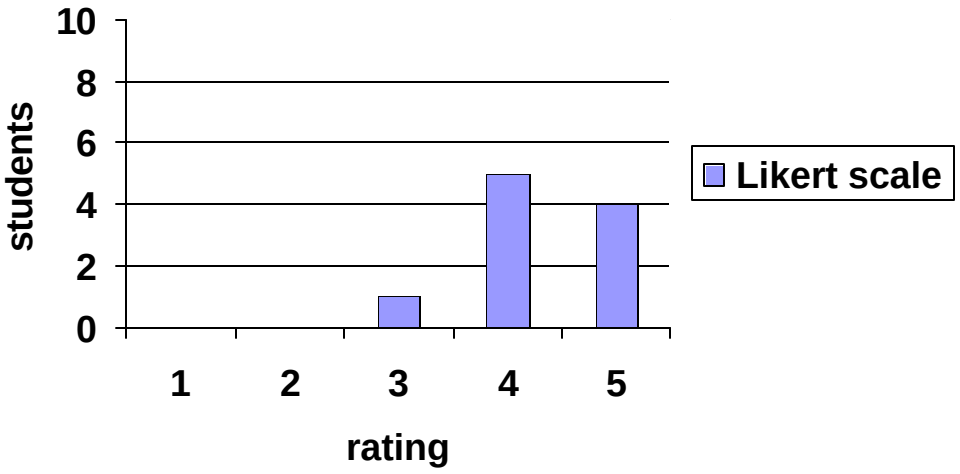

Figure 6 Students rate the course that it met their expectations

The combination of text with the other media components is very good and enhances the learning process. They made a great use of the communication options. That became sensible by the instructor from the number of email messages he received during the two weeks the course was delivered. He also joined very often chat rooms that were created by the students to discuss about course's issues. The majority of the students believe that the course was as good as most classroom courses they have taken, but some of them neither agree nor disagree with this issue.

3. Course Web Site Design And Usability

As we have mentioned earlier that the third section of the survey is related with the design and usability issues of our course web site. It seems, from the students rating,

that they did not have any particular difficulties with the web site structure. That means it was easy for them to navigate through the web site and they did not get lost or were not confused with the web site's structure. Any information they needed, related with the course, was not hard to be found. The text that was included to the course web site is not easily readable. Many students found the font size very small and they had to make an effort to read the text. The web site's pages were created in such way that the amount of page scrolling is minimum. The students were allowed to return to home page from anywhere they were.

A major observation, that was expected, is the long downloaded time for the media components. Although the animations do not take a long time to be downloaded, the video clip downloaded time is quite long. Another drawback the students noticed is that the information presented in some pages is crowded. This provides the user with a cluttered web page image when he is navigating through the course's web site.

The overall impression of the participants for the course content was very good. They also judged the course's web site design and navigation as very good. The overall impression about our web-based course is shown in figure 7.

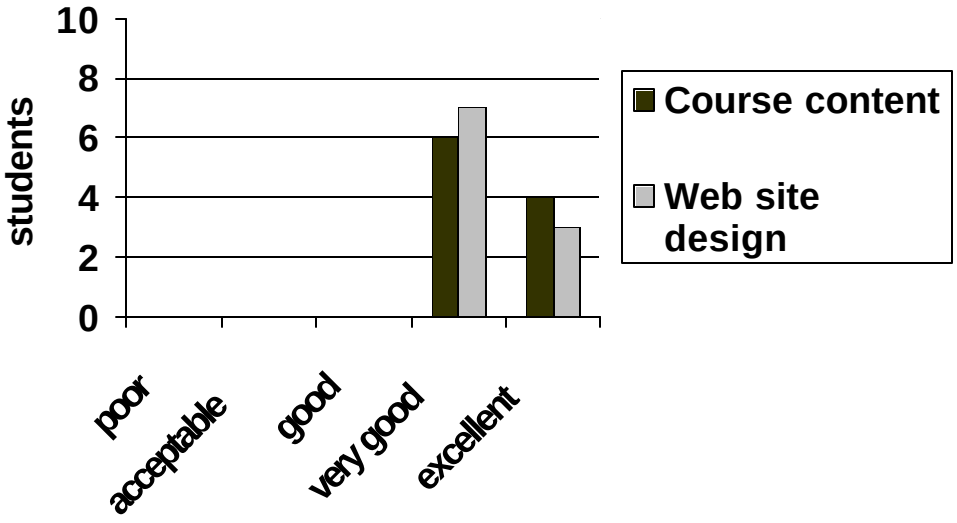

Figure 7 The students overall impression about our web-based course

C. FEEDBACK FROM OUR SURVEY

After gathering the Web Instruction Survey forms, we categorized the results and we tried to configure a final view of our web-based course. These results consist of the answers to the forms and the comments we gathered during the delivering period of the course.

1. Positive Comments

As a first impression we think that our web-based course was a success. We reach this first conclusion taking under consideration the students overall impression about our course (Fig. 7). Although students' previous experience in web-based courses was very low, they are advanced computer users who spend at least an hour daily navigating through the web. That means they know how to sort a web site according its functionality. Our first success is that we managed to give to the students a clear picture of the course, what we are going to teach. The students found the course content simple, accurate and understandable. The course structure follows a logical succession that helps students to build up their knowledge. This structure is very tightly bound up with the structure of the course's web site. Students had no difficulties in understanding and applying the course activities. The high student's average in the course's quiz proves that they took advantage of the learning material and had no difficulties with the learning strategies we followed (Table 3). The course's web site is the delivery medium and the communication channel between instructor and students. Its main characteristics according to students' comments were the simplicity, the ease of use and the user-friendly interface. There were no comments about complicated structure and nobody stated that he was lost during his browsing time. The directions of how to interact with the various learning activities are clearly stated. The students liked very much to interact with each other or with the instructor. I noticed this point because I spend a lot of hours using the chat application to discuss with students some issues, not always related with the course. The feedback from instructor was immediate and nobody had to ask the same question for a second time. The same happened with the quiz grades.

A major issue that we wish to discuss is the use of combined media components into the course content. We received very positive comments about how helpful the

Student	**Grade**
1	90
2	100
3	100
4	100
5	80
6	90
7	100
8	100
9	70
10	80
Average	**91**

Table 3 Students results after taking the course quiz

animations were that explain the main points of each lecture. Some students that have a limited experience in the Internet infrastructure were very enthusiastic about the animations. Here is an original comment we received from a survey form: “I was trying to understand how a router works reading from a book. It was very hard. When I asked the instructor, he tried to explain on the blackboard. I was lost. When I saw the animation you have in lecture two, I was very happy. I ran it again and again and I found out how simple it was. It was great and I had a very pleasant time”. We received the feedback that the animations and the video clip we introduced to our web-based course were very helpful for the students. The animations are explaining the basic issues of each lecture. If a student does not understand an issue reading the lecture, he may find an easier way to solve his problem with running the related animation. Other students that have understood the issues of a lecture, they may run the related animation in order to add an

image to their knowledge. The movie we use should be presented after finishing the study of the lectures. It describes with an understandable way and very nice images how all the issues are bound together and make Internet works. The students commented that the movie solved some of their questions and offered a great opportunity for reviewing the basic course issues before the quiz submission.

We understand that there is a difference between animations and video quality. That happened because it was the first time that we tried to insert some kind of animation in web-based instruction. We are not experienced animators having great comfort with animations software. However, we conclude that the included animations are very helpful to the better understanding of the course content. The students' comments that they had a great experience, the course was more interesting than many classroom courses they have taken and they have a great time during their learning process, is a proof that we manage to enhance the learning experience with the usage of combined media components.

2. Negative Comments

The sense that our web-based course was a success was enforced by the thorough study of the students' survey forms. It was very impressive for us to realize that there were no truly negative comments. Most of the students made some comments about what they did not like either to the course content or to the web site design.

An almost common observation is that the font size was too small. As a result the students had to make an additional effort trying to read the text. Although we tried to design resolution independent pages that adapt to whatever size screen they are displayed on, we received some comments about small font size. We understand that what we had previewed in our browser was different from what some of the students saw in theirs. When we investigate the problem we found out that our design was taking under consideration the screen resolution that means that it was not resolution independent.

Another observation has to do with the text information that is presented in some course lectures. Some students noticed that some web pages were very crowded. As a result the first impression about the web page was not as good as the others. That happens because we tried to give for an issue as much information as we can without force the

reader to scroll the side bar in order to continue his reading. Maybe we have to change the text content of an issue and present it in a more simple way with smaller text size.

The animations, as indicated by the survey, are the strong point of the course content. A number of students commented that animations could be better presented. We agree, because our experience in designing and developing animations was very poor. The animations provide a great value to the course content and this value would be greater if the animations would be in a more professionally way implemented.

A final negative comment that some students made was that although they got answers for the questions after a reasonable time, the feedback was not immediate as in a classroom. Of course that happens because the web-based course is delivered in asynchronous way. It is not possible for the instructor to be available 24 hours a day to check his student's email messages and respond at the same time he receives the message.

3. Suggestions For Improvement

We are very concerned about the students' suggestions for the improvement of our Web-based course. Some students suggested making some alterations to the textual image of the course content. A first change will be to the font size that seemed to bother most of the students. Another concern is about giving a specific form (boldfaced or colored) in key words and phrases that are important and should attract the students' attention. Other students propose to provide more hyperlinks into the text in order to navigate more easily and quickly through the web site. The last two suggestions are very interesting but should be applied with great concern because we believe that there is a danger these text alterations to call off the student from the real scope of the lecture.

Another suggestion made by the students was the creation of a course announcement page into the web site. This page may be used by the instructor to post announcements, like changes to the schedule or the content of the course. He also may post changes to his available times for interaction with the students. We find this suggestion very reasonable and we will try to add a course announcement page to the new version of our course's web site.

The course content adds a great value to the learning experience. The observations we received from a student make us to think that maybe some alterations will make the content more flexible. A drawback is the long downloaded time for the course movie. A student suggested instead of this kind of movies that take so long to download, to use small video clips and more pictures. We agree with this proposal because we believe that combined media components enhance the learning process and the long downloaded times is a drawback to this process. However, we include this movie to our course content because we believe it is a valuable instructional tool for the understanding of the concept we try to teach through our web-based course.

The suggestions for the quality of the animations were also very reasonable. When we started to design and develop our course, we chose the individual approach instead of the team approach. The lesson we got was that an individual might develop a web-based course with an acceptable quality. A team of experts implements the high quality courses. Our proposal is that an instructor who is going to implement a web-based course to get helped in some issues by experts. We believe that the learning results of our course would be better if we had designed the animations in each lecture with the help of an experienced person.

A last suggestion has to do with the learning activities. Some students suggest that the course should include more student-centered activities. That means they find the quiz not enough for their knowledge evaluation and they are concerned if some students did not take the quiz by themselves but with others assistance. Plagiarism is a great concern to web-based courses. Additional learning activities provided to the students by the instructor, like projects or assignments, would make the student's knowledge evaluation more accurate and real.

4. The Role Of Combined Media Components

The web instruction survey tool was implemented as an assessment tool for the evaluation of web-based courses. That means it does not provide any specific area to evaluate the importance of the combined media components we used in our web-based

course. We were based in some very specific data to conclude that the use of combined media components enhance the learning value of our web-based course.

Primarily, the input we obtained from the instructional quality assessment section of the web instruction survey tool. The students strongly agreed that the animations and the movie helped their learning. As we noticed in figure 5, the results of the survey for the specific question enforce our opinion about the value added in a web-based course with the applying of combined media components. The students rated our course content as one with high quality. We believe that the final result would not be so encouraging if we had not introduced the multimedia in the development of our web-based course environment. These two input data from the web instruction survey tool made us to believe that the combination of multimedia into our course environment helped students to learn easily specific complicated concepts.

Secondly, the comments we received in the interview questions of the web instruction survey tool. Most of the students were very enthusiastic with the new experience. We mentioned an example of a student's comment in the positive comments section of this chapter. The first reactions of the students when we introduced the general idea to them were very positive. The reactions continued to be positive after the delivery of our course. Some students made comments about how helpful were the presentation of the concepts using animations. Other noticed that they tried to understand the concept presented in the text by playing with the animation again and again. Two students suggested to decrease the textual part of each lecture and to increase the animations. The majority of the students noticed how helpful was the movie in reviewing the lectures before taking the test. This is proved by the excellent results they had in the test, as we see in table 3. A general comment that we have to make after studying students' interview questions is that they were very excited with the concept presentation using animations. The reason was that the material was presented in a way that help them learn easier, combining the text with the image. However, almost everybody noticed the pleasant time they had during the course delivery in the new learning environment.

We clearly state that there is no specific way or tool to measure the effectiveness of applying combined media components into a web-based course. The only method is to

ask the people who participated in the course if they were satisfied. We conclude from the results of our survey that the participants of our course were satisfied. The combined media components we used during our course delivery helped the students to learn easily and in a more pleasant way. We consider this result, as enhancement of the learning process ought in the creation of an educational environment based in the use of combined media components.

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VI. CONCLUSIONS AND FUTURE WORK

A. SUMMARY AND PERSONAL VIEWS OF THE RESEARCH

The web-based instruction establishes a foundation for continuous research in the area of distance education. The new ideas in this area have to do with the progress of computer and educational technology. Most of the problems I met during the development of my web-based course will be solved in the next few years due the new innovations.

When my research was started, I had two main concerns. The first one was to learn how to teach. I am not an instructor and my experience is very small, having to do with teaching technical subjects to navy personnel. I believe my research in the area of instructional design and practices gave me the opportunity at least to design a nice course. My second major concern was how to apply all these instructional practices to a new environment, like the web. The problem became bigger because my aim was to develop a course in the new environment applying combined media components that would enhance the learning experience. Gathering the results of the Web Instruction Survey at the end of the course, I realized that I had the chance to develop a web-based course that met my expectations.

The scope of my research was to develop a web-based course that would be more instructive and pleasant than web-based courses I experienced in the past. I tried to manage this by applying techniques for the first time, having no experience with them. The results encourage me to continue the research in the area of distance learning and more specific in web-based instruction. I have always on my mind how I can use and transfer my experience obtained during this research to the development of web-based courses for the Hellenic Navy. Web-based education offers a great opportunity to take advantage of the web in order to offer education independent of time and place.

During my research I tried to study how to deliver a course in a totally new environment, the web. I concluded that all the functionalities of a traditional classroom might be transferred to the new environment. But I also noticed the critical role of the instructor. The Internet is appeared as an environment where education is offered with no

limits in time and place. However, the role of the instructor is so critical that can not replaced at the whole. After conducting my research I realize that web-based instruction is not appeared as a total replacement of the traditional classroom. I believe that this will never happen. Instead of this, web-based instruction is a perfect solution for people who have place and time constraints. An example of this category is the personnel of the Greek Navy who miss a lot of educational opportunities due to their overload schedule. Another example is the professionals who are not able to attend educational programs because of time constraints. In our days the education is a continuous task and we should find ways to offer opportunities to everybody. Also the web environment offers some tools that may be used as a complement to the learning activities. That means instructors may create their courses' web sites with content that will complete and enhance the classroom teaching. For example this kind of web sites may contain web resources, discussion boards and explanation of difficult concepts using combined media components like animations, simulations or video clips. The teaching hours might be reduced and some learning activities will be accomplished through the course's web site.

My sense after completing this research is that I tried to develop a part of a web-based course following some basic issues of instructional and web design. I tried to make more understandable and friendly to the user some difficult concepts using a combination of different media components. The results from the survey gave me the impression that I managed to implement a instructive course environment that provides the students with a pleasant and instructive learning experience. I learn a lot from their observations and I understand what was good and what should be corrected. As the educational and computer technology advances, web-based instruction will gain a very large acceptance as successful educational practice. Web-based instruction is here to stay.

B. FUTURE WORK

As we mentioned in the previous section, web-based instruction establishes a foundation for continuous research in the area of distance education. There are many issues that need further investigation. In this section some potential subjects are proposed for future work and research.

My work was to implement a part of a web-based course. The next step will be the implementation of a whole course for the Hellenic Navy introducing combined media components. The beginning was made by LT G.Stavritis HN. He implemented a web-based course for the Hellenic Navy during his thesis work on September 2001 [Ref. 11]. This course was a good reference but it was not introduced the use of combined media components. According to my opinion the design and development of web-based courses for the Hellenic Navy, introducing multimedia, is feasible. I believe that my thesis work investigate some critical issues of how to proceed in the implementation of web-based courses for the Hellenic Navy.

Another possible area of investigation is the study of which kind of naval interest courses is possible to be developed and delivered through the web. This is a very important duty, the choice of the proper courses that their web implementation will offer almost the same result as the traditional way of teaching. The navy personnel are professionals having great sense of responsibility. The education that is provided to them should be at a high level in order to be ready to react in every difficult situation. That is the reason why the choice of the courses that will be implemented in the web environment, should offer the same high standard as the traditional classroom courses.

Finally, my web-based course lacked any security policy for the authentication and the check-in procedure of the students. A potential area of research might be the development of security policies for web-based courses offered in the Hellenic Navy or general in an organization with security restrictions. Plagiarism is an existing problem in web-based education. Creating applied security policies in web-based courses might be a very effective way to avoid this kind of problems.

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APPENDIX A. EXPERIMENTAL WEBCOURSE SCREENSHOTS

We provide some screenshots of our web-based course. We hope that they would be helpful to the reader to understand some of our project issues. Of course, due to the dynamic structure of the website this is just a sample of our work. Its full capabilities can be presented and tested only through the web.

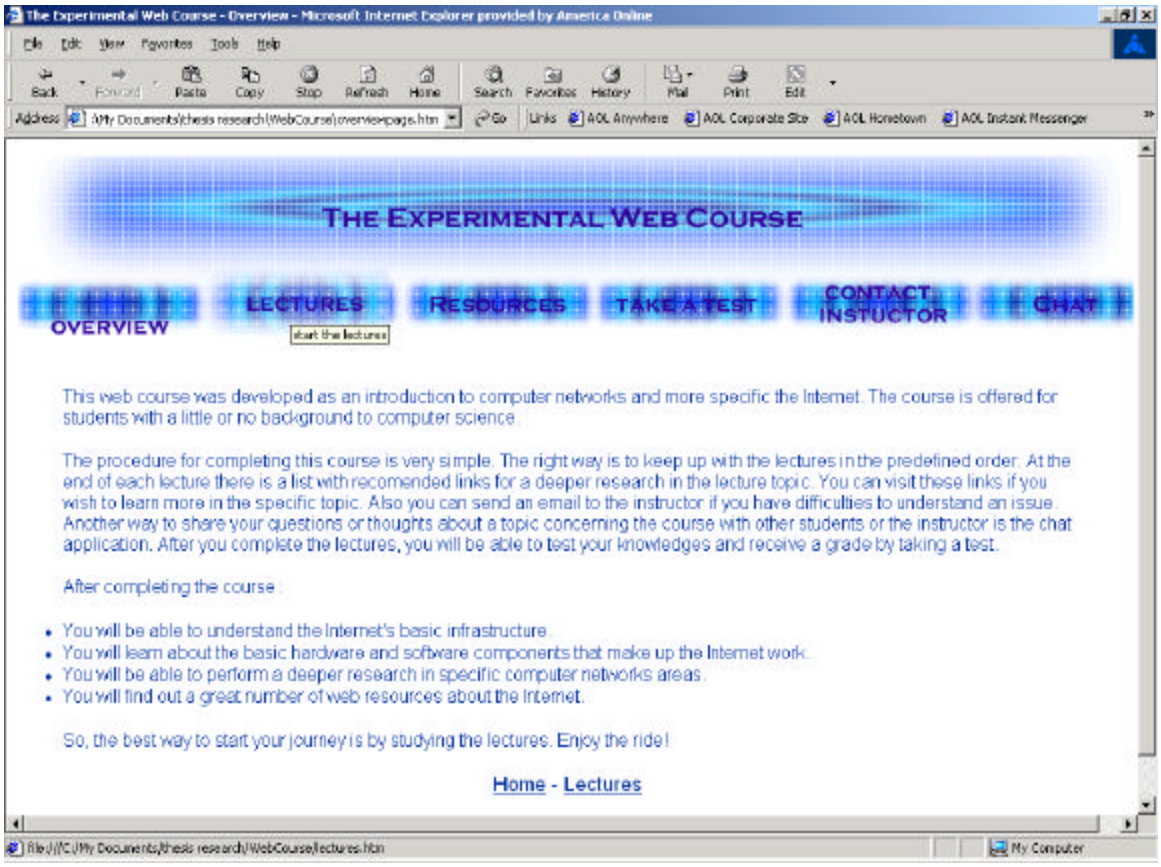

Figure 8 The course's overview page describes the scope and the objectives of the course. Also gives some directions how to get started.

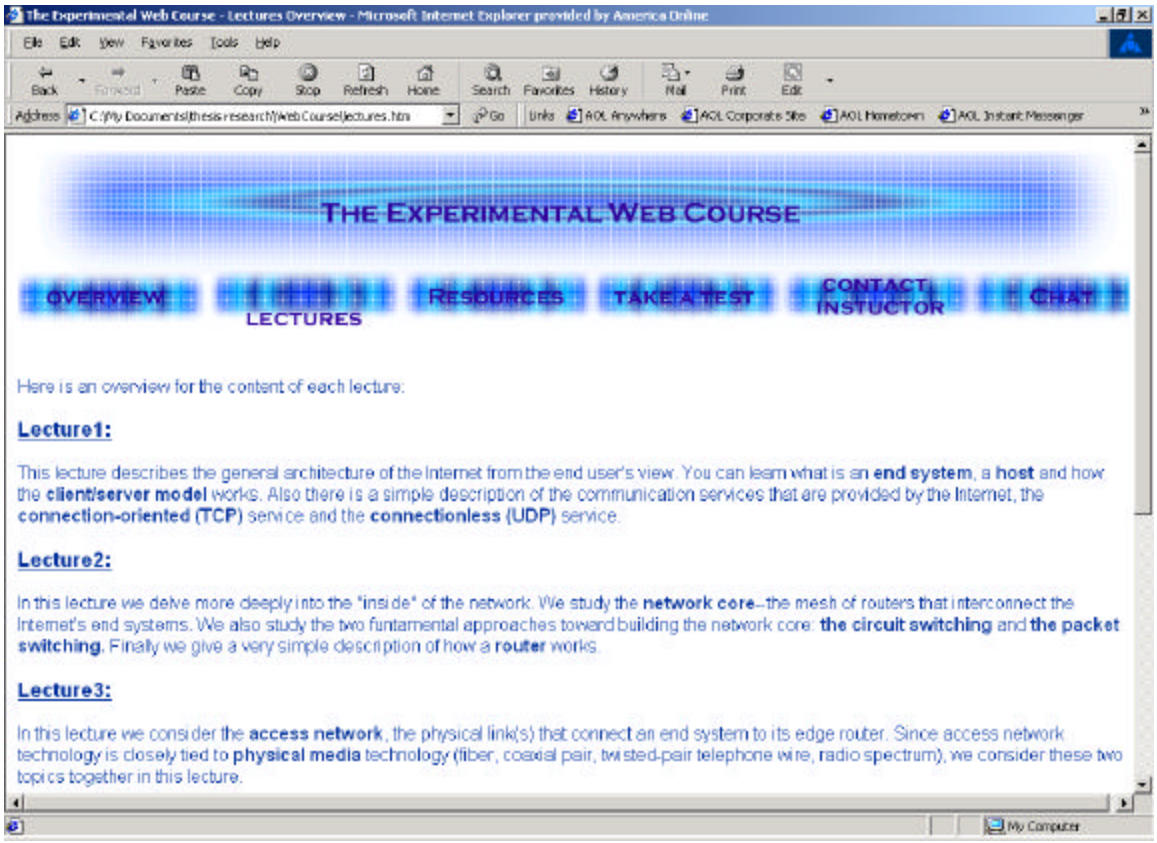

Figure 9 The lectures page. Here there is a brief description of each lecture's content. From this point the student may navigate in any lecture he likes.

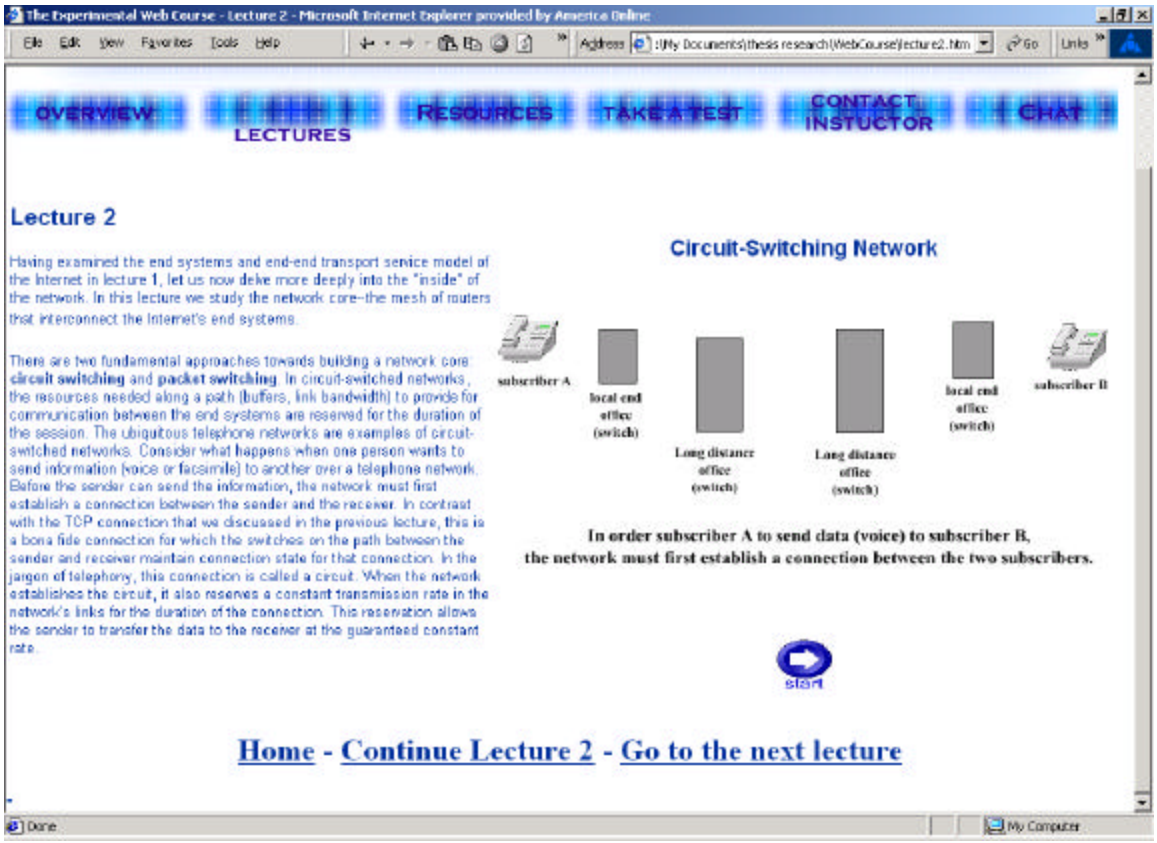

Figure 10 The first part of lecture 2. In the left side an issue is described and in the right side we see this issue animated. The student may continue the lecture or go to the next lecture.

Figure 11 The course resources page. We provide resources (books or web links) for each lecture, where the student may enrich his knowledge.

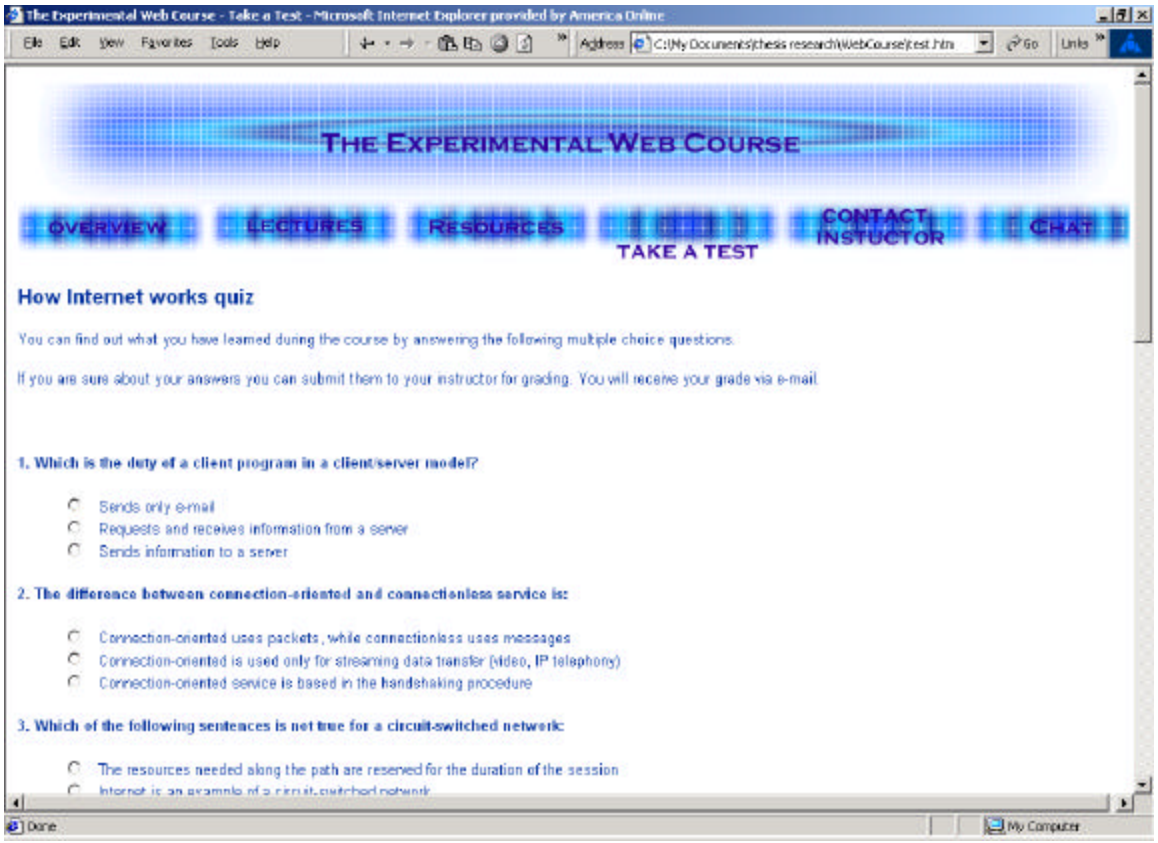

Figure 12 The course test page. The student may take the test when they feel ready and have an immediate feedback.

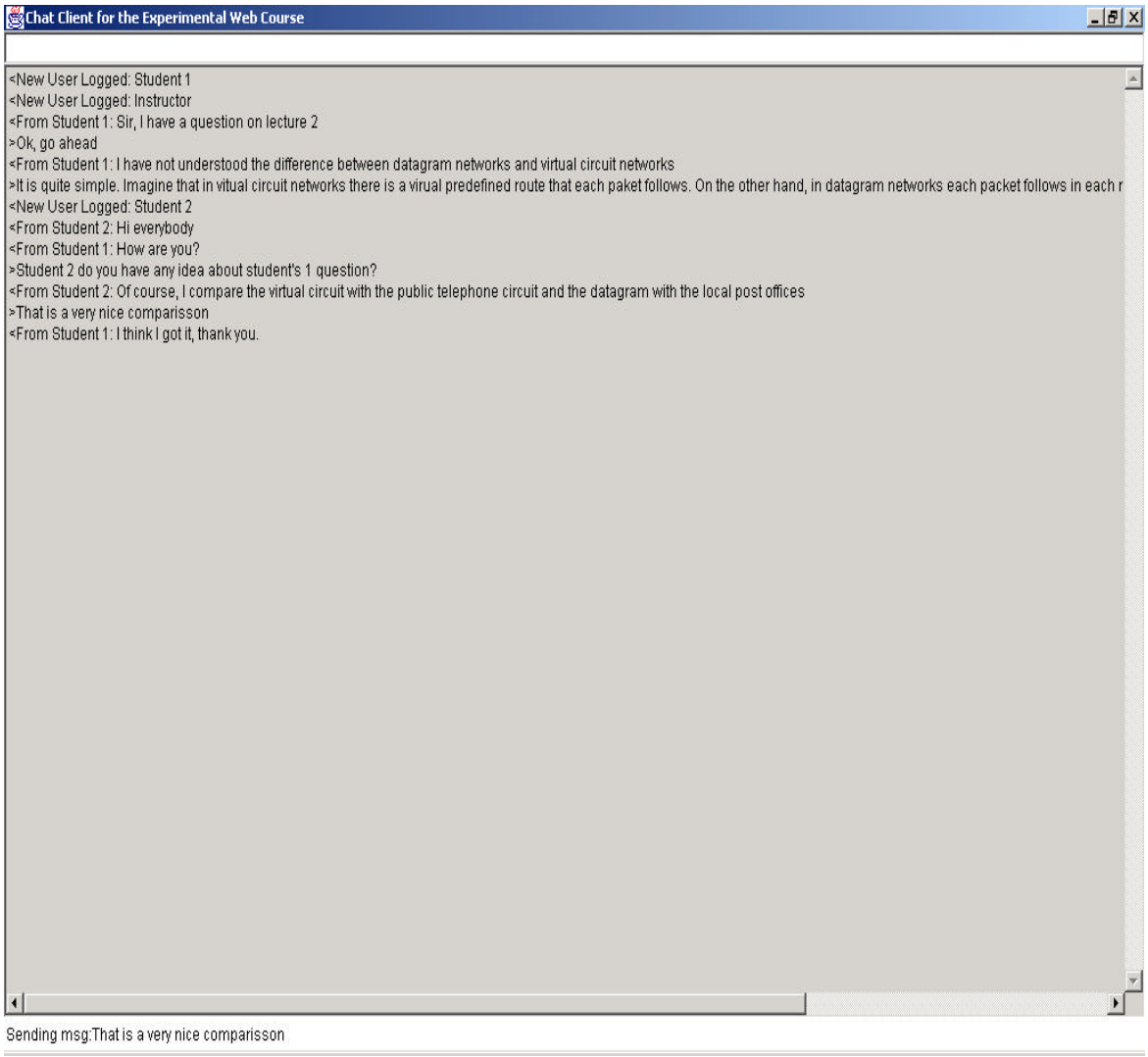

Figure 13 The chat application that gives the opportunity to the course participants to discuss have a synchronous conversation.

APPENDIX B. THE WEB INSTRUCTION SURVEY TOOL

WEB INSTRUCTION SURVEY

Please mark your choices by placing a checkmark in the appropriate box for each of the following items. Your specific answers will be completely anonymous, but your views, in combination with those of others, are extremely important.

SECTION 1: YOUR BACKGROUND AND USE OF COMPUTERS

1.What is your age?

Under 25…….☐ 26 to 30…….☐ 31 to 35…….☐
36 to 40…….☐ 41 or older…….☐

2.What is your sex?

Male……☐ Female…….☐

3.What is your primary position at the Naval Postgraduate School (NPS)?

Student ☐ Faculty ☐ Support Staff ☐ Supervisor ☐ Other ☐

4. Do you use a computer at (please check all that apply)?

Home…….☐ NPS…….☐ Mobile……..☐

5.Which of the following do you use (please check all that apply)?

PC……...……..☐ Macintosh……..…☐ Notebook……☐
Palm ……..…...☐ Windows ……..……...…..☐ Netscape Browser……..☐
MS Explorer……☐ MS Office ……...…….☐
Other (please write in): _____

6. What type of activities do you perform on computers (please check all that apply, whether at work, school, or at home)?

E-mail……..☐ WordProcessing……☐ WebAccess/Browsing……..☐
Games……....☐ Presentations Graphics…..☐ Spread sheet…….☐
FinancialPrograms…...….☐ Other…….☐

7. Have you taken an online (Web-based Course) before?

No…….☐ Yes…….☐ (I completed at least one course)
Yes...☐ (But I did not finish the course)
Yes…….☐ (I completed more than one course)

8. How would you rate your computer skills?

Novice or Beginner…….☐ Intermediate…….☐
Advanced or Expert…….☐

9. Approximately how often do you access the Web?

Several times daily…….….☐ Once daily……☐
Less than five times per week…….☐ Less than ten times per month……☐
Never……☐

10. When accessing the web, approximately how much time per day, on average, do you spend browsing or searching the web for any purpose?

Less than 30 minutes….☐ 30-60 minutes……☐ 1-3 hours…….☐
More than 3 hours……☐ No time….☐

SECTION I: INSTRUCTIONAL QUALITY ASSESSMENT

Please circle the number that best represents your view regarding the content of the course web pages. If a particular item is *Not Applicable* then write *NA* on the left of the number that identifies that item:

1. I understood the purpose of the course 1……2……3……4……5
2. The learning objectives were clearly stated 1…..2……3……4……5
3. The role of the instructor was well defined 1…..2……3……4……5
4. The class agenda (list of learning events) was posted on the site

   1…..2……3……4……5
5. The course learning activities were highly interactive 1…….2……3…..4…..5

6. Course content was clearly relevant to stated learning objectives 1...2…3…4…5

7. The course made good use of web resources…….1…2….3….4…..5

8. I received adequate feedback on my learning progress…….1….2….3….4…...5

9. The content of the course was technically accurate……1….2….3….4….5

10. The content of the course was current with no outdated materials

1….2….3….4….5

11. Course exams were based on the learning objectives……1….2….3….4….5

12. Course exams were at the right level of difficulty for me……1….2….3….4….5

13. Instructions for assignments and exams were clear……...1….2….3….4….5

14. Instructional presentations were well organized ……..1….2….3….4….5

15. The course included interactive learning activities …… 1….2….3….4….5

16. Some learning activities included student collaboration: …….1….2….3….4….5

17. Parts of the course required me to reflect on the subject ……..1….2….3….4….5

18. Parts of the course engaged me in problem solving activity: ...1….2….3….4….5

19. I knew where to get help if I had any questions about the course: 1…2…3…4…5

20. The instructor was available for help when needed……...1….2….3….4….5

21. Feedback on exams was timely ……1….2….3….4….5

22. The media (animations, simulations, video) helped my learning: 1…2…3…4…5

23. Internet links provide were very valuables to the course: ……1….2….3….4….5

24. The course had a logical structure that was easy to follow: ….1….2….3….4….5

25. The course was at the right level of difficulty for me: ……..1….2….3….4….5

26. Overall, the course met my expectations: …….1….2….3….4….5

27. The course content provided me with a valuable learning experience:

1….2….3….4….5

28. I would recommend this course to others interested in this subject:

1….2….3….4….5

29. There was a good blend of text, graphics, and other media: ….1….2….3….4….5

30. Communication options were adequate (email, chat room, forum)

1….2….3….4….5

31. This course was better than any other web courses I have taken

1….2….3….4….5

32. This course was as good as most classroom courses I have taken

1….2….3….4….5

SECTION II – WEB PAGE DESIGN AND USABILITY

1. I found it difficult to navigate between course web pages ……1….2….3….4….5

2. The log on procedure for the course was very easy to complete……1….2….3….4….5

3. Any information that I needed was not hard to find on the course web site

1….2….3….4….5

4. The course web page text was easy for me to read on the display screen

1….2….3….4….5

5. The amount of page scrolling was minimum…….1….2….3….4….5

6. The web page design allowed me to easily return to a home page….1….2….3….4….5

7. I never got lost or confused while navigating the course web site….1….2….3….4….5

8. The download time for graphics or animations was too slow……1….2….3….4….5

9. The Download time for media clips was too slow ……...1….2….3….4….5

10. The system alerted me if I made an error…….1….2….3….4….5

11. Error messages told me what was wrong and how to correct it…...1….2….3….4….5

12.Information displayed on some web pages was crowded or cluttered

1….2….3….4….5

Overall Impression about the Web Course (Please circle one number for each statement)

13. Course Content Web Pages (overall impression) ……1….2….3….4….5

14. Web Pages design and navigation (overall impression) ……..1….2….3….4….5

Open ended or Interview Questions:

1. **Did you find the course Web site easy or hard to use? Tell us why:**

2. **Was there anything specific that you found difficult to use or understand?**

3. **If you could change anything about the web site to make it easier to use, what would you change?**

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