ABSTRACT

DEVELOPMENT OF AN INTELLIGENT TUTORING SYSTEM FOR DISTANCE EDUCATION AT MASTER'S LEVEL

Yeşiltaş, Yalın

M. Sc., Department of Science and Technology Policy Studies

Supervisor : Assoc. Prof. Dr. Ferda Nur Alpaslan

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This thesis describes an Intelligent Tutoring System developed to be used in distance education at Master's level. The system was designed and implemented to help teachers to generate course material for online tutoring and to help the students to navigate through the course material according to their knowledge level. The system integrates many new technologies and provides individualized learning for students which is one of the most efficient ways for learning. How well the student has learned the course material is tested immediately after each smallest learning unit by end-of-section tests and the knowledge level of the student is derived from the answers given to these tests. This

knowledge level is used to build a user model. This thesis describes how this user model is used for navigational support for students while studying on the course material.

Keywords: Intelligent tutoring systems, user modeling, pretests, artificial intelligence in education

ÖZ

YÜKSEK LİSANS DÜZEYİNDE UZAKTAN EĞİTİM İÇİN BİR AKILLI ÖĞRETİM SİSTEMİ GELİŞTİRİLMESİ

Yeşiltaş, Yalın

Yüksek Lisans, Bilim ve Teknoloji Politikaları Çalışmaları Bölümü

Tez Yöneticisi : Doçent Dr. Ferda Nur Alpaslan

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Bu çalışma, Yüksek Lisans seviyesinde kullanılmak üzere geliştirilmiş bir Akıllı Öğretim Sistemini tanımlamaktadır. Sistem, öğretmenlere çevrimiçi öğretim için ders içeriği geliştirmede yardım etmek ve öğrencilere ders içeriği üzerinde bilgi seviyelerine göre dolaşmada yardımcı olmak üzere tasarlamış ve gerçekleştirilmiştir. Sistem pek çok yeni teknolojiyi birleştirmekte ve öğrenciler için en iyi öğrenme yollarından birisi olan bireysel öğrenmeyi sağlamaktadır. Öğrencinin ders içeriğini ne kadar iyi öğrendiği her en küçük öğrenme biriminden sonra hemen kısım-sonu-testleriyle test edilmektedir ve öğrencinin bilgi seviyesi bu testlere verilen yanıtlardan çıkarılır. Bu bilgi seviyesi bir kullanıcı modeli inşa etmek için kullanılır. Bu tez bu kullanıcı modelinin öğrenciler için

ders içeriği üzerinde çalışırken nasıl dolaşım desteği için kullanıldığını tanımlar.

Anahtar Kelimeler : Akıllı öğretim sistemleri, kullanıcı modelleme, öntestler, eğitimde yapay zeka

To My Parents And My Sister

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Date: Signature

CHAPTER 1

INTRODUCTION

In the last decade we became familiar with the terms internet and World Wide WEB. The power of Internet is continuing to grow up day by day. Internet is such a powerful tool that it brought many new things which made life easier and also brought many new trends with it. Distance education is one of these new trends and its popularity is growing as the power of internet grows.

It is not correct to say computer-based instruction is good or bad, since it has disadvantages as well as advantages when compared to class-based tutoring. First of all, until becoming a graduate student and a working professional, students generally prefer interacting with a real teacher in a class. Education through internet being independent from time and space makes distance learning popular especially among graduate students. Working professionals do not like attending to a class based master program since its cost is greater in terms of time. So, a working professional especially prefers attending to an internet based graduate program since this gives him/her the opportunity of following the course material and take examinations from anywhere as long as he/she has a computer and an internet connection.

The studies show that private tutoring is one of the best ways for teaching a student.[3] This leads us to the idea that for a student, individualized learning is one

of the best ways of learning. Application of artifical intelligence in education has opened the way for intelligent tutoring systems and made individualized learning for a student possible. Following this, in the last decade, with WWW-integrated intelligent tutoring systems, individualized learning through distance education became possible for a student. An intelligent tutoring system makes reasoning about the actions of the user (student) on the domain of the course and gives immediate responds to the student according to these actions. A user model is generated for each user to make assumptions about the user's knowledge level and learning needs to achive this goal. [22]

The graduate study [22] was in many ways taken as a reference to construct the system developed for this thesis. In this thesis the distance education system being used in Informatics Institute is taken as basis. The computer-based instruction tool being used for distance education in Informatics Institute is Net-Class. I tried to reach some new ways to make distance learning more efficient in this study, i.e. ways to increase the motivation of the students on learning the course material, providing new ways for students to test their immediate learning performances, etc. WWW-integrated Intelligent Tutoring Systems constitute an important part of my study. There are many WWW-integrated Intelligent Tutoring Systems today being used in the universities in many countries on the world.

In the system developed for this thesis, the course material is prepared and uploaded to the system by the teacher. The teacher also prepares the short out-of-grading tests

to be given to the students after each smallest learning unit, that is, section. These tests are called end-of-section tests in the system developed. The system measures the knowledge level of the student from his/her immediate perfomance on the concept taught by applying these end-of-section tests. The main idea in the development of this system for making distance learning more efficient is that the student cannot see the lecture notes of a section if its prerequisite has not been studied before. The system reasons about the user's actions by letting him/her see the lecture notes of a section if its prerequisite has been studied before or not letting him/her see the section if the student did not study the prerequisite of the section. The end-of-section tests here become a very important part of this system. The system also reasons about the user's actions on the end-of-section tests. It becomes possible for the student to see the lecture notes of the following section if all the questions in the end-of-section test of the section studied are answered right. If at least one of the answers of the student is wrong, this means the concept taught has not been learned well and the student is led back to the reading material of the section studied. The student is given a feedback about his/her performance after taking each end-of-section test.

In chapter 2, an information about the theory of the study is given and some of the previos work is described. This part especially includes the definition and implementation of Intelligent Tutoring Systems (ITSs) and some of the ITSs that are being used successfully today. In chapter 3, the system developed is described. The results of the evaluation of the study are given in chapter 4. Chapter 5 gives information about the deficiencies of the system and how the future work for this

study will be. The information given in this chapter is basically derived from the work done for chapter 4. Chapter 6 is the conclusion. The original 28 questionnaires whose results were used to evaluate the system developed for this study can be found in the library of the department of Science and Technology Policy Studies.

CHAPTER 2

THEORETICAL BACKGROUND AND RELATED WORK

The rapid growth of the Internet and World Wide Web offers new opportunities and challenges for many areas including education. Web-based education has many advantages such as the convenience of taking a course without leaving the workplace or home and the reduced cost. This makes independent of time and place education possible. In addition, teachers and educational researchers are encountering both unprecedented opportunities and challenges to adapt networks to their classrooms and research fields. However, most of the educational applications that have been delivered through the World Wide Web are just electronic books and these have very limited interactivity and diagnostic capability, a student or a learner may make use of them only by reading and getting information. Integrating ITSs into World Wide WEB and applying Web-based technologies in teaching with ITSs would be very beneficial for the purposes of education and would lead to a more effective teaching process.[4]

There have been many attempts to integrate ITSs into World Wide WEB since the first days of WWW and today there are many successful applications of WWW-integrated ITSs. The process has been accomplished by either moving existing ITSs to the WWW or by building from scratch Web-based ITSs. However, the goal of WEB-based ITSs is to reach a much more heterogeneous group of learners in settings

where no teacher is available to help the users during the learning process.[4] Private tutoring is one of the best ways for teaching[3]**.** Individualized learning so becomes one of the best ways for learning. WEB-based ITSs will make individualized learning more possible. The Web-based ITS authoring tools are addressed to a wide range of instructors with varying beliefs, preferences and teaching strategies. The students to be taught by Web-based ITSs also come from a large diversity of backgrounds and their needs, interests, learning styles have a great diversity. In order to meet the needs of such a great diversity of students and instructors, a careful and extensive knowledge acquisition phase should precede the development of a Web-based ITS. Today, the knowledge acquisition bottleneck, indeed, is becoming a particular trouble in the area of the World Wide Web and it is a widely accepted idea that the ubiquity of information accessible at the fingertips of millions of users drives a relentless demand for more intelligent computer assistance[4].

One of the best ways to integrate ITSs into World Wide WEB is to bring the technologies that have been used and are still being used by ITSs to WWW. Artificial Intelligence in education (AIEd) researchers have a very important role in this process. These people have been developing adaptive learning material for years in many disciplines like mathematics, programming languages, physics, electronics. One of the most important goals of AIEd researchers is to develope adaptive learning material that will facilitate learning for a student by providing the optimal conditions[5]. That means learning will be independent of place and time. This leads researchers to one place that is time and place independent, the World Wide Web. If the course material is presented on WWW as WEB pages, the student will have

access to the learning environment as long as he/she has a computer and an internet connection. All kinds of teaching operations like examples, tests, problems, questions can be applied in WWW-integrated ITSs. The WWW-integrated ITSs make use of many technologies like Java, XML, PHP, ASP and many more and the learning units, these may be lessons, sections etc. are generally presented in .html or .htm format WEB pages. This brings us to the point where we realize the importance of WWW in education. Integrating ITSs into WWW enables and individualized learning for students independent of time and space. There are many successful applications of WWW-integrated ITSs.

2.1 Intelligent Tutoring Systems

It was 1926 when the first intelligent machines to be used for teaching purposes was built. Sidney Pressey, an educational psychology professor at Ohio State University built several machines in 1926 which could test the students' automatic intelligence and information. His machines were asking the students multiple-choice questions and were responding the students according to their answers. The systems working principles were like the following: The student pressed the button corresponding to the first choice of answer after reading the question and seeing the alternatives. If that were the right answer, the device directed the student to the next question, otherwise the student was being forced to continue answering until he/she answered the question right. The device gave each student the permission to proceed at his/her own rate. Pressey's opinion was that this device not only tested and scored but also taught. This was the first application of technology into education. Since then, the

educational psychologists report that carefully designed individualized tutoring produces the best learning for most of the students and people.[1]

According to the early teaching theory, educational process can be viewed as the communication of knowledge to the student. However, this seems to have changed a little bit today. In class based teaching, the teacher tries to diagnose a student by trying to identify and interpret him/her and by using a suitable strategy and then continues communication with the student for remediation, that is, to overcome or correct the problem. These observations and views are widely accepted and constitute the basis for the definition of intelligent tutoring systems.[2]

It can be said that, an Intelligent Tutoring System is a system which provides individualized tutoring or instruction for students[24]. An ITS is generally composed of four modules. These are, as described in [3]:

-domain expert module

-student module

-pedagogical (teacher) module

-interface

The domain refers to the curriculum being taught as lectures. The expert domain knowledge is presented to the student and used to evaluate the peformance of the student, it also represents the goal of teaching. In an ITS, knowledge is represented to the student as a set of facts and rules. Shortly, the expert domain knowledge means

all the material presented to the student and used for measuring the knowledge level of the student by the instructor[3]

Student refers to the learner of the curriculum or user of the ITS. The ITS applies the student some diagnostic tests and according to the answers given by the student to these tests and the student's actions, it must be capable of modeling the student. This modeling constitutes the basis for an adaptive feedback given to the student.[3]

Pedagogical module refers to the teacher or instructor who teaches the student and the instructor's strategies for teaching, guiding or tutoring the student. These strategies determine when and how to instruct the student. There are many ways for instruction and these also depend on the instructing ways and strategies of the instructor. For example, the instruction may be directly pointing out the student's error and giving the student the correct answer, or indirectly providing hints for the students to find out the correct answer.[3]

The interface is the monitor which enables the communication between the ITS and the student or the learner. It becomes a very important part of an ITS since all the communication and interaction with the system takes place here, the course material is represented to the student here and the student inputs are received through this module. The interface must be well designed to keep the students' attention at a high level and must be easy to use and as interactive as possible so that the interaction with the system will be easy and not boring. The interface may be composed of many graphical elements like buttons, menus, text and also animations, multimedia. Virtual reality will make the system more attractive. Other advanced techniques may also be

used. An interface usually has capability of natural language processing to facilitate the communication between ITS and the student.[3]

An ITS teaches the students by giving them some problems to solve. The system knows the solution of the problem given to the student and after getting the solution of the student, it compares that solution with its own solution which it takes to be exactly true. After that, the system diagnoses the student based on the differences between the two solutions. This is followed by giving the student a feedback and then the system again puts the student through problem solving and updates the student skills. This process and the entire cycle is then repeated. The system knows what the student needs to know, what it must teach the student next and how the course material must be presented to the learner as it forces the student for problem solving. The selection of the problems is done taking all these facts into consideration. An ITS must anyway behave intelligently though it need not be intelligent. Considering all these, what an ITS must be capable of doing may be summarized like the following as described in *Figure 1* [24]**:**

-measure the students knowledge level, skills and styles accurately

-make the diagnosing using principles

-decide what to do in the next step

-make the adaptation of the instruction accordingly

-provide feedback to the students

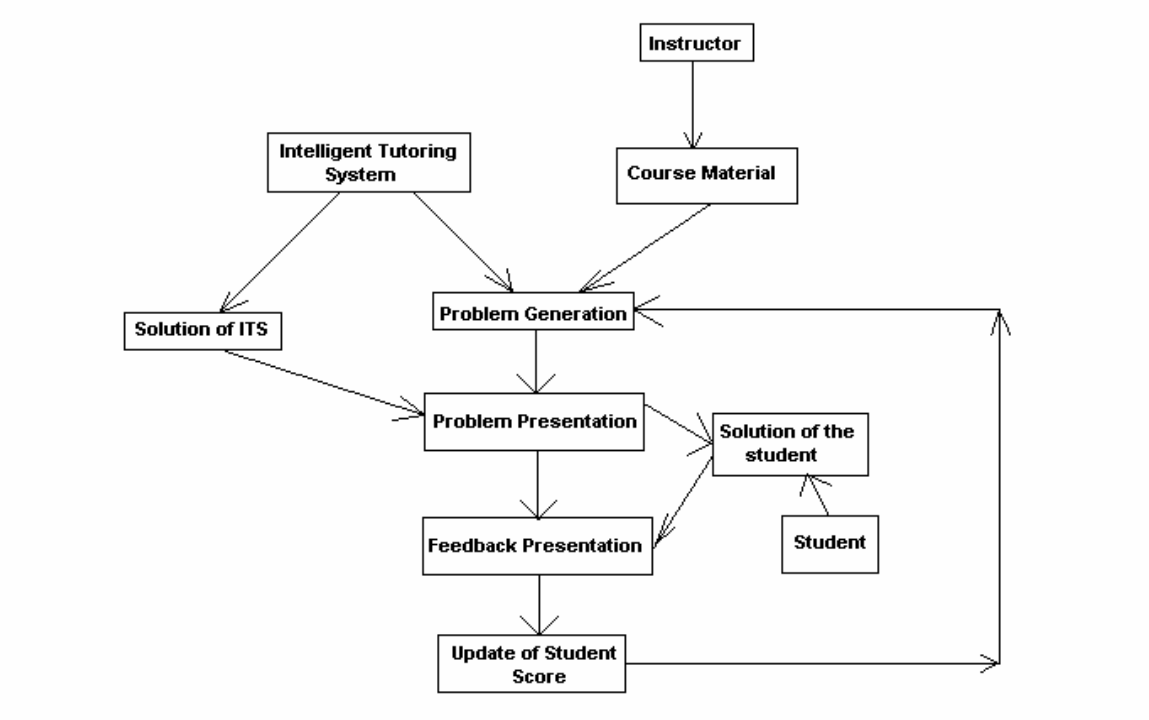

Figure 2.1. The general structure of an ITS

2.2 Advantages And Disadvantages Of Computer-assisted Instruction Over Class-Based Tutoring

Computer-based instruction with WWW-Integrated ITSs has also got many disadvantages as well as it has many advantages when compared to class-based teaching where the student interacts in a real classroom with a real teacher. In the year 1994, Ragusa compared computer-assisted instruction and intelligent computer-assisted instruction and class-based instruction and stated out the advantages and disadvantages of computer-assisted instruction and intelligent computer-assisted instruction over class-based tutoring. In other words, ITSs and class-based tutoring were compared. As described in [6], the results are like the following:

The advantages of computer-based instructions:

1.The multimedia presentation formats, graphics, and the other visual effects used in the course material increase the motivation of the students

2. Simulations can also be integrated with the course material and these are also useful in increasing the student motivation

3. Students participate directly in the learning process which increases the learning quality and efficiency

4. Each student can progress at his/her own pace

5. The consistency of instructions is provided by the computer-based course since the course material is prepared parallel to these instructions by the course developer

The disadvantages:

1. An ITS is an expensive and time consuming system to develop and maintain, also preparing the course material, like graphics, text, animations, simulations and presenting it to the students, like using a server is an expensive and time consuming process

2. New and different content developments are needed for different subjects

3. An ITS uses a single teaching strategy and that is the teaching strategy of the developer of the system. Anyway, this strategy sometimes does not meet the needs and preferences of the student because every student's learning strategy is different and this means that there must be a diferent teaching strategy for each student.

4. Each student responses to the tests in a different way. The courseware developer must take into consideration as many possibilities of student answers as possible and provide branched paths for each since there will be different responses coming from students.

It seems that the most important advantage of Intelligent Tutoring Systems over class-based tutoring is that the instruction is tailored for each student based on heuristics or rules. This decreases the possibility of making a mistake in the intruction to nearly zero. Also, ITSs work together with other disciplines and take advantage of using them. These may be AI, software engineering and authoring systems. ITSs also make use of them. However, developing an ITS is a very expensive and time consuming process. More important, the instructional effectiveness of ITSs is not still fully validated and remains a controversial issue.[6]

2. 3 Previous Related Work

There are many examples to intelligent tutoring systems that have been used since today. The system generally has two kinds of users, the teacher and the student. The design of the system is done by the teacher, in other words the teacher acts as the

server and the student acts as the client. The implementation of the system depends on the person who designed and coded the system. Each ITS developer is free to choose whatever technologies he/she wants to use in the development of the system. Here, I want to give some information about some WWW-integrated ITS's that have been developed before. I will describe more detailed Code Tutor that was developed in Yugoslavia [7], its implementation and the technologies it used, since it is more similar to the system that was developed for this thesis. The other systems, C-Tutor [11], Redeem [9] and EVA [8] are described in a more general way. These also constituted the basis for the system developed for this thesis and gave many new ideas in developing this thesis's system.

2.3.1 Code Tutor

This example comes from Yugoslavia. Code Tutor has got many similarities with the system developed for this thesis and because of that, I believe, it will be better to give a more detailed description of it including the technologies it uses, its implementation and how it was developed.

Code Tutor was developed for telecommunications college students. It is designed for students' briefing in the area of radio-communication. The students are supposed to exercise using expensive radio-station equipments after completing a course in radio-communication theory and this means that the course material must be learnt well since the students will interact with electronic tools that must not be damaged. The teacher is the one to take care of the electronic equipment and to make sure that it is always in good condition and that it is properly used. There is little time to check the students' capabilities for independent practical work after completing the course

and before the exercises begin. Code Tutor is used for training the students for this purpose and to keep the electronic equipment away from damages that may be caused by the lack of theoretical knowledge of students.

Code Tutor integrates many different current technologies. These technologies are as follows:

CLIPS, a tool for building Expert System (CLIPS, 2002) is used to generate knowledge base files.

Java-Based ES (Expert System) shell is used to interpret these files

Students communicate with the system through a standard Web browser

Java Servlet technology is used to implement the system's interactions with the students

Apache Server is used to store static HTML pages

Apache Jserv is used to interpret the servlets

XML technology is used to generate files that Code Tutor uses to provide recommendation to the students[1]

We can summarize the system analysis and architecture of Code Tutor as follows. Code Tutor is a client-server learning environment which has been designed as a Web classroom. The server studies and the client studies are connected by the WEB technology. Both the students and teachers work in a classroom which may be real or virtual. No matter the classroom is virtual or real, individual learning is provided

[1] **[7] pp.231-232**

for the students which has been proven to be one of the most effective ways for learning.

The system has two major actors: the student on the client side, and the teacher on the server side. Therefore, there are two general sets of use cases in Code Tutor-Client-side use cases which refer to student uses, and Server-side use cases which refer to teacher uses.

2.3.1.1 The Student Use Cases

The student is on the client side of Code-Tutor and this means the student has got less power on the system than the teacher. The student uses has four modes. The student's interaction with Code Tutor begins with "Authentication" mode. The student logs into the system and opens a new session. Then "Learning" mode begins with the student's selection of one of the chapters. Several lessons form each chapter, the elementary learning unit is the lesson which are 3-5 pages long. In this mode the student reads the course material. This is followed by the "Assesment" mode. After reading the course material, the student answers the questions related with the lesson. The questions are multiple-choice type. Submitting the questions triggers the "Validation" mode. In this mode, Code Tutor checks the answers of the student and according to this updates the student model by estimating the user's knowledge. (Ref. *Figure 2*)

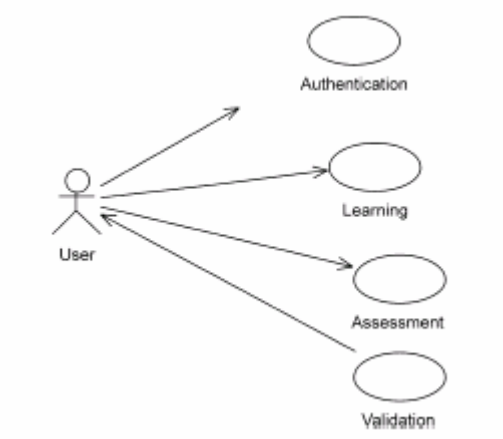

Figure 2.2. Client side use of Code-Tutor

Following these steps, the student has two options if he/she completed a lesson successfully. The first one is that he/she chooses a new lesson and repeats the same process again. He/she is helped by Code Tutor by taking recommends during learning. The second one is that the student repeats the same lesson and tries to get a better score. If he/she can succeed, the new score replaces the old one.

2.3.2 Teacher Use Cases

The teacher uses refer to the server side uses. The teacher's tasks include authentication, starting the server, monitoring the student's sessions, editing the knowledge base and stopping the server. Some of these tasks are similar to the student side and some like editing knowledge base are different. On the student side, there is only a browser but the teacher side GUI has a number of options.

The teacher session begins with authentication mode like the student session but the teacher's power is more than the student's over the system. After authentication, the

teacher may start the Web server (Start server) which makes the tutoring system available to the students. The teacher may monitor each student's session whenever he/she wants to do so. All the things done by the student in the system are stored by the system and the teacher has got access to all data of each student at any time. The teacher may edit or delete the course material as what he/she thinks will be better for the students. After the modifying of the course material, the teacher submits these updates to the system. All the students must finish the sessions before the Web server is stopped by the teacher. This is another power of the teacher over the system which the student does not have. Since the student models (scores) must be updated consistently, the stopping is necessary for the working of the system.(Ref. *Figure 3*)

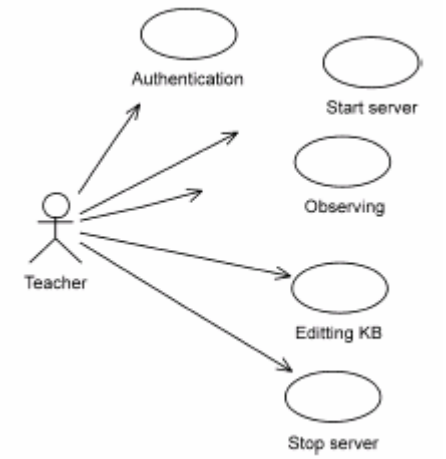

Figure 2.3. Server side use of Code-Tutor (KB refers to Knowledge Base)

The systems working is shaped by the students and the teacher. The student logs into the system and then goes through the four modes described earlier. The server must be started by the teacher when the student logs into the system so that the student

may see the lecture notes. The teacher monitors what the student does in the system and uses his authorities of editing the course material, editing the student authorities and the others. The system and the teacher guide the student through the learning process and the teacher stops the server when there is no more time left for lecturing. This way of lecturing decreases the possibility of having deficiencies about the theoretical part of the lecture for the students and following this, in the exprimental part of the lecture, the possibility of the students' damaging the electronic tool because of lack of knowledge is reduced to minimum.[7]

2.3.2 Eva

Eva is an ITS developed in Instituto Politecnio, Mexico. Its main objective and aim is to perfect the asynchronous and non-in situ (remote) educational model(s). The students are assumed to know what they want to study, that means they know their final states. They study on remote places through EVA but they can also learn making use of the way a student normally does, like buying a book, attending a lecture, studying with classmates, asking an advisor, practicing on the computer. So, the Knowledge Space or Learning Space means all these information and concepts that can be transmitted to a student of a given discipline. The discipline discussed here is Computer Science at the Master level.

Unlike Code Tutor, EVA applies to each student an examination which measures their knowledge level on computer science. The Graduate Computer Science knowledge is divided into modules (unit learning modules or ULMs). A module is a chapter of a book and the book is the written material to cover a graduate course for one semester, that makes 80 hours of classroom lectures. At the end of each module,

the student is given a quiz and with the help of the results of the quiz, EVA watches the progress of the student and so, in this way, it knows anytime what the student knows.

Synchronous and asynchronous question-and-answering sessions are provided by EVA.[8]

2.3.3 C-tutor

C-Tutor is an ITS developed for novice C programmers. Its main objective is to teach students with C programming language, analyze students' programs and give intention-based diagnosis. In C-Tutor, a programmer's intention is provided to the system as a problem description of the program task. As a learning environment, C-tutor teaches the students the C programming language and skills of programming based on the current status of the student. The problem assignment is given to the students in natural language. There is a program analyzer which analyzes the programs written by the students and debugs them. C-Tutor has got two interacting cycles. These are Student-System and Teacher-Student-System interacting cycles. Student-System cycle refers to the student model in the curriculum network. In this cycle, the system teaches a programming concept and presents a program task. The program is then analyzed and intention-based diagnosis is given. Based on this diagnosis, the system decides whether it will give the student a new programming task or it will teach a new concept. The Teacher-Student-System cycle acts as the teacher in the ITS. The way it acts is referenced from the way teachers act in real classrooms. In a real classroom, the teacher presents his/her own problems to the students and wants solution from them. In this system, the problem is described to

the students in natural language as well as a sample program is provided to the system. The system analyzes this program, generates a problem description of it and then this problem is given to the students. The student writes a program of that problem, then the system transforms this program into canonical form and analyzes it. A student may use the system until no more errors can be found in the program. [11].

2.3.4 Redeem

Redeem is a tool designed to allow teachers to create ITSs by taking existing computer-based material as a domain model and then overlaying the teaching expertise. This means, Redeem aims to support authors with little or no previous experience in computer-based learning to develop simple but effective ITSs very rapidly. Redeem can also provide opportunities for teachers to reflect upon their professional knowledge. A teacher uses Redeem's ITS authoring tools to describe the existing courses that have been developed before, construct teaching strategies and identify students.

Redeem has three main pieces of software: courseware catalogues, ITS authoring tools and the ITS shell. Courseware catalogue refers to the software that is used to edit course material. Course material is prepared outside the tool, or can be taken from an existing source with permission. Redeem is able to structure any computer based learning material which contains inividual pages of material. ITS authoring tools allow the teachers to describe the course, to construct teaching strategies, to categorise students and to assign different strategies and material to these student categories. The ITS shell takes the pedagogic decisions of the teacher and uses this

input in combination with its predetermined defaults to deliver the course material. For example, the ITS shell decides upon the appropriate tutorial action like teaching, testing, summarizing peformance, suggesting note taking or a non-computer task. The rules developed from interviewing teachers are used by the ITS shell. The experiments done with REDEEM showed that it is a poweerful tool to be used for teaching children.[9]

2.4 Pre-testing, Post-testing And Feedbacks

Class based pretesting and posttesting are methods that are used by instructors to assess and improve the effectiveness of teaching. The test is developed by the instructor and then applied to the students to learn about their knowledge level on the subject taught. These tests may include multiple-choice or true/false questions, problems and graphical exercises. [12]

In distance education, pretesting is also used for the same goal as the class based pretesting. ITSs especially make use of pretesting to measure the knowledge of students on the concept and guide the students according to this. Generally the questions are multiple choice type or true/false type. The pretest or the posttest questions ask the student the most basic knowledge about the concept to test if the concept was learned well. The implementation generally depends on the instructor who prepares the tests and these tests also become a preparation for the real examinations like midterms and finals.

Giving feedbacks to the students after tests is a good way to tell the student about his/her immediate performance. What this performance feedback consists of depends

again on the instructor who prepares the test [10]**.** Considering that the test will ask questions about the most specific subjects, we can say that the feedback will include information about the student’s knowledge on these most specific subjects.

CHAPTER 3

DESIGN AND IMPLEMENTATION OF THE SYSTEM

The system for this thesis was constructed under the light of all these previous work that was done before this work by other people. The graduate study [22] was also in many ways taken as a reference in the construction of this system. The ION course ION 525-Artificial Intelligence was used to present the system to the people who participated in the survey designed for the evaluation of the system.

Main features of the system:

-The smallest learning unit in this system is section. A course is formed by chapters and each chapter is formed by sections. So, the learning space is constituted by sections and section becomes the smallest learning unit.

-The system has got two types of users, instructor and the student. The instructor has got more power over the system and the student may see the lecture notes read only.

-The system makes use of the technique of pretesting-posttesting. The test is given in the format of a short quiz at the end of each section. The instructor prepares the test and the student answers the test after reading the course material. These tests are called end-of-section tests in this system. The questions are multiple-choice type or true/false type and they measure the knowledge level of the students on the most basic subjects taught in the learning unit. The tests are out of grading.

-The feedbacks are given after taking the end-of-section test to the student. Three feedbacks are given. One of the feedbacks directly tells the student which questions were answered right and which questions were answered wrong, this is the feedback that is given to the student right after taking the test. The second one is given after the first feedback and tells the student on which subjects he/she is good at and on which subjects he/she is not good at and has deficiencies. These subjects are determined by the instructor while constituting the quiz questions so that the student may learn on which subjects he/she is good and on which not right after taking the test. The student is directed back to the reading material if at least one of the test questions were answered wrong, like Code Tutor does. After reading the lecture notes once again, in the case that there is at least one wrong answered question, the student is given the feedback telling him/her the right answers of the questions that were answered wrong by him/her at the time he/she took the quiz for the first time. This feedback is also given to the student each time after viewing that learning unit again.

3.1 System Objectives And Requirements

The system's main objective is to increase the motivation of the students on the course material and let the students learn the course material more efficiently. The system was developed to present online WEB courses to graduate students who may be also working professionals at the same time. Once uploaded, the system may present any online WEB course. The WEB pages must be made ready in .html format and also, on the server machine, the space for the WEB course must have

been allocated according to some rules before the system is used. These rules will be explained in detail later. The system tests the student's knowledge level at the end of each learning unit and will evaluate the student according to this knowledge level.

3.2 The Ion Project And Net-class

The focus in this thesis is on graduate students who are generally working professionals. Online education is generally preferred by working professionals since it is independent of time and place as long as the student has a computer and an internet connection. Informatics Online (ION) project of Informatics Institute is the first of its kind in Turkey and gives online Master's degree.

The Computer-Assisted Instruction tool Net-Class is being used for the ION project. Net-Class is not an intelligent tool. It is also used by Informatics Institute in other distance learning projects like MetuOnline. The tool has been developed by using J2EE, Java servlets. It has been in use for the last two years. Informatics Institute has been giving online Master education through Internet for more than 1.5 years and ION is the name of this project.

3.2.1 Architecture And Implementation Of Net-class

A person entering the URL of the ION project [25] in the address bar of a browser is taken to the entrance page of the ION project. In the entrance page, the user is asked to log on to system. There are two types of users defined for this system, instructor and student. The tool contains the instructor tool and the student tool. Net-Class leads the user to one of these tools after checking the username and the password.

On the UNIX machine of the Informatics Institute, euclid, each course has a place and the instructor has the UNIX password of the course. The lecture notes are WEB pages in .html format. Each course is made up of chapters and each chapter is made up of sections. Generally each section is a single WEB page. Section is the smallest learning unit in Net-Class. The WEB pages are prepared out of the system, on the local machine, by using an editor like FrontPage or directly writing the html code in a text editor like NotePad. This process includes giving links inside the page, inserting images and other things realted with html coding. The navigation between the lecture notes are provided by some images like back image, forward image, contents image etc. The usage of these images changes from one course developer to another. For example, if the person browsing the lecture notes wants to go to the next section, he/she clicks the next image, or to go to the contents page he/she clicks the contents image. In the lecture notes using more than one html frame is not supported. The rest of the navigational support is provided by the tool Net-Class.

The instructor has more power over the system than the student. The instructor uploads the lecture notes to the account of the course on the UNIX machine using an

FTP program, also uploading the images used in the WEB pages must be done by the instructor in a similar way.

After logging on, the instructor is directed to the instructor tool. The instructor can make changes on the course material, may give online quizzes and examinations to the students using this tool and enter the grades.

After entering the username and password in the entrance page, the student is directed to the student tool. He/she can browse the course material using the navigational support given by the system and the WEB pages. The examinations link leads the student to the tests given by the instructor if there are any. There are two types of questions in these examinations, multiple choice and true/false. The student answers these questions and gets a grade. His/her grade is recorded in a database. This system does not test the immediate performance of the student and does not give a feeedback to him/her about his answers.

3.3 Programming Environment

The system developed for this thesis integrates many new technologies which make the system faster and more easy to use. The technologies used in the construction of this thesis are as follows:

-The communication with the system, for both the instructor users and the student users, is provided through a WEB browser like Internet Explorer, or Netscape

Navigator.

-Java Servlet and JSP technologies is used to provide the interactions with the system

-Jakarta Tomcat 3.3a is used to interpret the servlets and JSP pages

-Static HTML pages are stored in Apache WEB server

-The WEB server runs under the operating system Microsoft Windows XP

-Microsoft Access is used as the Database Management System

No tools like Microsoft J++ or Borland Jbuilder were used in the development of this system. All the Java codes for Servlets and JSP were developed using Notepad.

3.4 System Architecture

The system's working principles are based on developing a modular solution to the issue of "effective presentation of online course material to the student". The system may guide the students in learning the course material only if it knows the knowledge level of each student. Testing is a good way to measure the knowledge level of a student. The system developed for this thesis measures the knowledge level of a student by measuring his/her immediate performance. This is as follows: The system applies a test at the end of each section. Since, section is the smallest learning

unit, the system tests how well the reading material has been learned after each learning unit and does this right after the student reads the section. So, the system tests the immediate performance of the student and from this, determines the knowledge level of the student.

The idea here is that, the course material can be better learned if the system gets an immediate idea about how well the student had learned the previous learning unit before going to the next learning unit. Also, forcing the student to study the prerequisite of a section before studying the section itself is a good way for learning.

The testing mechanism of the system measures the knowledge level of each student by testing the students at the end of each section. The short quizzes given at the end of each learning unit here become an important element. These tests are called end-of-section tests. Each question in the test is related with a concept taught in the learning unit. Answering the question right means that the concept has been learned and answering the question wrong means the concept has not been learned. If at least one of the answers of the student is wrong, the system leads the student back to the reading material.

The course material and the end-of-section tests are created and then presented to the students through a WEB browser like Internet Explorer or Netscape Navigator. The user interface here is an important factor for the motivation of the student on the course material and better learning. The system gives messages to the student about his/her learning of the course material and about his/her knowledge level on each

concept related with the questions of the end-of-section tests through a user-friendly interface.

The database is used for tasks like storing the students' immediate performance, the knowledge level of the students about the concepts, and storing the other data related with the working of the system.

The navigational support becomes a very important element for individualized learning. The student motivation is very important in an efficient learning process and strong navigational support provides high motivation for students. If navigational support is not strong, the student may get lost in hyperspace. This will cause time loss and decrease the motivation level. If the navigational supportis strong, the student will be able to reach any available source in the system and will know where he/she is in hyperspace anytime.

The system has two types of users, the teacher and the student. The creation of the course material and the end-of-section tests are teacher's responsibilities. The system will present the course material and the end-of-section tests created to the students. The reasoning meachanism of the system will reason about the actions of students on the course material and the end-of-section tests. The results of this reasoning will be presented to the students through a user-friendly interface by the system.

The system's main tasks can be summarized as follows [22]:

- Generation and maintenance of the course material
- Generation and maintenance of the end-of-section tests
- Presentation of the course material to the students
- Presentation of the end-of-section tests to the students
- Reasoning about the actions of the student on the course material
- Reasoning about the actions of the student on the end-of-section tests
- Presentation of reasoning results to the student
- Database operations

Each of these except “database operations” are implemented in one module. All these tasks require functions in the “database operations” task.

The following figure shows the system architecture according to these explanations:

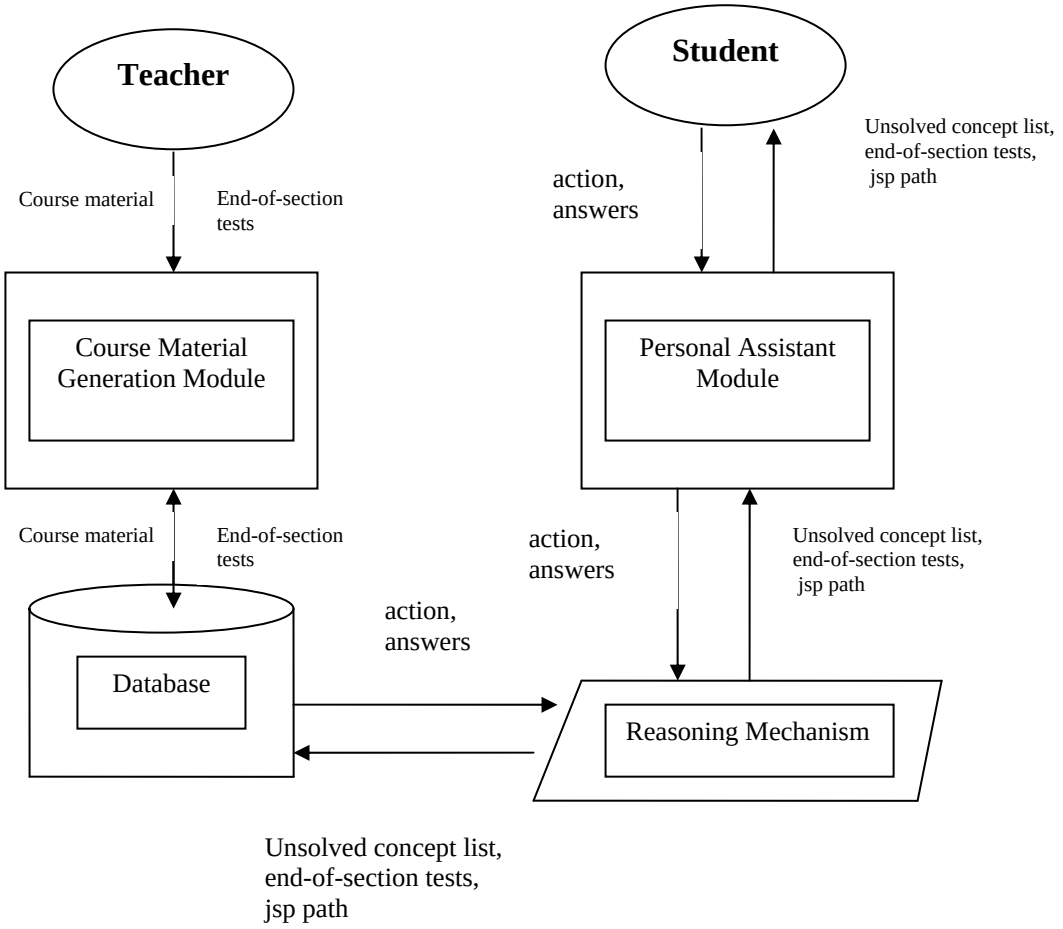

Figure 3.1 System Architecture

The users in the system are indicated by ovals. The rectangles in the figure indcate the modules in the system. The direction of the data flow is shown by arrows and the labels on the arrows specify the data. The database where the data is stored is indicated by the cylinder. The reasoning mechanism working on the user actions and the database is represented by the trapezoid.

How the system works can be summarized as follows:

1. The course contents are created by the instructor in the course material generation module.

2. The lecture notes which have been created by the instructor in .html format out of the system are uploaded to the system in the course material generation module.

3. The end-of-section tests are created by the teacher in the course material generation module.

4. The data related with the course material and the end-of-section tests are recorded in the database.

5. The course material and the end-of-section tests are presented to the student in the personal assistant module.

6. The student can study the course material and take the end-of-section tests in the personal asisstant module.

7. Student actions are evaluated by the reasoning mechanism.

8. The reasoning mechanism updates the database according to the student action.

9. The reasoning mechanism gives unsolved concept list to the personal assistant module so that the personal assistant module can do advises and gives navigational support to the student according to the student action.

10. The reasoning mechanism gives .jsp file pathname to the personal assistant module so that the personal assistant module can open the .jsp page for the student to study.[22]

These operations will be explained in more detail with system implementation.

3.4.1 Operations With The Database

The data objects of the system are as follows:

- course
- section (smallest learning unit)
- end-of-section test
- .jsp files
- student

The database tables used in this system keep the records of these objects.

3.5 Implementation Of The System

The implementation of the system is provided through Java Servlets. The course material is presented to the students in .jsp format. Each of the Java servlets used in

the implementation of the system has a different task and each interacts with the DBMS. The main objective is providing a more efficient learning for students and the servlets have been designed to help the students for this. There is a strong navigational support so that the student will not get lost in the hyperspace.

3.5.1 Prework

Before using this system there are some things that must be done by the instructor or the administrator of the machine on which the WEB server is running. We can summarize these as follows:

- The lecture notes must be ready in the html format before using the system

- The system will not create new folders, so the places where the lecture notes will be uploaded must have been created before the system is used. Apache Tomcat keeps the jsp files under the folder:

  (Path of the WEB server on the hard disk) / webapps / root.

  So, the Lecture_Notes folder must first be created here, then in that folder the chapter folders must be created and their names must be chapter1, chapter2,..., chaptern where n represents the total number of chapters. Under each chapter, section folders must be created and their names must be

section1, section2,..., sectionn where n represents the total number of sections of that chapter. The organization must be like the following:

(Path of the WEB server on the hard disk) / webapps / root / Lecture_Notes / chapter number /section number

For example, let's suppose that the course is composed of 10 chapters. Then there must be 10 folders in the form of

(Path of the WEB server on the hard disk) / webapps / root / Lecture_Notes / chapter number(1,2,…,10)

Now, let's suppose that chapter 1 is composed of 5 sections. As it was told before, section is the smallest learning unit in this system. Then five folders must be created before the system is used with the paths given as the following:

(Path of the WEB server on the hard disk) / webapps / root / Lecture_Notes / chapter number / section(1,2,3,4,5)

- There is not a way in this system to upload the images. So the images which are used in the WEB pages must be uploaded separately so that they will be able to be seen by the students in lecture notes.

3.5.2 Instructor Usage (Ref. *Figure 2*):

- The instructor designs the course material to be used in lecturing
- The instructor logs into the system
- The instructor uploads the course material
- The instructor prepares the end-of-section tests which will measure the knowledge level and immediate performance of the student at the end of each section, diagnose the student according to the answers given and guide the student according to this diagnose

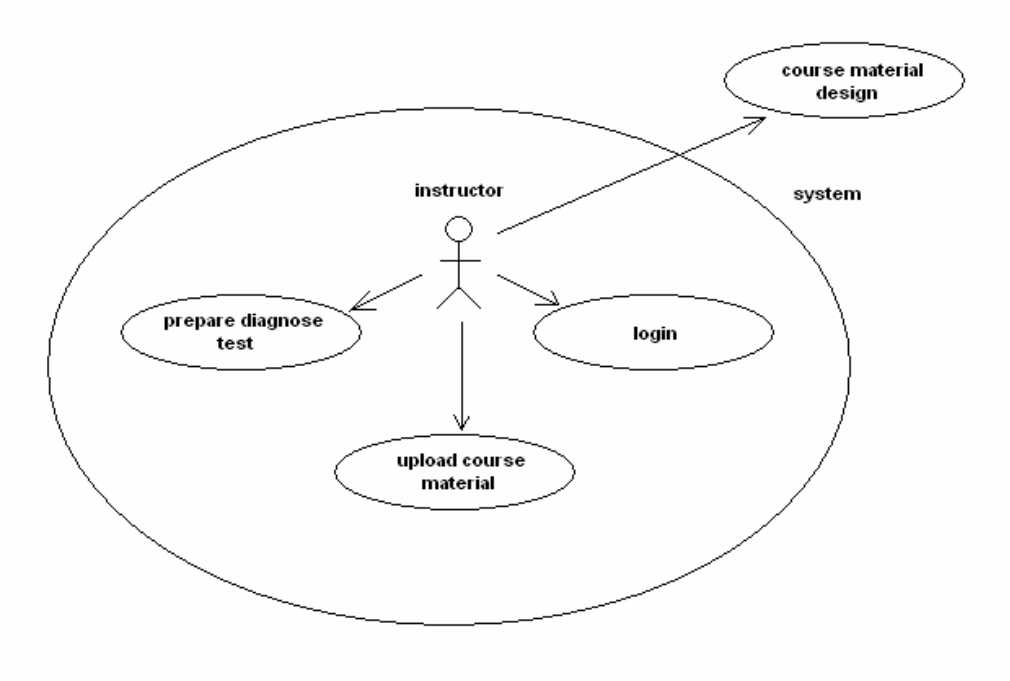

Figure 3.2. Instructor Usage

3.5.3 Student Usage (Ref. *Figure 3*):

- The student logs into the system
- The student reads the course material

- The student takes the end-of-section test at the end of each section and is diagnosed
- The student sees his/her feedback and is guided in the system according to his/her knowledge level

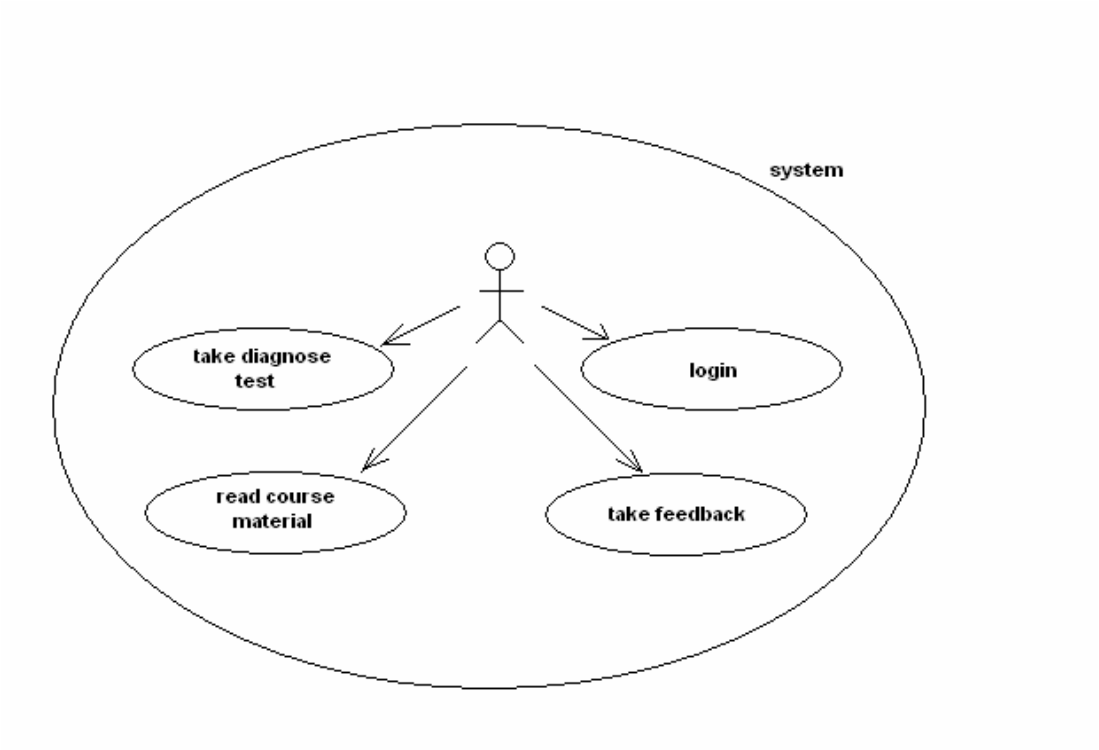

Figure 3.3. Student Usage

The implementation of the system through the tasks described before is as follows:

3.5.4 Preparing The Course Material

The instructor creates the course material using the course generation module. First, the instructor checks that all the prework is done. The teacher's operations through Course Material Generation Module are as follows:

1. Teacher logs into the system

2. Teacher prepares the hierarchical course structure

3. Teacher uploads the .html files to the system

The teacher must first log into the system to use the course material generation module. Step 2 needs attention since Step 3 will rely on the parameters coming from Step 2. The system requests the teacher input the titles of the learning units from the biggest to the smallest. The teacher will first input the chapter titles and then, the section titles under each chapter. The system will get this information and record it in the database.

Following this, the system will request the teacher upload the previously prepared .html files to the system. When uploading a section, the instructor is directed to a page where there is a browse button and upload section (section number) button. The instructor here browses the hard disk and then chooses the file to be uploaded (html file). After that the instructor clicks the Upload Section (section number) button. Clicking that button, the html page chosen is uploaded to the server with the name index.html, no matter what the name of the html file being uploaded is. For example, if section 1 of chapter 1 is being uploaded, the path and the name of the file uploaded becomes

http://name of the server:8080/Lecture_Notes/chapter1/section1/index.html (as the file is uploaded to (path of the WEB server / webapps / root / Lecture_Notes / chapter1 / section / index.html, the folder Lecture_Notes / chapter1 / section1 has already been prepared).

After the html file is uploaded, the parameters for the file like size, name are given as information to the instructor. The system will take these .html files and turn them to .jsp files with some additions to handle comingstudent requests.

3.5.5 Test Operations

The end-of-section tests are created similarly by the instructor. The test creation follows course material creation. The test question creation page asks the instructor to input the question body, question answers, right answer, and the concept the question is related with. There are two question types: multiple choice or true/false. The instructor inputs four question answers if the question type is multiple choice. The question answers true and false are automatically input if the question type is true/false. The teacher selects the right answer. The teacher must also input the concept since this will be used for measuring the knowledge level of the student and giving the student a feedback about his/her knowledge level. Question bodies, question answers, right answers and question concepts are recorded in different database tables. The system asks the teacher if he/she wants to add one more question or not after adding each question. The teacher may add as many questions

as he/she wants. Following this test creation process, the system thanks the instructor for using the instructor tool and the teacher exits.

3.5.6 The Personal Assistant Module

In the Personal Assistant Module, the student follows the course material in WWW using the interface of the system. The system guides the student in his/her learning process.

The student enters his/her username and password and logs into the system. He/she is directed to the page which has a welcome message and shows the chapter names. Under each chapter name, there is a button on which it is written “Go To Chapter (Chapter Number)”. The student may choose one of these buttons to go to that chapter.

Following, the student is directed to a page which tells the student to click the button after the text to go to the sections of that chapter. After clicking the button, the student goes to the page where the sections of that chapter start. Like the chapter titles, there is a button on which it is written “Go To Section (Section Number)”, and these buttons bring the student to the contents of that section.

Clicking “Go To Section (Section Number)” button the student is directed to a test page. This page checks if the student is eligible to see the contents of that section. To be eligible, the student must have taken the test of its previos section. For example,

to be eligible to browse section 2, the student should have been tested by taking the end-of-section test of section 1. So, this page checks the database to see if the results of the diagnosis test of this section exist or not and decides accordingly. In this page, if the student clicks the button “Go To Section n”, the system checks the database table where the results of the students’ diagnosis tests are kept. There may be five different cases and these will be handled as follows:

1. If the chapter number is 1 and the section number is 1, this means that the student is entering the system for the first time and had not read any course material before. So, the system allows the student see the course material and writes a message “This is the first page you view on this course. Welcome. Click the following button to see section 1”.

2. If the student had browsed section n previously but answered at least one question of the end-of-section test of section n wrong, the message “Click the following button to see section n” is displayed.

3. If section n’s test had not been taken but section n-1’s test had been taken, a mesage saying “You had browsed section n-1 previously. You may see section n. Click the following button to see section n”.

4. If section n’s diagnosis test had been taken but at least one of the questions were answered wrong, a message like: “Click the following button to see section (Section Number)” is displayed by the system.

5. If section n-1’s diagnosis test had not been taken, this means the student had not read the previous section and the message “You are not allowed to see this page” is displayed.

CHAPTER 4

EVALUATION OF THE SYSTEM AND THE SURVEY

This system's main objective is to increase the motivation of the students on the reading material and providing a more efficient distance learning for students, especially graduate students and working professionals. After the system's design was over, I thought the best way to test how this system contributed to distance learning is to make a survey about the the system's efficiency. The system developed for this thesis was evaluated on 28 graduate students in METU. The ION course ION 525-Artificial Intelligence was used to present how the system works to the people who participated in the survey. The questionnaire used for the evaluation was designed by me and it contained 11 questions asked to users. Some of these questions contained alternatives and tested if the system was found efficient by the user and some of the questions requested advices from the user. The original questionnaires can be found in the library of Science and Technology Policy Studies Department in METU. In this chapter I want to give the results of this survey and evaluate them.

4.1. The Survey Results

The people chosen for the survey are all graduate students except three and they come from different backgrounds. The three people who are not graduate students are just working professionals. The students for the survey were especially chosen

from different disciplines, for example from natural science departments, engineering departments and social science departments.

The disciplines the students graduated from and how many students graduated from these disciplines are as follows:

Table 5.1 Backgrounds of people who participated in the survey

Name of the department	Total number of people who graduated from that department
Computer Education and Instruction Technology	4
Physics	3
Sociology	2
Business Administration	2
Electrical and Electronics Engineering	1
Environmental Engineering	1
Food Engineering	1
Mining Engineering	1
Industrial Design	1
Mathematics	3
City Planning	1
Psychology	1
Inductrial Engineering	2
Computer Engineering	1
Biology	1
Mechanical Engineering	2
Civil Engineering	1

Taking Computer Education and Instruction Technology, Physics, Electrical and Electronics Engineering, Environmental Engineering, Food Engineering, Mining Engineering, Industrial Design, Mathematics, City Planning, Inductrial Engineering, Computer Engineering, Biology, Mechanical Engineering, Civil Engineering as natural and applied sciences departments and Sociology, Business Administration, Psychology as social sciences departments, total number of students coming from a natural science background is 23 and the total number of students coming from a social science background is 5. (APPENDIX B Chart 1)

As the second question, the students were similarly asked the graduate program they are attending now. Three of the students who entered the survey are not attending to a graduate program, the rest were attending to different graduate programs. The names of the graduate programs and how many people who have filled out the questionnaire are attending to them are as follows:

Table 5.2 Departments the people who participated in the survey are attending

Name of the department	The total numbe of people attending o that department
Information Systems	15
Sociology	1
Science and Technology Policy Studies	2
Electrical and Electronics Engineering	1
Engineering Sciences	1
Cognitive Science	4
Biochemistry	1

Following this the students were asked nine questions to test how good they have found the system and to get their advices. The third question asks the students their opinions about the system's being user friendly. The answers and the total number of people giving these answers areas follows:

Table 5.3 Answers given to Question 3

(a) Very Much	(b) Yes	(c) No
4	18	6

We see that %21 of the students who entered the survey did not find the system user friendly(Ref. APPENDIX B Chart 2)”

Table 5.4 Answers given to Question 4

(a) It makes this system much more efficient	(b) I agree taking short tests at the end of each section	(c) This does not affect my learning	(d) I disagree taking short tests at the end of each section	(e) It would be much too better if these tests were not given at the end of each section
13	12	1	0	2

Totally %83 of the students say that the end-of-section tests make learning more efficient (a) or it is preferable for them to take short tests after reading each section, before getting to the next section (b). This means that a great majority of the students

entering the survey find this positive and one student has got a neutral opinion about taking short end-of-section tests .(APPENDIX B Chart 3).

Table 5.5 Answers given to Question 5

(a) This improves my learning much	(b) This improves my learning little	(c) This does not affect my learning	(d) It would be better for me if these feedbacks were not given after short tests	(e) I strongly disagree taking feedbacks at the end of each section after short tests
24	3	1	0	0

Only one of the students (%4) entering the survey says that taking such feedback after first reading does not affect his/her learning and the rest (%96) has a positive opinion on this. Especially, %85 of the people who entered the survey say that taking feedback improves their learning much and this is a very high ratio. (APPENDIX B Chart 4).

Table 5.6 Answers given to Question 6

(a) Much too beter	(b) I agree taking out of grading summary tests before examinations	(c) This would make no difference for me	(d) I disagree taking out of grading summary tests before examinations	(e) Much too worse
10	13	5	0	0

Taking the alternatives (a) and (b) positive opinion, totally %82 of the students have a positive opinion about taking out of grading tests before examinations and believe that this will help them learn the course material better and get ready more easily for the examinations. (APPENDIX B Chart 5).

Table 5.7 Answers given to Question 7

(a) Yes, it would be much beter	(b) Yes, I agree that all the tests are graded	(c) It would make no difference for me	(d) No, I disagree that the tests are graded	(e) No, it would be much worse
5	10	5	7	1

The answers given to this question are interesting. Majority of the students say that grading all the examinations make distance learning more efficient (%53), but %22 of the students disagree that the tests are graded or say that grading the tests would be much worse. %18 say that this does not make a difference. More than half of the students agree taking grades from these examinations and this means more than half of the students believe that this makes distance learning more efficient. (APPENDIX B Chart 6).

Table 5.8 Answers given to Question 8

(a) Yes, it is much too preferable	(b) Yes, I prefer this model	(c) It does not make any difference	(d) No, I prefer the other model	(e) No, I strongly prefer the other model
11	11	4	2	0

The results show that nearly %40 of the students find this system very preferable and the same percentage find this system preferable, this makes a total percentage of %79. Only 2 students who entered the survey (%7) prefer the model that is currently being used and the rest (%14) think that this system does not make any difference.(APPENDIX B Chart 7).

The 9th, 10th and 11th questions ask different things about the opinions of students and I want to make comments on these questions separately. We understand that the idea of taking short end-of-section tests before getting to the next section is generally accepted by the students and students also accept the idea of taking feedbacks about these tests, especially taking feedbacks about the subjects taught is strongly supported by the students. The idea of taking sample out of grading tests before graded examinations, like midterms and finals is also strongly accepted by the students. It is not possible to say the same for the idea of grading all the tests given in this system. These two are not included in the system developed for this thesis. The evaluation of the eighth question is also in accordance with the other results, as a whole, great majority of the students accept the system developed for this thesis. I believe, it is possible to say that the system makes distance learning more efficient by testing the knowledge level of the students and helping the students learn the course material better. Anyway, more importance must be given to navigational support and user interface.

The 9th, 10th and 11th questions of the questionnaire do not ask the students about the contributions of this system to distance learning, so I thought it would be better to evaluate these questions separately.

The 9th question asks the user if he/she had any technical problems with the system. Some of the users did not answer this question and nearly all of them answered this question “No”. Anyway most of the presentations made to the users who entered this survey were made on a local machine and some of the users found this question not

applicable because of that. There are also some comments like “The pages must be improved further for better presentation” or “long loading time”. No matter what most of the users who entered the survey say, I believe the system must work on a stronger machine so that loading time can be made shorter and access to the WEB pages may be faster.

The 10th question requests the opinions of the users about the user interface and asks them how the user interface can be developed further for making learning with this system more fun. Not all the students filled out this question. Though the model was found efficient and good by the people who took role in the survey, there are many comments, also negative comments and advices about the system. Taking care of all the comments, I want to summarize these:

-Especially many of the people who got role in the questionnaire say that the graphical support for the system must be better. The user interface was found very simple though it is efficient and the system works well. The pages must be more colorful. The size and the font of the letters must be arranged better for more visuality. This means the WEB pages must be more visual, must have more visual effects and they must be improved further for more visuality.

-The feedbacks about the user’s knowledge level, (whether the student read the section or not) should also be given on the same page.

-Navigational support must be stronger

-Users can be provided with more options to control the learning path. There is a feeling that the program forces you to choose a static path.

-The design of the quiz section can be changed to promote the user and increase his/her interest to the subject

-Treeview can be more usable and efficient to select the desired content. The lecture notes can be shown at the left side of the page in a different frame in treeview form. Chapter hierarchy can be shown similarly at the beginning of every section.

-The student must be able to access whatever section he wants from a single interface and whenever he wants (Lecture 1 --- Section 1, Lecture 2 ---Section 2 ...)

11th question is the question to understand the deficiencies of the system. These deficiencies will be considered to construct the future work for this thesis. The general idea is that the system is efficient and well designed but, anyway it needs some improvement. The comments can be summarized as follows:

-The end-of-section quiz questions can be given beginning from the easiest question to the most difficult one

-There are too many links. The user must go through many links to reach the lecture notes. It would be better if this path were shorter.

-At the end of every chapter, it will be wise to show all the quiz questions that were answered wrong and where they were asked, like section 1, section 2.

-If the student had taken the quiz of the section before, he/she need not see the wrong answers he/she had given after viewing the section next time before going to the next section again.

-The end-of-section tests must be optional, the student must be able to take the quiz if he/she wants to do so, otherwise, he/she must be able to skip the quiz and go to the next section without taking the quiz.

-Besides true false questions, there must be comment questions as well, it would be better if the system could process natural language.

-The most important factor affecting the learning efficiency is the content and the presentation of that content. If there are no problems regarding the content and the presentation of that content, then having end-section tests or not, actually does not affect the efficiency of learning much.

-The model should be tested under real conditions and the improvement in learning should be quantified.

-It would be better if the mistakes done by the users were collected in a pool and sent back to the user at some specific intervals (maybe days, weeks, after chapters etc.)

-General statistics about the results of end-of-section tests (which subject is understood, question is not understandable, lesson is not understandable) should be evaluated to discover the general knowledge level of the students who are taking the course and these statistics should be represented to the students. Statistics will be useful for students (as graphics) to see his/her overall performance or overall performance of all students. These statistics can be very useful to discover how the learning efficiency is improved.

-Providing short end-of-section tests is very important in improving effectiveness of learning but in this system, the type of questions and their presentation seem to force memorization. More techniques can be developed to reinforce learning and support more constructive learning models.

-The feedbacks can be more informative.

-The student may enter an unread section by writing the necessary URL in the address bar. That destroys the possibility of going to the next page without taking the test of the previous page.

-If homework uploading is added, this would enhance the usability of the model.

-The system should be more interactive and the chance of interacting with the instructor or interacting with the WEB pages must be added

-The model should display the correct answers as well as the wrong ones in evaluation pages, when the page is browsed next time. Moreover, the tests should be available (fully available) in later weeks or months for restudying.

-Overall test and grading summary should be added at the end of each chapter
Taking care of all the answers given to the multiple choice questions and comments written, it is possible to say that the system is found to be efficient, increasing the motivation of the students on the reading material and that it improves distance learning by helping the student learn the course material better, but it needs further improvement for more efficiency. I want to constitute the future work of this thesis by taking these comments and answers as references.

CHAPTER 5

DEFICIENCIES OF THE SYSTEM AND FUTURE WORK

The results of the survey show that the system was found efficient and can be used in distance learning but it has some deficiencies. The future work of this thesis will be based on the comments of the people who entered the survey and will aim to improve the system and leave no deficiencies based on these comments.

5.1 Deficiencies Of The System

Some of the things described as deficiencies of the system by the people who entered the survey cannot be applied to this system because of technical problems. For example, some comments suggest that the hierarchy of the lecture notes can be shown as treeview in a different frame in the page but this is not possible to apply because Net-Class is also composed of many frames and the developers of the WEB courses are especially told to use only one frame in their page design. Also some of the comments are out of the scope of this study. Comments saying “Learning will be better if simulations are used in representing the course material” are irrelevant because the course material is directly uploaded to the system by the instructor after he/she prepares the html pages and the system has no power on the contents of the

course material. Excluding comments that are irrelevant or not applicable, the system's deficiencies can be summarized as follows:

-Navigational support is not strong. It must be improved so that the student will not get lost in the hyperspace while taking the course.

-The servlets which provide system's interaction with the users should have better graphical support. The pages are effective but too simple. They must be visualized further by using WEB design tools.

-The learning path should be shorter. The student goes through so many links to reach a desired page and this fact may decrease the motivation of the student on the course material.

-The student may see the lecture notes of any section without taking the end-of-section of the previous section by writing the URL of the learning unit in the address bar in a browser. This contradicts the objective of this study.

These are the deficiencies of the system that must be repaired anyway for more efficient learning. Based on these deficiencies and the recommendations taken from the people who entered the survey, the future work for this study is constructed.

5.2 Future Work

Future work of this thesis will be to repair the system's deficiencies and to improve the system for more efficient learning, this will be by making additions to the system as recommended by the users and making some changes in the working ways of some components. We can summarize these like the following:

-The deficiencies will be repaired.

-The system will be able to process natural language. So, it will be possible to give questions in other formats than multiple choice or true/false and this will lead to a learning less dependent on memorization.

-The results of the end-of-section tests will be collected in a pool and general statistics about the students' immediate learning performances will be derived from here. These statistics will be presented to the students in a forum and each student will be able to see his/her position in the curve. The statistics will be given to the students periodically, for example, after every chapter and this will make possible for each student to follow his/her own pace and development. The student will be able to reach his records using the forum anytime, and so he/she will be able to see the end-of-section tests and the answers he/she gave to these tests anytime.

-The feedbacks can be made more informative by using some other techniques in the course design and software.

- There will be an additional tool in the software for assigning the students homeworks, the instructor will be able to upload homeworks for the students and the system will also help the students in doing their homeworks. The teacher will enter the solutions of the homework questions also and these solutions will be three or more steps. The student will see the homework questions, and while answering the questions, the system will guide him/her by showing at least one step if the student clicks a button that he/she needs help.

This list will get longer as the technological developments continue and there are new methods in distance learning. This system was developed using some important technologies of today and it was found to be efficient by the users. The systems further improvement will need hard working and analyzing the integration of new technologies with systems developed with old technologies. Java programming language is a very useful technology for this process. Since this system was also developed using Java, it will be possible to follow the new developments for this system though it needs hard working and a high capacity for research.

CHAPTER 6

CONCLUSION

The system developed for this thesis mainly aims to open a way for a more efficienct distance learning by increasing the motivation of the student on the course material and providing the student with ways to learn the course concepts better. It makes use of many new technologies which are being used effectively in the industry like Java Servlets, JSP and databases. The system integrates Intelligent Tutoring Systems into World Wide WEB by using the internet technologies. It is mainly designed for graduate students who are also working professionals and it may be used to present an online course from any discipline; natural sciences, engineering or social sciences. The pretest-posttest approach is used effectively for making the system more efficient.

The system was evaluated by 28 people who all have a bachelor's degree from a university and, except three, are graduate students. These people are generally assistants and they were chosen to evaluate the system mainly because of these two factors. The ION course, ION 525-Artificial Intelligence was used to present the system to the people who participated in the survey. The evaluation of the system showed that the system is found to increase the efficiency in distance education. The term "efficiency" is used here to indicate the concept of "better motivation and learning".

Many comments and recommendations were taken from the people who took part in the survey and these comments and recommendations show that though the system increases the efficiency level of distance learning by using this tool, it has got some deficiencies. Taking into consideration these comments and recommendations, the future work for this thesis was constructed and I believe, this future work will lead the system to increase the efficiency level of online instruction. The ION project of Informatics Institute gives online masters education through internet and the students of the program are generally working professionals. Since this system was found to be effective by the people who took part in the survey and it also aims to instruct working professionals, when integrated into Net-Class, it can be easily used in the ION project after the deficiencies are repaired and future work is done.

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APPENDICES

APPENDIX A

QUESTIONNAIRE

The original questionnaire used in the survey contained 11 questions and it was used by 28 people to evaluate the system. The original 28 questionnaires can be found in the library of the department of Science and Technology Policy Studies. A copy of the original questionnaire is as follows:

EVALUATION QUESTIONS FOR STUDENTS

Yalın Yeşiltaş

1. Please write the department you have graduated from:

2. Please write the name of the graduate program you are currently studying:

3. Did you find this distance learning model user friendly?

a)Very much b)Yes c) No

4. What do you think about taking short tests at the end of each section?

a) It makes this learning model much more efficient

b) I agree taking short tests at the end of each section

b) This does not affect my learning

c) I disagree taking short tests at the end of each section

d) It would be much too better if these tests were not given at the end of each section

5. In this model, the short tests you are given at the end of each section test how well you have learned about the subjects taught. After each short test, you are given feedback about these subjects. What is your opinion about this?

a) This improves my learning much

b) This improves my learning little

c) This does not affect my learning

d) It would be better for me if these feedbacks were not given after short tests

e) I strongly disagree taking feedbacks at the end of each section after short tests

6. In your opinion, if you take out of grading summary tests just before the examinations (like midterm, final) in this distance learning model, how would this help you learn the course material?

a) Much too better

b) I agree taking out of grading summary tests before examinations

c) This would make no difference for me

d) I disagree taking out of grading summary tests before examinations

e) Much too worse

7. Do you think that taking grades from all the tests given in this model would help you understand the course material better?

a) Yes, it would be much better

b) Yes, I agree that all the tests are graded

c) It would make no difference for me

d) No, I disagree that the tests are graded

e) No, it would be much worse

8. In your opinion is this model preferrable to a model in which no end-of-section tests are given? (Consider that all the tests you take in this model are out of grading)

a) Yes, it is much too preferable

b) Yes, I prefer this model

c) It does not make any difference

d) No, I prefer the other model

c) No, I strongly prefer the other model

9. Did you have any technical problems with the program, like long loading time, or showing error messages? If any, please write them.

10. Please write your comments about the user interface. How can the user interface be developed to make this distance learning model more efficient?

11. Please write your additional comments about the model and how the model can be developed further for more efficiency in distance learning?

APPENDIX B

ANSWER CHARTS

The answers given to the questions of the questionnaire by the people who participated in the survey were analyzed in the following graphics. The graphics show the percentages of the given answers.

CHART 1

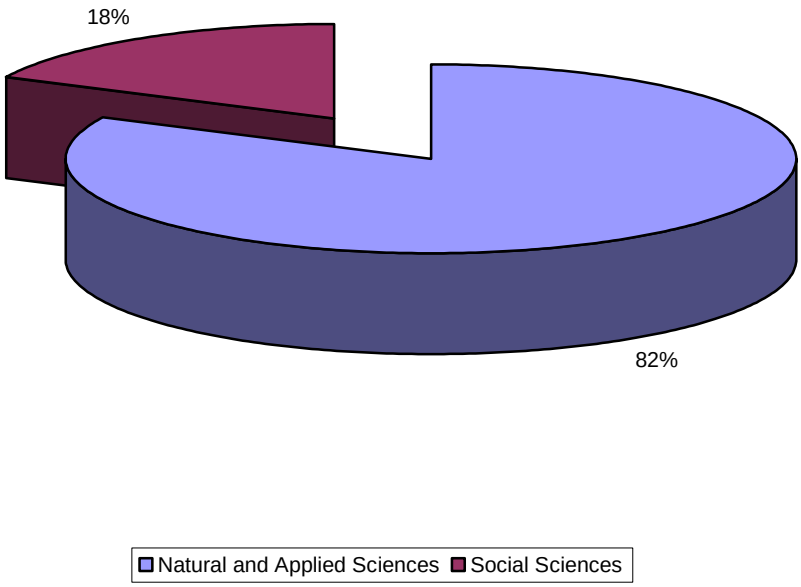

CHART 2

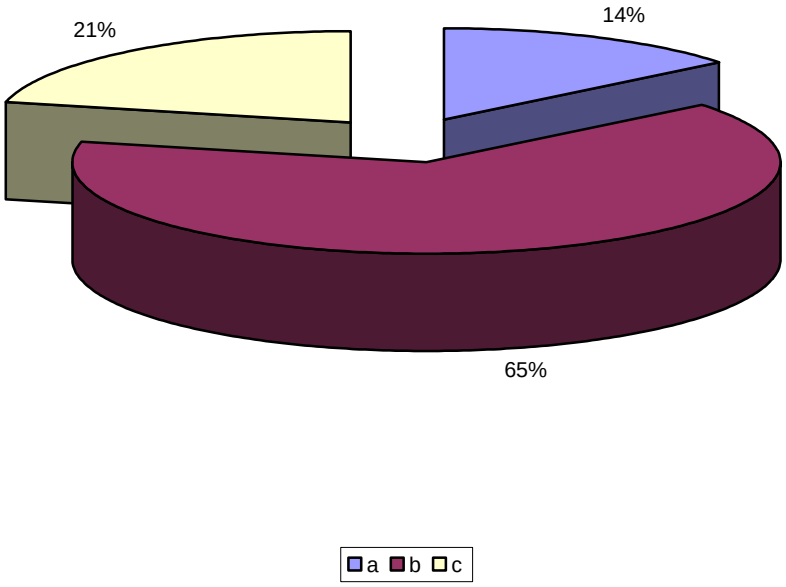

CHART 3

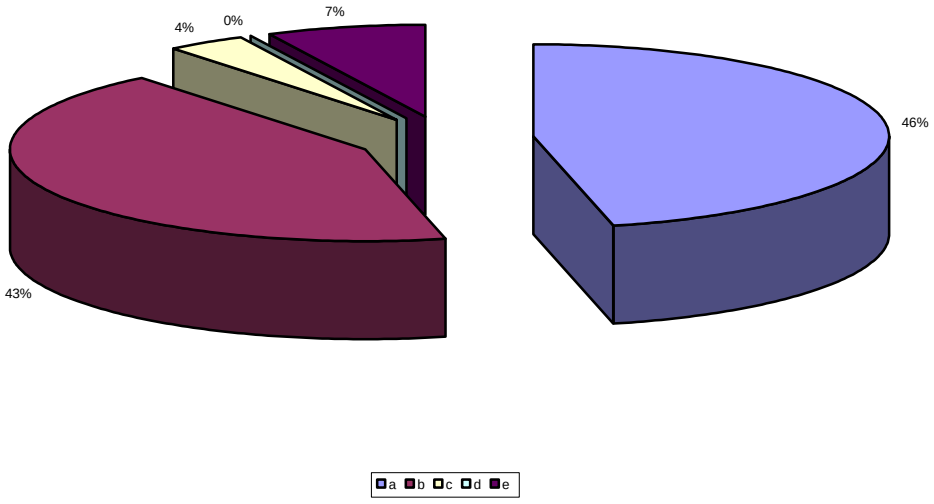

CHART 4

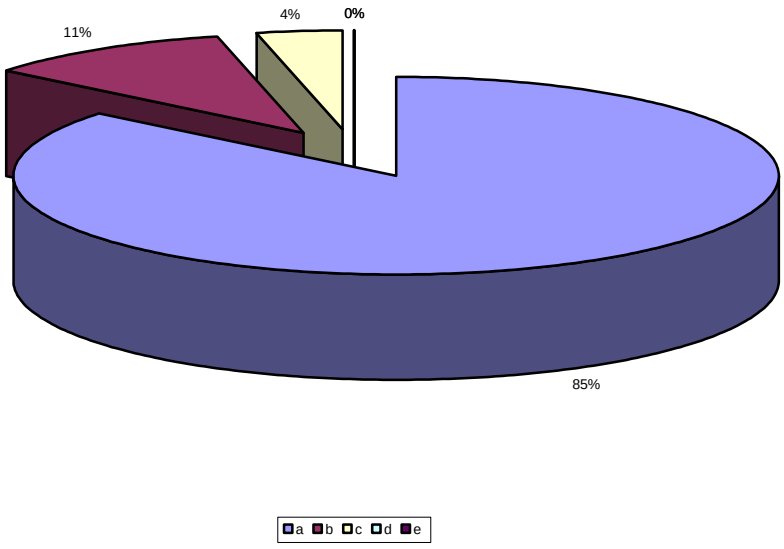

CHART 5

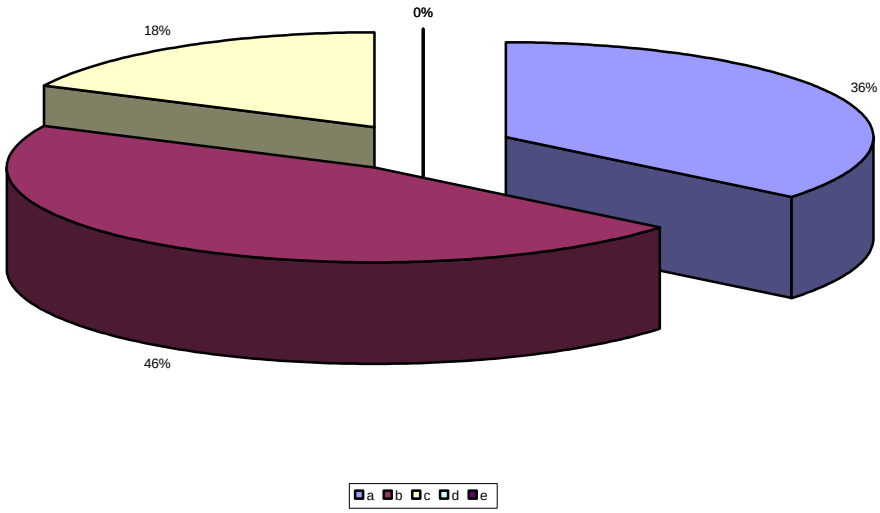

CHART 6

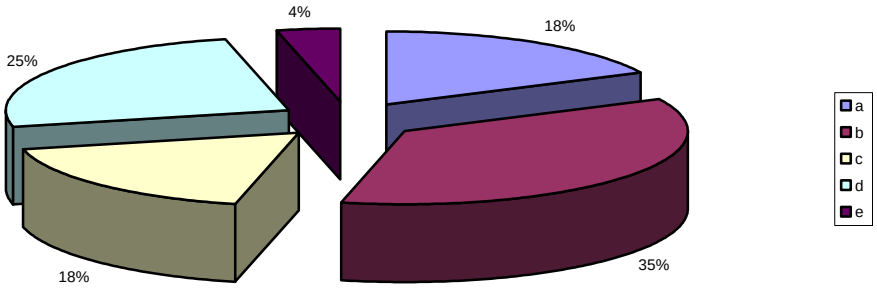

CHART 7