ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

INTEGRATION OF COMPUTER ASSISTED LEARNING INTO THE CURRICULA OF ETHIOPIAN SCHOOLS

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Integration of Computer-Assisted Learning into the curricula of Ethiopian schools

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ABSTRACT

This thesis is an investigation into the feasibility of integrating Computer Assisted Learning into the curricula of Ethiopian schools. It analyses the availability of appropriate and sufficient hardware and software, literacy level of teachers and students on computers, knowledge and skill of teachers about use of computers for instructional purposes. The results of these factors were used to compare status of the schools with different models for the integration of Computer Assisted Learning into the teaching and learning process.

The findings of this study indicated that the use of computers beyond the actual computer classes is poorly exercised. The distribution of hardware and software and computer related skills of teachers and students are generally low.

The comparison of the schools' status with some models for Computer Assisted Learning integration in the teaching and learning process showed that almost all schools are either at the initial phase or do not correspond at all.

A courseware was developed for the subject "Int. to Information Technology" for grade eleven. Lesson presentation, dynamic and randomly generated test questions, auto scoring and immediate feedback are some of the features of the courseware.

Based on the results obtained from this study a number of recommendations are given on how Computer Assisted Learning can be integrated in the Ethiopian schools.

Key words/phrases: CAL, computers in education, CAI, Computer Assisted Learning/Instruction, Integration, Models.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER ONE

INTRODUCTION

This chapter discusses the background information, objectives, and problem statement of the research work. Furthermore, the research methodology and thesis overview that guides to the thesis are presented.

1.1 Background

Technological innovation has been incorporated into so many areas of our lives such as in travel, at home, in communication, in industry, in finance, in recreation, and in medicine. Education is no exception. Computer Assisted Learning (CAL) has been in use for many years assisting education with computer technology.

As described in [58], the educational use of computers is divided into three main categories:

- As a tool in the teaching and learning process
- As an entity being studied
- As an instructional delivery platform

The term CAL is often used to refer to the development of a computer program or series of programs with explicit aim of replacing the current methods of instruction, often referred to as Computer-Based Instruction (CBI) (Corbett et al. [17]).

Computer-Based instructional programs are traditionally categorized into Computer-Based Tutorials, Computer-Based Drill and Practice and Simulation and games. Today, hypertext, hypermedia and multimedia are becoming part of the category.

On the other hand, many researchers on CAL such as [53, 54] have regarded it as one of educational strategies that can be integrated into a particular subject. Accordingly, its role must be reevaluated with respect to the pedagogical advantages it provides in areas of the subject where other strategies are failing.

A well designed and properly integrated CAL tool presents materials in an effective way, facilitates communication between teachers and students, and students themselves, enables student collaboration [24, 59], easy access to resources, encouraging self-paced learning, and providing online assessment. Therefore, CAL can enforce a steep learning curve. With this regard it plays its part in enhancing the teaching-learning process.

In order for CAL to be effective, i.e., to give the uses of CAL mentioned in the previous paragraph, it must be thoroughly planned and prepared. As such it requires academic expertise and knowledge of Information Technology (IT). Research [5] shows that the extent of introduction of IT innovation in schools is rather limited by a number of constraints that need to be addressed. Some of these constraints are the following:

- The extent of use of computers beyond the actual computer classes.
- Literacy level of teachers and students on basic skills of using computers.
- Knowledge and skill of teachers about use of computers for instructional purposes, and training opportunities.

- Availability of expertise, guidance and help for instructional use of computers, and technical assistance.
- Availability of appropriate and sufficient software and computer hardware are also other important problems that must be verified.

The above points indicate that before CAL can be incorporated into schools' curricula, it needs to be researched.

1.2 Statement of the Problem

Research [59] shows that the use of computers for the teaching and learning process is generally known to improve the quality of learning in an affordable cost. Accordingly, many countries have integrated computers into their curricula and the adoption of the technology in education is increasing from time to time aiming at promoting quality of education.

The formal curriculum of the Ethiopian school system[1] is characterized as low in quality and coverage. The school standards, teacher training, libraries and laboratories are poorly exercised (Appendix E).

According to the national education standards, the first cycle primary education requires teachers with minimum qualification of Teacher Training Institute (TTI) certificate, teacher training college diploma for the second cycle teachers and first degree for secondary level.

[1] According to the report by UNESCO [60], the formal curriculum of the Ethiopian school system has been divided into kindergarten, general and technical-vocational education curricula.

However, the education statistics annual abstract [21], shows that the proportions of qualified teachers, which is one among the most important quality indicators, of second cycle primary and secondary levels are only 30.9 and 39 percent respectively.

The Gross Enrolment Ratio (GER) and Pupil to Teacher Ratio (PTR), which are coverage and efficiency indicators, are also below the target. The education statistics annual abstract [21] shows that the GER is only 2 percent, 64.4 percent, and 19.3 percent in Kindergarten, Primary and first cycle secondary respectively.

Accordingly, UNESCO [60] reported that there are some challenges eminent to the Ethiopian educational development. These include low level of literacy among the population, lack of appropriate kits and laboratory facilities for mathematics and natural science, and reorientation of the educational system towards problem solving approach and creative thinking. Thus, the demand for quality education is even higher in the Ethiopian education sector.

As pointed out earlier, when properly integrated, educational technologies such as computer-based tools (tutorials, drills and practices, simulations, and games), communication tools, and other educational technologies can assist classrooms, laboratories, and libraries thereby improve the overall quality of education. It is with this in mind that the Ethiopian Ministry of Education (MoE) is launching the schoolNet project as part of the national ICT development program aiming at making use of the advantages of educational technologies.

Following the new education and training policy, the structure of education, which was 6-2-4, has been replaced by the 8-4 structure. The latter offers 8 years of primary in two cycles each having 4 years duration and 4 years of secondary education in two cycles each having 2 years duration.

Computer Assisted Learning can play an immense role in supplementing the above mentioned activities. However, there are no detailed studies with regard to its current distribution, feasibility of implementation with respect to the skill of learners to use such systems, availability of computer gadgets, and readiness of teachers to use it.

It was to address such things that necessitated the investigation of the main research topic:

How effectively can Ethiopian schools integrate Computer Assisted Learning?

The goal of this research is thus to show the possibility of integrating CAL into school curricula, to suggest alternative technologies and to lay a foundation for future design and implementation of CAL systems in the country.

1.3 Justification

In Ethiopia the introduction of computers is closely related to application of computers and thereby the development and awareness of automation. Therefore, although the technology is not well practiced in the country, it has already created awareness in the minds of people including the school community. On the other hand, trends show that the price of computers is falling from time to time. Consequently, this global effect enabled many Ethiopian institutions including schools to own computers. Currently, the Ethiopian schools are acquiring computers and related accessories through one or combination of the following:

- For the implementation of school based projects. Some schools have acquired computers by donation for the purposes of small projects proposed by the schools or for other objectives.

- For the purpose of introduction of the subject “Information Technology” in the curriculum. Regardless of the type of the school, almost all preparatory and technical and vocational schools have introduced computers and they are providing their students with theories and basic skills on computers.
- Competition among private schools. Many private schools have introduced computers even at the Primary and Kindergarten education.
- For the implementation of the schoolNet[2] project. The schoolNet project, which is government-led, is establishing broadband multimedia network at almost all government high schools including the rural ones and other institutes. The aim of the project is to improve access and quality of education by supporting classrooms through Internet technology [30].

Accordingly, a report by Getaneh et al. [26] on the base line study on deployment and exploitation of ICT in Ethiopia showed that, out of the surveyed schools, 59.7 percent are reported to have computers, 22.3 percent have Internet connection, and 18.7 percent have MoE resource center. Furthermore, the average number of computers and the percentage of computer literate teachers per school are also reported to be 13 and 11 respectively.

Regarding trained manpower, the MoE is implementing teacher development programs by means of fragments of training projects (Appendix G). In addition, currently, there are significant number of Technical and Vocational Education Training Institutes (TVETs), colleges and universities training professional in the area of ICT.

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[2] In parallel with the learning video contents launched by the Educational Media Agency (EMA), the Internet Service Provider (ISP) connects schools to the Internet. Both the EMA and ISP are connected to the Very Small Aperture Terminals (VSAT) hub at “Sululta” using the broadband multimedia network (BMN) and each school down streams the Internet.

The ways in which computers are being exploited in schools vary [26]. Some schools use computers for writing letters; others use computers for the preparation of teaching materials and for examinations. But, trend shows that the use of computers in schools is mainly to learn how to use computers, that is learning about computers.

However, according to Whitrow [57], people understand computers more while doing useful things. In other words, the integration of computers in the actual teaching and learning processes of all subject areas has two fold advantages: primarily it facilitates the teaching and learning process and furthermore the technology can be understood more. Hence, schools that have already acquired the technology (computers, connectivity, and digital contents) can be better achievers in their learning outcome through student-centered learning by the assistance of technology.

Therefore, the results gained from this study could be used to impart schools to utilize the available educational technologies (if any) through reevaluation of their curricula.

1.4 Objectives

The primary objective of this research work is to study the feasibility on the use of CAL systems in education to lay foundation for future implementation in Ethiopian schools.

The specific objectives of the project are to:

- Investigate the ICT infrastructure in Ethiopian schools and weigh against the demand for the implementation of CAL.

- Evaluate and show the magnitude of the use of CAL in Ethiopian schools, if any, and the difference it has exerted on its users.
- Evaluate the experience and tendency of Ethiopian school teachers to enhance their teaching practices using the potential of CAL systems.
- Evaluate the experience and tendency of school administrators towards the use of CAL systems to promote quality education in their schools.
- Point out future directions for the implementation of CAL systems in Ethiopian schools.

1.5 Scope and limitations

This study encompasses Kindergarten, Primary, Secondary, Preparatory, and TVET schools in Addis Ababa.

The scope of the study is limited to the practices of schools in which computers are deployed relatively better and to compare the existing practices with different matured models for technology adoption in schools. In addition, the development of complete model for the different trends being exercised is beyond the scope of this work. This is because of the fact that it requires time and resources for the detail reevaluation of the existing curricula, pedagogic and technical services and active involvement of the target schools.

Although it is expected to be similar, the practices in rural schools are not surveyed because of time and resource limitation.

1.6 Research Methodology

This section discusses the research methodology – study sample, research instrument, procedures, and scoring employed in this study.

1.6.1 Study sample

The study was organized into two phases. Surveying of 80 schools taking into account school ownership, location, and school levels began the first phase of the study. The objective was to assess the deployment and usage of technologies (computers, connectivity, and digital learning content) in Ethiopian schools, which is necessary for the implementation of Computer Assisted Learning. Accordingly, ten schools that have relatively better practices on the use of computers in the teaching/learning process were selected for the second phase of the study.

A total of 350 questionnaires, 120 for teachers and 230 for students (See Appendix A and B respectively), were distributed to the selected schools and a total of 248 (70.8%), 175 from students and 73 from teachers were collected. Eight of these questionnaires were not used in the study due to respondents incorrectly completing the questionnaires. After accounting for incorrectly completed responses, sample size was 170 students and 70 teachers (See Appendices C and D respectively).

1.6.2 Research Instrument

In this research work, interviews, visits, and questionnaires are used as methods of data collection. Each of them is conducted as follows:

1.6.2.1 Interview

Three types of interviews were prepared (See Appendices E, F and G). These interviews were designed to elicit relevant information from the respective officials of the following organizations:

- Education Media Agency (EMA)
- Ethiopian Telecommunications Corporation (ETC)
- Institute of Curriculum Development and Educational Research (ICDER)

1.6.2.2 Visit

Schools have been visited to elicit information about their experience on the deployment and exploitation of computer-related technologies in their teaching and learning process. The visit was accompanied with a set of questions (See chapter 4) for the respective schools' administrators and/or IT personnel.

1.6.2.3 Questionnaire

Following the preliminary analysis and thereby selection of target schools, two types of questionnaires were prepared and distributed to the target schools. Type I was for teachers while type II was for students. Both questionnaires are more or less similar in format but different in content. Each has five parts: Part A, Part B, Part C, Part D and Part E and the description of which are given next.

Part A. This section of the questionnaires investigated aspects of students' and teachers' personal background that may have influenced their computer skills, their experience on the use of computers for academic purposes and their views on the integration of CAL into different school levels.

Part B. This part is to solicit computer-related skills of respondents, which covers basic computer skills, application, Internet, Web and educational software.

Part C. This part aims at soliciting data about usage of computers in the teaching/learning process.

Part D. Questionnaires Type I and Type II have different goals with this part. "Type I" is on teachers' views of computers in teaching while "Type II" is on the impact of computers on students' learning.

Part E. This part has been included for respondents' comments and suggestions, which is not included in the analysis. However, some comments have been incorporated in the discussion and recommendation.

1.6.3 Procedures

We used the following procedures to conduct this research work:

- Interview
- Document collection
- Visit
- Preliminary analysis
- Administration of questionnaire
- Collection of data and checking correctness
- Tabulation
- Analysis

1.6.3.1 Interview

The three organizations described above are selected for the interview because of their close ties with the curricula and the schoolNet project. Accordingly, their respective officials have been interviewed.

1.6.3.2 Document collection

Documents have been collected from the Ethiopian Science and Technology Commission (ESTC), Ministry of Education (MoE), Basic Education System Overhaul (BESO) and the Education Bureau of Addis Ababa City.

1.6.3.3 Visit

Schools in Addis Ababa have been visited and interviews have been conducted with the respective school administrators or IT personnel (See section 1.6.2.2).

1.6.3.4 Preliminary analysis

After the collection of relevant information, preliminary analysis has been made (See chapter 4). The result of this analysis was used to have views on the deployment and exploitation of technology at school level and thereby schools have been selected for the next phase of this work.

1.6.3.5 Administration of questionnaire

Questionnaires were distributed to respondents by selecting those who have relatively better exposure to IT in the respective schools. This selection process has been made by the respective school's IT personnel. Respondents were given an average of one-week time to complete the questionnaires. However, in some cases students were asked to complete within 30 minutes.

1.6.3.6 Collection of data and checking correctness

Data was collected from the IT personnel of the respective schools a week after the distribution of questionnaires and the responses were analyzed for correctness during coding.

1.6.3.7 Tabulation

Each part of the questionnaires has been tabulated differently on EXCEL 97. Accordingly, the raw data in appendices A and B has been divided into four Parts:

Part A. Each response of the questions about personal details was tabulated according to the respective response number as it appears in the questionnaires.

Part B. This part contains ten questions and the respective responses were tabulated as 1, 2, 3, or 4 which represent "High", "Medium", "Low", or "None" respectively (See Appendices C and D).

Part C. This part is comprised of twelve questions. The responses of each statement were tabulated as 1, 2, 3, 4 or 5, which represent "very often", "often", "sometimes", "seldom", and "None" respectively.

Part D. This part contains 12 statements. The first 8 statements are on the impact of computers in students' learning (questionnaire type II) and teachers' views on the support of computers in teaching (type I). The last 4 statements are on the views of teachers and students in the integration of computers at different school levels. The responses for each statement have been tabulated as 1, 2, 3, 4, or 5 to represent "strongly agree", "agree", "disagree", "strongly disagree", and "undecided" respectively.

1.6.3.8 Analysis

In this research work, statistical analysis has been conducted. This includes averaging, standard deviation, and correlation of variables. More on this is detailed in chapter 4.

1.7 Thesis Overview

This thesis is divided into five chapters including the current one. It presents literature review, data analysis and discussion of results, conclusions and recommendations and points out future works. A brief overview of these topics is explained in the following paragraphs.

In the second chapter, two contextual definitions of CAL, i.e., CAL as Computer Based Learning (CBL) and CAL as an integrative technology are explained. Other contexts such as the use of computers as learning content delivery platform and instructional courseware are also discussed.

Chapter 3 discusses on the integration of computer-related tools and software with the different curricula, methodology and technical practices of schools. Different models of successful integration of computer (technology) are also explained. A model for teachers' development (attitudes, knowledge and skills) is also included, as there is a difference between the acquisition of an innovation in education and its deployment for the intended purposes.

In chapter 4, detailed methodology, analysis and discussion of this work are explained. It was found out that the practices of Ethiopian schools on the adoption and integration of educational technologies in the teaching and learning process is generally low and it varies among schools. In addition, different models have been used to trace the existing practices in the selected schools with respect to the rationale of each model, and it revealed that schools reside around the initial phases of the successful technology integration models or do not correspond at all.

A courseware prototype was developed for the subject “Int. to Information Technology” which is offered in grade eleven. Chapter 5 discusses the current methods of instructional delivery of the course and their drawbacks, development approaches for the prototype, features of the developed courseware and its deployment possibilities.

Chapter 6 presents conclusions, recommendations, and future works. In this chapter, we have pointed out that technology, which is the most important among the factors required for the successful integration of Computer Assisted Learning into schools is not sufficiently available in most school levels. However, the preparatory and TVET schools are relatively better and the ongoing projects are also improving these school levels and the first cycle secondary schools. Therefore, we recommend that the preparatory and TVET schools can integrate Computer Assisted Learning into their teaching and learning process and the first cycle secondary can use the technology as supplementary to the existing practices.

All the schools that have been incorporated in the second phase in this study are chosen as they have relatively better practices on the deployment and utilization of technology in the teaching and learning process. Therefore, it is inappropriate to suggest and/or develop a single model for technology integration at schools all across the country.

Such a work demands detailed investigation at each school level. Subject to further study at a smaller granularity, i.e., at each school level, we have explained some recommendations.

CHAPTER TWO

COMPUTER ASSISTED LEARNING

2.1 Introduction

This chapter provides historical background, definitions of Computer Assisted Learning, and types of instructional courseware. Explanation about Leaning Management Systems, Learning Objects, and Authoring tools is also included.

2.2. Definition of Computer Assisted Learning

The acronym CAL that stands for *Computer Assisted Learning* is one of the most commonly used acronyms within the areas of Computing and education. It is difficult to say exactly when the term “CAL” was first employed; however, literature shows that since mid 1980s CAL has been increasingly used to describe the use of computers in teaching.

There are varieties of terms used to describe the educational use of computers (besides educational administration, education about computers and peer learning) and each has slightly different meaning. CAL is an all-encompassing term to describing any educational use of computers, which Taylor [58] broadly divided it into three main categories: tool, tutee, and tutor.

1. Tool - when the computer is used as a tool for teaching and/or learning. This includes for example, the use of word processor, spreadsheet, databases and graphics application in the teaching-learning process.
2. Tutee-when the student teaches the computer and in doing so must learn as well, as with the use of computer programming.
3. Tutor-when the computer is used as a delivery platform for some instructional material

This third situation is termed Computer Based Instruction (CBI) or Computer Assisted Instruction (CAI) which is an older term than CBI.

Other terms such as Computer Based Education (CBE), Instructional Application of Computers (IAC), Computer Based Learning (CBL), Web Based Learning (WBL), Computer Mediated Learning (CML) and the like, are also equivalently used in many literatures to mean similar thing.

This thesis deals mainly with this third aspect of use of computers in education, CBI and this will be referred as CAL.

CAL covers a range of computer-based packages, which aim at providing interactive instruction usually in specific subject area, and many predate the Internet.

There are two common contexts of usage, namely CAL as Computer Based Learning (CBL) and CAL as an Integrative technology. On the basis of whether to meet a required goal such as increasing the pupil to teacher ratio or quality of education, there are two basic motives whether the CAL system is intended to be CBL or an integrative technology.

The first motive characterizes CAL as a Computer program or series of programs, which replaces specific part or the whole of a lecture course without any support provided by other methods. The term that is used to describe this context of CAL is referred as Computer Based Learning (CBL). In this regard the computer is used as the primary medium of instruction. The tendency here is only to replace the traditional medium of instruction, which was the motive of the early 1990s [39].

In fact it has its own learning advantages such as accessibility any time and anywhere in cases such as the web, which has a bearing on the quality of learning. However, since the main concern is with learning resource rather than the actual learning, the communication between tutor and student is one sided with little opportunity for the student to express their views of the topic.

According to literature [39], the CBL can be made to maintain the context of CAL which is "assisting learning" by adding some form of formative or even summative assessment areas such as multiple choice questions where the student can check his/her conception of the topic and hence the progress.

The second motive is, instead of totally replacing the traditional lecture, CAL is incorporated into the subject just as a supportive learning resource. This context of CAL describes an integrative approach to teaching a subject in which learning technology forms a part and which comes only after the re-evaluation of the current learning methods for the subject. Hence, the context of CAL is transformed from being a computer program for learning a subject to an art of educational strategy devised to teach a particular subject. This context of CAL is detailed in chapter 3.

2.3. Instructional Courseware

This section presents a generalized concept called "courseware" which is defined by High-tech dictionary [29] as the program and data used in computer-based instruction. From this context, any computer-based instructional material that is "intended" to assist learning is termed as courseware. As a result, the program and data used for CAL and the CAL itself, are a tool and a strategy respectively used in learning.

2.3.1 Overview of Instructional Courseware

Several terms have been used in recent years with respect to instructional courseware, but one that is particularly well suited for this study is *computer-assisted (or aided) instruction* (CAI). CAI may be used as a supplement for instruction or as a complete lesson. With CAI, the computer can assist the teacher in implementing any or all of the four essential phases of instruction (Alessi et al. [55]):

- Presenting information
- Guiding the student
- Providing student practice
- Assessing student learning

Commercial software vendors release new instructional courseware titles in ever increasing numbers. A teacher must determine when to implement CAI in the classroom and what CAI to use. Additionally, he/she can create his/her own CAI with authoring tools that are readily available and relatively easy to use. An authoring system is a computer program that lets the teacher create instructional software of his/her own. In cases where no suitable CAI exists, this may be the only option to provide students with instructional courseware.

2.3.2 Types of Courseware

Instructional courseware (CAI) has traditionally been composed of five main components listed below. Each methodology has its own particular strengths and is discussed briefly below.

- Tutorials
- Drill and Practice
- Games
- Simulation and Modeling
- Test

Modern technologies have added *Hypertext, Hypermedia and Multimedia* to the above components.

2.3.2.1 Tutorials

The purpose of tutorial is to present information and guides the student. Tutorials strive to provide sequenced, interactive material, to the learner. The learner is engaged in direct and continual two-way communication with the computer, i.e., an active participant. A tutorial is ideal for presenting new material, allowing students to progress at their own pace, and reviewing previously learned subjects [55].

A teacher can design a tutorial in linear fashion (like a book) or with branching that allows students to control the lesson by their choices. Regardless of the type of design, tutorials should include embedded questions and remediation loops to ensure learners master material before moving on to more difficult concepts. Figure 2.1 shows the instructional activities of computer-based tutorials.

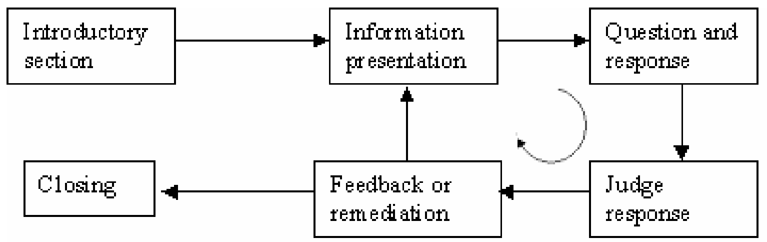

Figure 2.1 Instructional activities of Tutorials

Advocates of tutorials suggest that they can facilitate learning better than a teacher because of the one-to-one learning. Many tutorials permit students to learn at an individualized rate. Review of tutorials prior to using them in class will ensure that they meet needs of the learner. Tutorials are often combined with other types of courseware such as drills.

2.3.3.2 Drills

Computer-based drills can take the practice previously found in workbooks to a higher level by adding interactivity. When used in conjunction with other computer-assisted instruction, usually a tutorial, drills are not intended to teach new material. Drills are designed to give students the opportunity to practice what they've already learned. Some of the arguments for using the drill software is that the software can determine the proper level of difficulty based on student ability, ensure completion, provide feedback to mistakes, suggest supplemental activities, and depending on its design, record student results. Figure 2.2 shows the instructional activities of computer-based drill and practice tools.

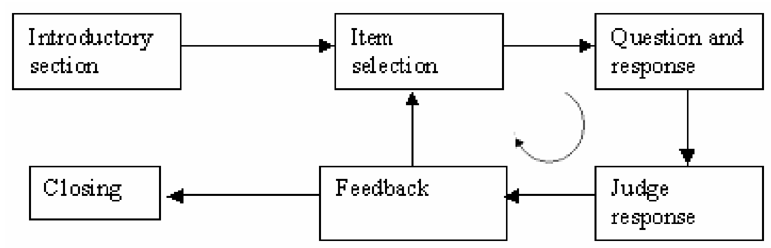

Figure 2.2 Instructional activities of Dills

Some drill software supports to incorporate randomly generated questions, interactive graphics, pacing and time-measured responses, and student progress updates.

Many drills are used in subjects such as mathematics, foreign languages, spelling, grammar, and vocabulary, but they are suitable for practically all subjects that require the student to memorize facts.

2.3.3.3 Instructional Games

Instructional games provide students a means to practice previously learned material or gain new information. But unlike drills, games are competitive by design, pitting the student against the computer, another player, or time.

Instructional games are difficult to design, and all too often, even those which are professionally designed turn out not to be fun and become another piece of unused software. Instructional games come in many varieties such as adventure, arcade, board, card or gambling, combat, logic, role-play, psychomotor, TV quiz, and word games. Like drills, these can be adapted to any subject that requires repeated practice.

2.3.3.4 Simulations

Simulations attempt to give the student a chance to participate in a real-life decision-making situation. The degree to which a simulator imitates the real- life situation is termed as fidelity [55].
Simulations are effective way of learning because they require problem solving and decision-making. Also, they provide a non-threading learning safe environment. Students can easily work in-groups to solve simulation problems. Whole class discussions can assist in helping students prepare for the simulation and help them understand what happened after the simulation.

When utilizing simulations, it may be difficult to assess student learning using traditional evaluation methods. Alternative assessment strategies may be required to ensure that the objectives of instruction have been fulfilled.

2.3.3.5 Tests

The use of computers to construct or administer tests offers the advantages of automatic scoring, randomly generated test items, testing at students' convenience, cross reference of test items to learning objectives, and ease of test bank maintenance. There are numerous testing software packages that can be utilized in the classroom.

2.4 Complexity and characteristics of courseware

A courseware can have varying levels of sophistication. For example, as long as a student is utilizing for his/her learning, some literatures consider the word processor along with the learning content as the simplest courseware. A better level of sophistication can be achieved using Microsoft PowerPoint or similar application based learning resource [7].

Although PowerPoint slideshow is usually linear, it allows including hyperlinks to jump to other sections of interest; audio and video can also be included in a slideshow.

A courseware may exist to support two or more methodologies. Therefore, depending on the number of components that it supports, a courseware can be simple or complex. Nowadays, many courseware that use individual differences as a basis of system's adaptation are available [25].

When choosing or developing instructional courseware for classroom, it is imperative that it matches the objectives of the course. Additionally, "good" instructional courseware has certain characteristics, which should be considered when designing or selecting the software. Some of the areas that must be considered when evaluating or designing instructional courseware are the following:

- Ease of use
- Complimenting instruction with graphics and sound
- Provision of appropriate pretests and posttests
- Ability to measure student progress

- Provision of adequate control to students over the lesson
- Allowing learner to review previous information
- Recorded student scores automatically and allowing access to it
- Usability in collaborative groups

2.5 Advantages of courseware

Instructional courseware has been shown by many literatures to benefit students in a variety of ways. When an instructional courseware is appropriately integrated in a classroom (chapter 3), it can have the following benefits:

- It can enhance student learning in terms of recall and time spent on instruction
- Motivate students
- Assist in developing teamwork skills
- Provide allowances for the difference in students
- Facilitate learning transfer to new situations.

2.6 Authoring Systems

Authoring systems enable a teacher to create his/her own instructional courseware. Today, most authoring systems use a windows "drag and drop" interface that makes it easier than ever to design, test, and implement new lessons. Authoring systems vary widely in functionality.

At a simplest level, Microsoft PowerPoint or a similar presentation application can be used to author courseware [7]. In addition to its sequential nature, PowerPoint allows to jump to the section the reader is interested in. It also allows linking to other multimedia contents. However, it lacks features like testing and scoring. Currently, there are a number of advanced level courseware authoring tools like Authorware, HyperStudio, Quest, ToolBook, Flash, WebDesign, DreamWeaver and FrontPage.

Courseware authoring tools exist not only as an independent but also built within a larger learning system such in Learning Content Management System (LCMS) or Learning Management System (LMS) which is discussed in the following sections.

2.7 Learning Content Management and Delivery Systems

The introduction of computers as a delivery platform (tutor) requires that computers should be able to manage and deliver learning content. According to Henry [28], implementation of computer/Internet-based learning involves three key elements- technology, services and content. For our purpose we consider only the technology part.

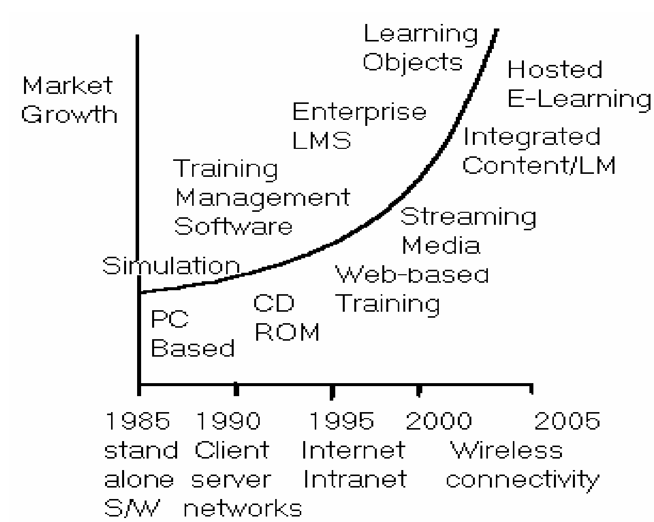

Figure 2.3 E-learning technologies, adapted from Barron [6].

Since the beginning of use of computers in education, a number of delivery technologies has been playing a fundamental role in facilitating computer/Internet based learning by allowing for a range on content delivery options [12]. Figure 2.3 depicts the trend in e-Learning technologies.

Around the summit of the curve (Figure 2.3), e-learning platforms such as Learning Management System and Learning Objects which can be offered at the enterprise level provide both a way to design, host, and deliver online courses. In some cases these tools are used for instructors who need web-based content to support their face-to-face courses and fully online instructors. These systems allow posting of lecture materials, online bulletin boards, and assessment capabilities like online surveys and tests. Some of these tools are the following.

Blackboard. Blackboard [8] is a popular course management system, which allows instructors to author in text or HTML lessons. Features include online lectures, rosters, live whiteboard, asynchronous bulletin board, document sharing, and assessment pools. Other similar alternatives include WebCT, eCollege, and LearningSpace.

FirstClass. FirstClass [22] is a messaging, collaboration groupware, and communication system, which supports online bulletin boards, calendaring, and document sharing. Instructors often use FirstClass's messaging system to develop an online course.

In the preceding sections, we will discuss features of learning technologies namely Learning Content Management Systems, Learning Objects and Learning Management Systems.

2.7.1 Learning Content Management System - LCMS

As explained in section 2.7, many courseware-authoring tools are available for the purpose of ease of development of course contents. In addition to its capability of creating content, the Learning Content Management System (LCMS) allows store, reuse, manage and deliver the learning content termed as Learning Object (LO).

Learning Objects, also called Reusable Learning Objects, are not really a set of technology, but rather a philosophy for how content can be created and deployed. As described by Yang et al. [32], learning objects refer to self-contained chunks of training content that can be assembled with other learning objects to create courses and curricula.

Learning objects are designed to be used in multiple training contexts, aimed to increase the flexibility of training, and make updating courses much easier to manage. Update a part of a learning object, and the change should appear in any course using that learning object.

The size of a learning object differs based on the instructional designer, from as small as a single page of content to as large as is required to contain an objective, presentation material, a practice section, and an assessment. However, the current Sharable Courseware Object Reference Model (SCORM) specifications provide a more precise, yet flexible, definition of what a learning object should be.

The development of reusable learning object is possible because of the fact that LCMS often strive to achieve a separation of content from presentation. This allows many LCMS to publish to a wide range of formats, platforms, or devices such as print, Web, and even Wireless Information Devices.

The Web is fundamentally changing. Today, not only virtual environments (section 2.9) such as virtual school and virtual universities (like the African Virtual University-AVU) but also many traditional schools and universities all over the world are fully or partly using the Web to provide more and more courses. This brings the need for systems, which allow developing and managing reusable learning content.

The focus of an LCMS is on learning content. It gives authors, instructional designers, and subject matter experts the means to create e-learning content more efficiently. The primary business problem an LCMS solves is to create just enough content just in time to meet the needs of individual learners or groups of learners. Rather than developing entire courses and adapting them to multiple audiences, instructional designers create reusable content chunks (LO) and make them available to course developers throughout the organization. This eliminates duplicate development efforts and allows for the rapid assembly of customized content [51].

The LCMS stores learning objects, which are the smallest unit of learning content, in the form of repository of learning objects. Instructional designers retrieve and assemble these objects into personalized course.

Greenberg [37] noted that the object level management has been around for long and solves a myriad of IT problems, but it's not a panacea. He assumes the following metaphor to illustrate the function of an LCMS. "Traditional courses are bags of jelly beans, learning objects are the beans inside the bag, and LCMSs are systems that open all the bags, pour the beans into one big jar, and put descriptive tags on each bean so they can be repackaged into new bags on demand".

Although capability of LCMS varies, the most important components include learning object repository, automated authoring application, dynamic delivery interface, and administrative application [32]. Each of the components is described below.

*Learning object repository***.** The learning object repository is a central database in which learning content is stored and managed. It's from this point that individual learning objects are either dispensed to users individually or used as components to assemble larger learning modules or full courses, depending on individual learning needs. The instructional output may be delivered via the Web, CD-ROM, or printed materials. The same object may be used as many times and for as many purposes as is appropriate. The integrity of the content is preserved regardless of the delivery platform. According to Changtao et al. [15], XML serves this function by separating content from programming logic and code.

*Automated authoring application***.** This application is used to create the reusable learning objects that are accessible in the repository. The application automates development by providing authors with templates and storyboarding capabilities that incorporate instructional design principles. Using these templates, authors may develop an entire course by using existing learning objects in the repository, creating new learning objects, or using a combination of old and new objects.

*Dynamic delivery interface***.** To serve up a learning object based on learner profiles, pretests, and/or user queries, a dynamic delivery interface is required. This component also provides user tracking, links to related sources of information, and multiple assessment types with user feedback. This interface may be customized for the organization using the LCMS.

*Administrative application***.** This application is used to manage learners' records, launch e-learning courses from course catalogs, track and report the progress of learners, and provide other basic administrative functions. This information can be fed into an LMS designed with more robust administrative functionality

2.7.2 Learning Management Systems -LMS

Authoring a courseware is one of the most important phases of the development of a learning system, but not an end by itself. Courseware needs to be packaged, stored, accessed and administered. Systems, which provide part or all of these services, are usually referred to as Learning Management Systems (LMS).

An LMS is a high-level, strategic solution for planning, delivering, and managing all learning events within an organization, including online, virtual classroom, and instructor-led courses. The primary solution is replacing isolated and fragmented learning programs with a systematic means of assessing and raising competency and performance levels throughout the organization. For example, an LMS simplifies global certification efforts, enables companies to align learning initiatives with strategic goals, and provides a viable means of enterprise-level skills management. The focus of an LMS is to manage learners, keeping track of their progress and performance across all types of training activities. It performs heavy-duty administrative tasks, but isn't generally used to create course content.

From the user perspective, LMS provides a single point of access to disparate learning sources. It automates learning program administration and offers unprecedented opportunities for human resource development. It identifies the people who need a particular course and tells them how it fits into their overall career path, when it's available, how it's available (classroom, online, CD-ROM), if there are prerequisites, and when and how they can fulfill those prerequisites. Once learners complete a course, the LMS can administer tests based on proficiency requirements, report test results, and recommend next steps. In that capacity, LMSs are instrumental in assuring that organizations meet rigid certification requirements in such vertical markets as healthcare, finance, and government [32].

According to Yang et al. [32], the capabilities that are looked for in an LMS are blended learning support, human resource integration, administrative capability, content integration, meets standard, test and score capability, and skills, and each are described as follows.

*Support for blended learning***.** People learn in different ways. An LMS should offer a curriculum that mixes classroom and virtual courses easily. Combining those features enable prescriptive and personalized training.

*Integration with human resource***.** When systems are integrated, a human resource employee can enter a new hire's information into the human resource system, and the employee is automatically signed up for training tailored to his or her role within the company.

*Administration tools***.** The LMS enables administrators to manage user registrations and profiles, define roles, set curricula, chart certification paths, assign tutors, author courses, manage content, and administer internal budgets, user payments, and charge backs. It also builds schedules for learners, instructors, and classrooms.

*Content integration***.** It is important for an LMS to provide native support to a wide range of third-party courseware. An LMS supplier should be able to certify that third-party content so that it works within their system, and accessing courses should be as easy as using a drop-down menu.

*Adherence to standards***.** An LMS should attempt to support standards, such as SCORM and Aviation Industry CBT (Computer-Based Training) Committee (AICC). Support for standards means that the LMS can import and manage content and courseware that complies with standards regardless of the authoring system that produced it.

*Assessment capabilities***.** Evaluation, testing, and assessment engines help developers build a program that becomes more valuable over time.

*Skills management***.** Skills management component enables organizations to measure training needs and identify improvement areas based on workers' collective competence in specified areas. Skills assessments can be brought together from multiple sources, including peer reviews and feedback tools. Managers determine whether results are weighed, averaged, or compared to determine a skill gap. Businesses also might use this feature to search their employee base for specialized skills.

There are some differences and overlaps between LMS and LCMS. Greenberg [37] reviewed a summary of capabilities and differences between the two systems as follows.

Both LMS and LCMS manage course content and track learner performance. Both tools can manage and track content at a *learning object level, too*. An LMS, however, can manage and track *gathered* courses and curriculum assembled from online content, classroom events, virtual classroom meetings and a variety of other sources. Although an LCMS doesn't manage *gathered learning,* it does manage content at a lower level of granularity than a *learning object, which* allows organizations to more easily restructure and repurpose online content. In addition, advanced LCMSs can dynamically build learning objects based on user profiles and learning styles. When both systems adhere to XML standards, information is passed easily from the object level to the LMS level.

According to Greenberg [37], a good LMS provides an infrastructure that enables organizations to plan, deliver, and manage learning programs in any format it chooses. Therefore, it should support multiple authoring systems and integrate easily with the leading LCMS systems. In its role as a catalyst for the overall learning environment, an LMS can integrate LCMS learning objects via technical specifications and standards and assume responsibility for all content management.

The key to successful integration is an open and interoperable approach. Currently, leading LMS and LCMS suppliers are launching certification programs that proactively address compatibility issues and ensure interoperability between their products. Although time-consuming and expensive for the suppliers, certification programs shield customers from integration hassles or having to settle for patchwork solutions from suppliers who try to do it all. The certification approach gives buyers the freedom to choose both the LMS and LCMS that best meet their needs.

2.7.3 Virtual Learning Environment

According to Milligan [16], there has been a range of Virtual Learning Environments (VLEs) and Managed Learning Environments (MLEs) developed to manage online learning in the educational sector. VLEs tend to be software, which resides on a server and are designed to manage or administer various aspects of learning, including the delivery of educational content, discussion, library and resource materials, student tracking, assessment whilst MLEs tend to provide a greater link to student administration and management.

In this respect, Milligan argued the VLE is essentially a database of objects, which creates tailored web pages on request. Although there are various software packages that seek to control the entire learning process, there is no reason to presume that individual tools could not be brought together to create a loose (more flexible) environment for online learning.

Current VLEs typically provide the following kinds of services as part of licensed software like webCT [33]:

- Delivery and management of course materials, including streaming media as well as text
- Access control, typically through a login and password based
- Administration: student tracking, collation of marks, record of progress,
- Time-tabling and calendar facilities,
- Assessment: usually formative (e.g. for self assessment) but some have summative assessment provision, such as online examinations and quizzes,
- Communication: on various levels, one to one, one to many, synchronous and asynchronous, including whiteboard facilities and, increasingly, web casting
- Document storage and personal space for participants to exchange and store materials,

We conclude this chapter with the following remark. The instructional courseware (LO), authoring tools, and LMS, which are used as learning content, development, management and delivery technologies are considered within the context of CBL. However, the context of CAL as an integrative technology deals with the reevaluation of the curricula on how to implement these technologies in subjects (explained in detail in chapter 3).

CHAPTER THREE

INTEGRATING COMPUTER-ASSISTED LEARNING INTO SCHOOL CARRICULA

3.1 Introduction

As was discussed in chapter 1, the rate of development of quality of education in developing countries such as Ethiopia is either stagnant or growing at a very slow rate. To work out this problem, many literatures recommend that students and organizations must be kept up to date with the growing technology. Bransford et al. [9] describes how technology can strengthen learning by bringing exciting curricula into the classroom, providing tools and scaffolds, allowing for feedback and reflection, developing local and global communities, and expanding opportunities for teacher training.

According to Web-based Education Commission [62], the main importance of integrating technology into the curriculum is the impact on student learning. Current research has validated learner-centered principles as being critical when planning technology-supported activities for the classroom [40, 41, 48].

An important step to successfully integrate computers across the curriculum involves analysis of the program. According to Eib et al. [20], data may be analyzed in relationship to student academic success, the curriculum, national standards, or the attitudes of teachers and students. Nash et al. [44] support this view that the evaluation of computer attitudes is an important technique in response to the current trend of computers becoming more centralized in education through integration.

It is imperative that learner-centered principles connect the subject matter with the student. Establishing a learner-centered environment means creating an emphasis on hands-on learning, implementing choice in the classroom, and enhancing students' motivation for learning by connecting the subject material to the learners' experiences, backgrounds, and needs. Students too often complain of boring, rote instruction of materials that is irrelevant to their lives (McCombs [40]).

It is also of importance to the school as computer-related attitudes predispose future behaviors including choice of enrolment, career paths and use of computers (Levine et al. [38]).

3.2 Defining Integration of CAL

Like the definition of Computer Assisted Learning (discussed in chapter 2), there are many contexts on the definition of integration of Computer Assisted Learning. Miller [46] defines the integration of CAL as using the power and ability of the computer to assist learning in every subject area.

The integration of CAL is neither computer literacy nor computer awareness. It means using the computer where it is the best medium to support the learning goal (Anderson [59]). The entire school community of students, teachers, principals, and parents has to accept that computers are part of the every day school life (kearsley [34]). Therefore, it involves a different kind of teaching and whole-school awareness. International Federation for Information Processing [31] takes into account the following factors for the integration of technology in schools.

- Hardware provision and maintenance
- Support by technical staff
- Development and provision of complementary materials
- Equity access for all students
- Software development and provision
- Training teachers in new skills
- Internal school organization
- Reforming the curricula through subject matter reevaluation
- Funding

Miller [46] noted that if one accepts that integration represents the means to combine the above factors and combining to build one larger unit, all stakeholders in the education must reach agreement on the organization and setting of the goal.

In order to integrate technology, schools have to exploit technology for the betterment of their students and themselves and computers form part of that technology [42].

Successful integration takes place when technology becomes invisible or transparent and both the teacher and students can concentrate on the content of the course and therefore making it possible for students to use computers in the natural flow of classroom activities [10, 47].

As described in [43, 46], the impact that computers make in the classroom depends on their availability and upon the ways in which they are used.

3.3 Models of Integration of CAL

The trend of school level integration of CAL depends on the insight of the form of education in the school; which includes the methods of teaching being group work or lecture; exam oriented or continuous assessment. This trend of integrating CAL is what we call model for integration.

Different models have been developed with different goals and they describe the different phases of the introduction of CAL. We consider the following four models.

- The Apple Classroom of Tomorrow (ACOT) model
- The CAMI mathematics model
- The Make It Happen Model
- The Evolutionary model

3.3.1 The Apple Classroom of Tomorrow (ACOT) model

The ACOT model was developed by the ACOT project aiming at documenting how learning and teaching change in the technology-rich ACOT classroom (kindergarten to grade 12) in the United States of America. According to Apple Computer, Inc. [4], the project has identified what factors inhibit the changes and what support is needed to effect fundamental and sustainable change. Accordingly, Fisher et al. [23] noted that the ACOT model provides insight into how technology would affect teaching and learning.

The ACOT evolutionary model involves parents, students, teachers, administrators and volunteers and is divided into five phases: Entry, Adoption, Adaptation, Appropriation, and Invention [19].

The first phase in the ACOT model is the entry phase where computers are installed and teachers start using technology. The staff is unsure of the technology and the method of teaching remains what it was in traditional school lecture, recitation, and seatwork instruction.

The second phase, where the computer is used to support traditional text-based instruction using drill and practice or word processing application is the adoption phase. In this phase there is high computer access but students receive whole-group instruction via lecture, recitation, and seatwork.

Phase three is an adaptation phase where the computer has been integrated into the classroom teaching. There is high computer access in the form of word processor, spreadsheet, database, and graphics applications. There has been a change in the social and cognitive outcome of classroom instruction but the classroom teaching is still in the form of lecture, recitation and seatwork instruction.

Phase four, appropriation phase, is where the change is mainly on the teachers' mastery of computers and high computer access supports lecture, recitation and seatwork instruction but the teachers' experience facilitates creative activities in collaborative work. Cooperative interdisciplinary projects are created as well as multi-modal, self-paced and individualized work, and social interaction and school timetable changes.

In the last phase, Invention, of the ACOT model, learning is something the students create or do and students have intensive access to computers. There is much interaction between the students and teachers who collaborate in the construction of knowledge and the type of learning has totally changed from that of the entry phase.

3.3.2 The CAMI Mathematics model

This model was based on the running of a commercial computerized mathematics school and the implementation of software and methodology in schools [61]. Unlike the ACOT model, the CAMI Mathematics model does not focus on technology but on teachers' skills, hardware, software, and examination results. In this model there is an individualized seat-based learning in the initial phase with the emphasis of improving the retention of knowledge. This developmental model is divided into three phases: knowledge retention, knowledge processing and knowledge expansion.

The first phase (knowledge retention) does not require sophisticated hardware and software nor does much computer knowledge on the part of the teacher. The work done is simple drill-and-practice.

The knowledge-processing phase requires hardware sufficient to run productivity software such as word processor, database and spreadsheet; and knowledge of computer application, planning and preparation is required on the part of the teacher.

The last phase, knowledge expansion, exposes students to new unknown topics through CD-ROM and other technologies. It requires more hardware and software, and greater computer skills than the previous phases. The teacher also requires greater planning, organizational, technical, and application knowledge. According to Vorster [61], all these three phases of the CAMI mathematics model must be covered before one tries to have a fully computerize school.

The whole approach of the CAMI mathematics model is gradual introduction of computers into school considering cognizance of educational practices of the school, teachers capabilities at each stage, matching hardware and software deployed at each phase [61].

As one moves from one phase to the next along the CAMI mathematics model, preparation by teacher and cost of the computer system increases while computer access time decreases. According to this model, the integration process can be halted by not purchasing the necessary technology for the next phase.

3.3.3 The Make It Happen! (MIH) model

This model is where technology is deliberately integrated into a curriculum, which is based on inquiry-based learning, to meet the needs of all students. As described in Zorfass [64], this model is with the explicit aim of schools to facilitate collaborative planning and teaching to foster higher-order thinking in adolescents and it sets the following goals:

- Organize the school administration such that it supports computer integration.
- Organize teachers to evaluate and tune the curriculum so that it can use computers for inquiry-based learning.
- Expand adolescents thinking capability, cooperative learning behavior, and positive attitude towards learning.

The MIH model has three components - the curriculum, the teacher development and the school facilitation component, which can be implemented over a two years period in three phases.

In the first phase, teachers and administrators evaluate the school curriculum goals, start revising, select topics that could be studied in the interdisciplinary inquiry-based *unit*, and begin to form a shared vision of successful integration. Teachers learn application and inquiry-based software and the principal identifies participants for the MIH team.

In phase two, the work initiated with small group of teachers in the first year continues with that group to discuss on problems, plan and make decisions.

The third phase continues to design, implement and evaluate the curriculum unit with the same group, add more teams of teachers, and mentors members of expansion teams. Finally, the MIH team becomes an expanded team.

3.3.4 The Evolutionary model

Miller [46] has developed a new model, which he called evolutionary model after synthesizing the three models for the reason that the school, which he used it as a case study involves dominant features of the three models. The support infrastructure required for the successful integration of this model are the following [46]:

- The staff should own (by some means) the necessary hardware and software and have to practice with it out of class; therefore, they should play a role in the design and evaluation of the curriculum.
- The school should make computers part of its planning; train teachers in the method being used in the classroom; and share the vision and goals of CAL and involve all the school community.

The evolutionary model is divided into five phases- introduction, entry, intermediate, penultimate, and creation, which does not have a particular time limit and individuals, can be at different phase in their personal CAL integration [13]. This development takes time because it involves people, skills, attitudes, beliefs, organization and finance.

In the first phase, introduction, technology (computers, network, Internet, etc.) is introduced into the school. Technology is checked and understood how they work; plans are drawn up and training begins; and teachers try to teach with computers.

In the entry phase, teachers start using the equipment; the computer is used mainly to support classroom instruction by means of drill and practice; teachers lose their fear of the technology by doing simple computer tasks with technical support. The teacher needs to develop discipline strategies for the new classroom dynamics, to accommodate the small change in the classroom layout.

In the intermediate phase, teachers and students use the computer as a tool- where word processor, database, and spreadsheet are the main package. Teachers experiment with different computer applications, investigate teaching strategies for problem solving and higher-order learning, and look for new systems and classroom rearrangements.

The fourth phase, penultimate, is where instructional strategies change. Team teaching develops as a result of peer observation; collaboration occurs as teachers share new instructional patterns. In addition, school timetable is rearranged to fit team teaching; teachers' organizational skills have to be well-developed for the newly formed student groups; and much technical and application skills required. The teacher's role is changed to one of facilitator or collaborator. Students also get involved in collaborative and creative projects; use many different packages as knowledge building tools to support the growing constructive approach to learning and as a result mixed ability student group is formed. Teachers still require new and better technology.

The creation phase is the last phase of the evolutionary model for the integration of CAL. This phase never ends but it is an ongoing process as new technologies are being introduced. In this stage, schools are required to decide which new technology suite their instructional need and adapt accordingly.

When schools reach this stage, they realize what forces were induced by the integration of CAL and the pick change in teaching and learning process. According to Vorster [61], few schools have attained this phase owing to the costs and skills required.

Some of the features of this phase include staff work in collaboration teams; timetable adjusted; teachers question their methods of teaching and evaluation; students create knowledge in the form of web pages, multimedia, etc.; students are motivated to learn; and the learning mode is much of constructivist rather than cognitive.

3.4 Successful integration of technology

Technology is only a tool that shifts the focus of education from teaching to learning. Milton [51] strengthens this notion by saying "To ask what this tool can do is similar to asking what the pencil can do." Hence, in the absence of statements of explicit objectives and desired outcomes, it is difficult to define what success in technology integration looks like.

Integrating technology in schools and classrooms is a complex proposition. It requires combining different parts of the learning environment so that they work together and make the whole school curricula. The learning environment to be combined include the technologies provided, the school context, the technical skills of teachers, the technical support provided, maintenance and upgrading of hardware and software, the pedagogical preferences and skills of teachers, the availability of appropriate electronic resources and the skills and motivations of students. Described from the perspective of the learning environment, the following are some of the items that would demonstrate successful integration [49, 52].

- A culture of innovation
- Clearly defined educational goals that include deeper understanding and problem solving
- Teachers and students use technology as a tool for their own learning
- Teachers and students work in collaboration creating professional as well as learner communities
- Learners become more skillful in choosing their own goals, constructing their own strategies, assessing their own knowledge and monitoring their own progress

According to Robert [35], in order to achieve successful integration, the focus needs to be shifted from the design of instruction to the design of learning environments. In addition to introducing computers, connectivity, and educational content such as the development of learning object repositories, teacher capacity building is an important constituent for the successful integration.

Teacher development is the single most frequently identified factor in successful technology integration. As discussed earlier, there is a difference between the acquisition of technology in education and its deployment for the intended (teaching and learning) purposes. Large scale analyses of student performance data in which no or little correlation between reported computer use and student achievement may well reflect the difference between acquisition and deployment.

The issue of capacity building for successful technology integration has proven to be not a matter of equipping teachers with the technology skills required to use computers. These are relatively easily acquired. If the goal of integration is to encourage and support new teaching practices, then a stage model of teacher development is useful. In relation to teacher capacity building, Laferrière [36] offers the following tentative six-phased model:

During phase one of this model, teachers develop an awareness of the network phenomenon. It is assumed that the more aware a teacher becomes of the transition towards a knowledge society and its implications, the more he/she may be willing to put in the efforts required to access and master the technical possibilities of the new technologies.

In phase two, the teacher masters the Internet and Intranet resources. Teachers are provided help and practice in the use of applications, choice of web sites and other digital resources, communicate with each other and experts and produce their own learning contents.

Once the technical skills are mastered, a new field of possibilities becomes available to the teacher, imagining new collaborations. This characterizes the third phase in the teacher development model.

Phase four introduces teachers to the complexity of new social dimensions in the classroom, identify ways to manage time and the issues raised in heterogeneous settings and linking on-line learning opportunities to classroom work, creating learning environments and modeling social and ethical learning behaviors for students.

By phase five teachers begin directing project-based learning. They make use of a variety of teaching and learning strategies, curriculum integration and focus on activities that call for a high degree of participation by students.

Phase six, knowledge-building communities represent a major challenge to established educational practice. The capacities and performance of each person (whether teacher or student) is brought to bear in a shared space dominated by knowledge building and experience sharing.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter discusses the results of the study. It outlines methods used to analyze the raw data and presents the statistically analyzed results. It describes the findings of this study and makes comparisons of the Ethiopian context with previously developed models for the integration of CAL in the teaching and learning process.

4.2. Process of Analysis

The analysis techniques used in this study are the correlation function, ratio, percentage, mean and standard deviation. Scoring mechanisms including the Likert's rating scale have been employed.

4.2.1 Scoring of questionnaire

For tabulation purposes, the response number of respondent's choice for each statement has been recorded (See chapter 1). However, in order to apply the statistical functions explained in the following sections, we used some rating mechanisms for the four parts of the questionnaires. Accordingly, four scoring mechanisms were employed:

Part A. For the purpose of application of correlation function, the raw data in Appendices C and D have been rearranged. Responses along with their number were ordered into ascending order. For more information, see section 4.5.

Part B. In this part, the responses for the 10 statements were scaled as shown in table 4.1. The range of possible scores of each respondent is therefore 0 to 30 (See section 4.5).

Response	Score
High	3
Medium	2
Low	1
None	0

Table 4.1 Scale for computer related skills

Part C. The scoring for part C (See chapter 3) is shown in table 4.2. The range of possible scores of each respondent is 0 to 48.

Response	Score
Very often	4
Often	3
Sometimes	2
Seldom	1
Never	0

Table 4.2 Scale for usage of computers in teaching (learning)

Part D. This part contains 12 statements (See chapter 1). All the statements were positively worded. Students and teachers were asked to indicate their degree of agreement in an ordered rating on their views on the impact of technology in students' learning and opinions of students and teachers on the integration of technology in schools. Accordingly, we used the Likert's rating scale method (See table 4.3), which is very popular in assessing attitude.

The ranges of possible scores for each respondent are 8 to 40 for the first 8 statements (See chapter 1) and 4 to 20 for the last four.

Response	**Score**
Strongly Agree	5
Agree	4
Undecided	3
Disagree	2
Strongly Disagree	1

Table 4.3 Scale for teachers'/students' views of computers in teaching (learning)

4.2.2 Correlation function

The population correlation analysis function measures the relationship between two data sets that are scaled to be independent of the unit of measurement. It returns the covariance of two data sets divided by the product of their standard deviations.

We used this correlation function to determine whether the variables such as grade level, access to computers, computer skills, computer related qualification, teacher qualification, and teaching experience move with the use of computers in teaching and learning process. The possible values are positive correlation, negative correlation, and zero correlation.

4.2.3 Estimating using ratio, percentage, mean, and standard deviation

The percentage, mean, and standard deviation, which are among the commonly used tools, are employed in this study.

The ratio was used to calculate pupil-computer in order to evaluate availability of computers. Percentage was used to explore the percentage of schools and respondents with regard to technology adoption and availability of infrastructure.

The mean was used to see the average responses of respondents for each computer-related skill and usage of computers in teaching and learning process.

Similarly, the standard deviation measures how widely values of responses are dispersed from the mean value.

4.3 Sample size

The study was began with a visit of 80 schools 40 from primary and 40 from secondary; 62.5% of these schools were found to have computers.

The data in table 4.4 (Section .4.5) has been used as criteria to filter out 20% of the schools to respond to the questionnaires. A total of 240 questionnaires were correctly completed. The respondents were 170 students and 70 teachers from the selected schools.

4.4 Availability of Infrastructure

In this section, we explore the availability of computers, tools or software infrastructure in schools in relation to the need for CAL integration. To do this, the pupil-computer ratio, connectivity and educational software were employed. Each of these is discussed in the following subsections.

4.4.1 Pupil-Computer ratio

The pupil-computer ratio is one among the indicators considered in this study. For this purpose, data has been obtained through visit of 80 schools and from the raw data of recent survey by the education bureau of the city government of Addis Ababa, UNDP, and BESO. Out of these surveyed schools, 62.5 percent were found to have computers and the result of the pupil-computer ratio analysis is as follows:

- *Technical and Vocational Education Training (TVET).* The main sources of data for the analysis of pupil-computer ratio are recent TVET school enrollment and survey documents on the number of computers available in the respective schools from education bureau of Addis Ababa.

  The attributes, number-of-pupils and number-of-computers in the schools respectively are taken from the two documents. Then after, the corresponding pupil-computer ratio of all these schools has been calculated using Microsoft Excel 97. The result revealed that the pupil-computer ratio ranges from 1 to 24 and the average is 15, which means 1 computer for 15 students.

- *Preparatory schools*. Unlike the TVET schools, no data about the number of computers available and enrollment status was found. The information has been obtained from a different source (UNDP) where 9 computers have been distributed to each government school all over the country. In addition, all preparatory schools have obtained at least 20 computers each for the purpose of supplementing the subject on Information Technology.

  Therefore, each government preparatory school all over the country has at least 29 computers. In order to confirm this figure, actual data has been obtained from some schools. Information about preparatory school enrollment of the schools in the city government of Addis Ababa is obtained from (BESO). As a result we have the variables number-of-pupils and minimum number-of-computers.

  The pupil-computer ratio for preparatory has been calculated using similar methods as for the TVET school and the result was found to range from 2 to 73 where the average is 27.

- *First cycle Secondary school (grade 9 and 10)*. In this school level, only private and some NGO[1] schools allow their students to use computers. In addition, the pupil-computer ratio of these schools is very high. This is because this school level is characterized by high student population and is often within the same compound and administration of the preparatory or TVET schools.

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[1] NGO schools include foreign community, church, mosque and mission.

- *Primary schools*. Fourty primary schools have been visited, 10 from private and NGOs schools and 30 government and public schools. It was found that none of the 30 government and public schools has computers but all the 10 private primary schools have computers.

  In order to calculate the pupil-computer ratio, school enrolment data of the visited schools was obtained from the annual abstract of the education bureau of the city government of Addis Ababa [1]. Result of calculation of the pupil-computer ratio was found to range from 5 to 166 and the average is 48.

- *Kindergarten*. To elicit the introduction of computers at this level, 25 private kindergartens were included in the survey and only 2 are found to have computers for the purpose of delivery of multimedia presentations and computer toys.

4.4.2 Connectivity and setting

Connectivity of computers is one among the criteria required in order to establish collaboration based e- learning. During the survey of 80 schools, we have tried to assess the trend on computer connectivity regarding current status and ongoing projects.

- *Current status*. The trend on Local Area Networking (LAN) is either no connection at all, which characterizes almost all of the schools, or schools have any of the following experiences. Two to five computers are connected peer to peer; less than eight computers are connected with simple eight port HUB or standard LAN connecting at least 10 computers. Of the schools having computers, only 12 percent were found to have either of such connectivity. The motive of most schools is to connect as much computers as possible to the Internet. However, some schools have additional motives like sharing resources that are available locally.

The Internet connectivity also has similar trend with that of LAN. According to the survey on the schools in Addis Ababa, those schools that have the standard LANs, have dial-up connection using proxy where students and teachers can have access. In addition, 12 percent of the schools that have computers have 1 or 2 computers with dial-up connection. However, not all schools allow all their teachers to have access to it. Therefore, out of the schools having computers only insignificant number of them have Internet connection. Some of the problems that were identified during the survey are lack of budget, premature awareness, unaffordable cost of connection, and lack of extra telephone lines.

- *Ongoing projects*. The national ICT capacity building program is currently running different projects such as the satellite education (multi-channel interactive TV), schoolNet, agriNet, healthNet and woredaNet.

The technology that is used to establish the infrastructure for satellite education and schoolNet, is broadband VSAT. According to response of the interview (Appendix F), the technology allows to broadcast digital video (broadband multimedia) through 8 channels with 2 Mb/s bandwidth each. Besides that it has 18 Mb/s free bandwidth, which can be consumed by other services including the broadband Internet. As a result, the technology creates fertile environment to establishing virtual learning environment.

4.4.3 Educational software

As a matter of tradition, on top of the operating system (usually Microsoft Windows), productivity software such as word processors, spreadsheets, databases, presentation programs, etc. are installed in almost all computers. In addition to these, we found out that there are some experiences where schools have owned and/or used special educational software. Some of these software which were found in the surveyed schools are Encarta 2004 and/or earlier versions, CD-ROMs of the Global Certification of Secondary Education (GCSE), which includes features such as tutorial, drill-practice, and test on subjects such as mathematics, physics and language specific tools. Educational games for learning alphabet and numeric also exist. However, the survey has revealed that only 14 percent of the schools have one or more such educational software and teachers of only 6 percent of these schools have some culture of utilizing these resources.

We conclude this section with the following remarks. The pupil-computer ratio in TVET and preparatory schools is generally encouraging. According to TVET schools, quality assurance office in the Ministry of Education, each TVET school all over the country has at least 20 computers. The regional education bureaus are also adding more computers. Therefore, availability of computers for this school levels is not as such a problem. However, lack of maintenance and support, inappropriate schedule, and lack of appropriate settings are some of the problems that threaten the current status.

Regarding the connectivity of computers, although some schools have encouraging experiences, it is generally low. However, the schoolNet project is potentially a turning point to change the current situation. Furthermore, the project is expected to show dramatic change to the low availability and usage of learning content by connecting schools to varieties of online digital libraries around the world.

4.5 Adoption of Computer Assisted Learning

In this section, we investigate the experience of schools, students, teachers and school administrators on the use of computers as a tool or tutor and their impact on students' learning, if there exists any.

In this study, we have considered two different granularities of entities: the schools and individual students, teachers and administrators. Schools have been evaluated for their experience on the utilization of computers as educational content delivery platform. The experience of students, teachers and school administrators on their adoption of computers in the teaching and learning process is also evaluated.

4.5.1 School level evaluation

The experience of schools on the use of computers as learning content delivery platform or as an educational tool has been elicited according to the questions indicated below. Responses for these questions were obtained through an interview to IT staff or school directors of the respective schools and have been recorded as shown in table 4.4.

Questions presented to school Administrators or IT personnel	Response			
	None	Some	Majority	All
Question 1	80%	16%	4%	0%
Question 2	90%	6%	4%	0%
Question 3	60%	26%	10%	4%
Question 4	86%	8%	2%	4%

Table 4.4 Usage of computers for teaching and learning

The first question was to elicit the number of teachers utilizing computers for the purposes explained above which was presented as follows:

Question 1. How many non-IT teachers use computers and / or Internet in your school for preparation of their teaching?

Some of the practices made by teachers include preparation of teaching materials and examinations, searching documents, e-mail etc. Table 4.4 shows that, 16% of the schools have "some" teachers utilizing computers for academic purposes; 4% have "majority"; no school was found to have "all" its teachers using computer for teaching practices. The experience of eighty- percent of the schools is only hands-on practice on how to use computers.

Question 2. How many non-IT teachers permit their students to make use of computers (Internet) to supplement their learning?

For this question, only 4% of the schools have majority of their non-IT teachers permitting students to make use of computers to supplement their learning and 6% have some of their non-IT teachers permitting students to make use of computers to supplement their learning. Some of the problems that might have contributed to such a small figure include lack of sufficient computers, non-optimal scheduling of computer rooms, and lack of motivation of teachers. The absence of teachers' computer supported teaching skills in the teacher profile has also significant contribution.

The third question is about self-directed or motivated student's use of computers in learning.

Question 3. How many students use computers or Internet for subjects other than Information Technology?

Our observation on the experience of students is a bit different from that of teachers in that wherever there is awareness of the technology and have access to it, students tend to use computers more than teachers do.

Table 4.4 also shows that 40 percent of the schools have the experience in this regard. All students in 4 percent, majority of students in 10 percent and some of the students in 26 percent of the schools use computers or the Internet for learning subjects other that Information Technology.

The last question is about usage of computers as a learning content delivery platform.

Question 4. How many students utilize computers as a delivery platform (tutor) for learning content?

The experience of respondents on computers or existence of integrated curricula basically influences the expected response for this question. However, the most important requirement is the possibility of access to technology.

The result in table 4.4 indicates that 4 percent of the schools have all their students using computers as educational content delivery platform.

We have observed that there is a positive correlation between the availability of educational software, discussed in section 4.4.3, such as tutorials, drill and practices, PowerPoint slides etc. and usage of computers (Internet) as learning content delivery platform.

This analysis has been used as a means of preliminary step to select schools to which questionnaires were distributed for the remaining work of the study.

4.5.2 Student level evaluation

This analysis was employed to evaluate students' computer related skills, usage of computers for learning, the changes in learning experience and correlation with other variables.

Information about computer related skills was elicited by means of part B of questionnaire type II (see Appendix B). Students were asked a series of questions and the response was as indicated in table 4.5. The responses were "None", "Low", "Medium", and "High" and were scaled as 0, 1, 2, and 3 respectively.

Table 4.5 shows that 99.4 percent (the highest percentage) of the students were found to have word processing skill, i.e., 58.2 % with high skill level; 34.1% with medium skill level and 7.1% with low skill level.

The students' skills in basic windows operations (97.6%) and spreadsheet (95.9%) are also high. The mean scores 2.5, 2.4, and 2.1 for word processing, basic windows and spreadsheet, respectively, show that the average skill of students on these items is medium. In addition, the deviations of values of responses from the mean for these items are the least. This indicates that students have relatively better experience on word processing, windows and spreadsheet. The two items where least percentage of students responded to have skills are web page development and publishing.

Software/tool	High	Medium	Low	None	Mean	SD
Basic windows operations	53.5%	37.1%	7.1%	2.3%	2.4	0.73
Word-processing	58.2%	34.1%	7.1%	0.6%	2.5	0.65
Spreadsheet	32.9%	46.5%	16.5%	4.1%	2.1	0.81
Database	16.5%	30.0%	30.0%	23.5%	1.4	1.02
E-mail	41.8%	27.1%	14.7%	16.5%	1.9	1.11
Search engine	31.2%	24.7%	14.7%	29.4%	1.6	1.21
Educational CD-ROM	44.7%	24.1%	12.4%	18.8%	1.9	1.15
Online learning materials	24.7%	26.5%	23.5%	25.3%	1.5	1.12
Web page development	8.8%	25.3%	22.4%	43.5%	1.0	1.02
Publishing a web page	8.2%	20.6%	22.9%	48.2%	0.9	1.01

Table 4.5 Students' computer related skills.

Similarly, students' usage of computers in learning was elicited by means of part C of the same questionnaire. This part focuses on the utilization of computer related tools/software for the purpose of learning and the responses of the students were "Never", "Seldom", "Sometimes", "Often", and "Very often" which was scaled as 0,1,2,3, and 4 respectively.

The result in table 4.6 shows that educational games, word processor, educational CD-ROMs, spreadsheet application, PowerPoint slides, and online learning materials in that order, are the most commonly used learning tools. Word processor was reported to be the highest most frequently used learning tool (34.7%). The mean value of usage of these tools shows that students use these tools sometimes, however, the deviations from the mean values are large which might indicate that there is a wide gap on students' use of computers for learning any subject. The use of Local Area Network (LAN) for collaborative work is low and is the least used tool of the tools in table 4.6. This might be an indication for its low existence in schools.

Software/Tool used in learning	**Very often**	**Often**	**Some Times**	**Seldom**	**Never**	**Mean**	**SD**
Reading from PowerPoint slides	17.1%	24.7%	23.5%	12.4%	22.3%	2.0	1.40
Reading from Acrobat reader	10.0%	17.1%	19.4%	15.9%	37.6%	1.5	1.40
Using word processor for learning	34.7%	24.7%	21.8%	5.9%	12.9%	2.6	1.35
Using spreadsheet for learning	12.4%	20.6%	35.9%	13.5%	17.6%	2.0	1.24
Using email for collaborative work	24.1%	18.2%	13.5%	13.5%	30.6%	1.9	1.59
Using educational CD-ROMs	33.5%	18.2%	22.9%	10.0%	15.3%	2.4	1.43
Using Online Learning materials	22.9%	18.2%	17.1%	15.9%	25.9%	2.0	1.52
Using LAN for collaborative work	4.7%	7.1%	17.6%	16.5%	54.1%	0.9	1.19
Using Computer based simulation	14.7%	16.5%	18.8%	15.9%	34.1%	1.6	1.46
Using PC based educational games	32.9%	18.8%	23.5%	12.4%	12.4%	2.5	1.38
Using Computer based Tutoring	15.3%	15.9%	21.2%	18.8%	28.8%	1.7	1.43
Using the Internet as main source of learning materials	14.7%	18.8%	25.3%	11.8%	29.4%	1.8	1.43

Table 4.6 Usage of computers in Learning

According to Hadley et al. [27], significant changes can take place as computers are integrated into the teaching and learning process. To see if the use of computers has influenced learning, students were asked to respond to a five-point scale (1. Strongly Disagree, 2. Disagree, 3. Undecided, 4. Agree and 5. Strongly Agree) as fourth part of the questionnaire to indicate their level of agreement with statements about how the use of software/tool might have changed their learning environment.

The mean response (table 4.7) shows that word processor, spreadsheet and Internet are perceived to have good impact on students learning and there is some consideration of the contribution of computers in learning.

Impact of computers in student learning	Mean	SD
Word processors simplified my writing (compilation).	4.1	1.0
Spreadsheet programs helped me to analyze my data.	3.9	1.1
The Internet allowed us to cooperate with each other.	3.9	1.2
The Internet helped me to get materials that I couldn't 'afford to buy.	3.5	1.4
Computers allowed me to learn on my own pace.	4.1	1.1
Computer-based tutorials improved my learning.	3.7	1.2
Computer-based simulations improved my learning.	3.7	1.1
Computers have improved my Learning.	3.9	1.2

Table 4.7 Impact of software/tools on students' learning.

In order to determine the relationships between selected variables and the levels of adoption, i.e., usage of computers in learning and impact on students' learning, we have calculated correlation coefficients shown in table 4.8. The values of the selected variables were ordered in an ascending order. For example, lower scales were assigned for lower grade levels and higher scale for higher grade levels. Similarly, access to computers was assigned numbers 1, 2, 3, and 4 for "none", "at school", "at computer center", and "at home" respectively by rearranging the raw scores of respondents (See Appendix D). The variable "computer skills" is the average scores of each student for each of the items in table 4.8. Accordingly, the variable "computer skills" was found to have better correlation with usage of computers in learning and has moderate effect on successful integration.

Selected Variable	Usage	Impact
Grade level	-0.14	-0.03
Access to Computers	0.27	0.24
Computer skills	0.70	0.35

Table 4.8 Correlation between variables and usage and Impact of on students' learning

4.5.3 Teacher level evaluation

A similar approach with that of students' was used to evaluate teachers' computer skills, adoption of the technology in teaching and correlation between variables. (See Appendices A and C, for instruments and scores used in this analysis respectively)

The result in table 4.9 shows that highest percentage (92.9%) of teachers have skills in word processing and it is the most frequently used application. However, unlike students who have mean "medium" skills on multiple tools, teachers have mean medium skill only in word processing.

Software/tool	High	Medium	Low	None	Mean	SD
Word-processing	44.3%	34.3%	14.3%	7.1%	2.2	0.93
Spreadsheet	22.9%	34.3%	24.3%	18.6%	1.6	1.04
Database	12.9%	27.1%	34.3%	25.7%	1.3	0.99
E-mail	27.1%	27.1%	25.7%	20.0%	1.6	1.09
Search engine	15.7%	10.0%	28.6%	55.7%	1.0	1.10
Online learning materials	10.0%	17.1%	30.0%	42.9%	0.9	1.01
Educational CD-ROM	22.9%	15.7%	22.9%	38.6%	1.2	1.19
Learning Management System	10.0%	11.4%	15.7%	62.9%	0.7	1.03
Web page development	5.7%	8.6%	20.0%	65.7%	0.5	0.88
Publishing a web page	1.4%	10.0%	15.7%	72.9%	0.4	0.73

Table 4.9 Teachers' computer related skills

According to the data in table 4.10, teachers' usage of computers in teaching is generally low. It shows that teachers use word processor more than other tools. Spreadsheet application, educational CD-ROMs and simulations are rarely used.

Software/Tool used in teaching (preparation)	Very often	Often	Some Times	Seldom	Never	Mean	SD
Providing PowerPoint slides to students	4.3%	8.6%	4.3%	12.9%	70.0%	0.6	1.17
Using Word Processor	20.0%	12.9%	8.6%	10.0%	48.6%	1.5	1.65
Using spreadsheet programs	8.6%	10.0%	8.6%	14.3%	58.6%	1.0	1.37
Using educational CD-ROMs	10.0%	8.6%	11.4%	12.9%	57.1%	1.0	1.40
Using email for academic matters	1.4%	10.0%	14.3%	18.6%	55.7%	0.8	1.10
Using Online Learning materials	1.4%	4.3%	5.7%	15.7%	72.9%	0.5	0.90
Using LAN for collaborative work	4.3%	1.4%	4.3%	10.0%	80.0%	0.4	0.97
Using Computer based simulation	10.0%	8.6%	10.0%	15.7%	55.7%	1.0	1.39
Using Computer based Intelligent Tutoring	11.4%	4.3%	5.7%	5.7%	72.9%	0.8	1.40
Using course authoring tools	4.3%	2.9%	7.1%	7.1%	78.6%	0.5	1.05
Using Learning Management Systems	2.9%	5.7%	10.0%	5.7%	75.7%	0.5	1.07
Using the Internet as main source of teaching materials	1.4%	7.1%	21.4%	15.7%	54.3%	0.9	1.08

Table 4.10 Usage of computers in teaching

Similar to that for the students, the variable "computer skills" was found to correlate with the use of software/tools by teachers in teaching or preparation for teaching (table 4.11). The variable "access to computers" also shows significant correlation with usage. However, teacher qualification, teaching experience and computer related certification do not significantly correlate with usage of computers in teaching and attitudes of teachers.

Selected Variable	Usage	Views
Teacher qualification	0.05	-0.05
Teaching experience	-0.06	-0.06
Access to Computer	0.52	0.14
Computer skills	0.78	0.26

Table 4.11 Correlation between variables and usage and views of teachers on the use of computers in teaching

4.5.4 School administrator level evaluation

While conducting the survey, we had interviews with 65 school administrators. Of these, 75 percent are computer literate; 5 percent have officially integrated computers; and 5 percent said that they have planned to incorporate in the near future.

4.6 Computer related attitude of the school community

In this section, the views of teachers on the advantages of properly implemented technology in education was asked by means of a set of questions (See Appendix A, Part D) which was prepared to be completed by teachers and the scale was the same as that of section 4.5. In addition to this, the views of students and teachers on the integration of computers in Ethiopian schools and Kindergartens education is included to evaluate the tendency of the school community to utilize technology in education. This was elicited using the last four items of part four of both questionnaires and using the same scale. School administrators and IT personnel were also asked during the interview to give their comments in this regard.

Teachers view of technology in education	Mean	SD
Computers can improve quality of education.	4.7	0.6
Computers can provide self-paced learning.	4.3	0.7
Internet can provide collaborative learning.	4.4	0.7
Computers can provide equal opportunity to the “haves” and “have nots”.	2.8	1.3
Online learning resources help for self-empowerment.	4.1	0.9
Computers can help teachers to teach better.	4.3	0.8
Computer-based tutorials can improve learning.	4.2	0.8
Computer-based simulations can improve learning.	4.1	0.9

Table 4.12 *Teachers views on the pedagogic advantages of technology*

Teachers' views on technology support. Many literatures show that technology can greatly enhance the learning environment of even the most successful schools so as to meet learning goals in a reasonable cost.

According to the results in table 4.12, it seems to confirm this fact; the mean responses of all the items except one are strongly agreed. However, for one item which was stated as "Computers can provide equal opportunity to the "haves" and "have not" learners", table 4.12 shows that the average response of teachers is a disagreement that is close to neutral. This may be an indication for the under-utilization of computers in schools, which has not yet induced economic relevance of technology in education.

Tables 4.13 and 4.14 depict the views of the school community on the integration of computers in the school curricula. The results in these tables show that both students and teachers agreed on the incorporation of computers in all school levels. In both tables, the mean value for the statement "Computers should assist secondary education" is the highest.

Students view of Integration of Computers in schools	**Mean**	**SD**
Computers should be integrated in all subjects.	4.3	1.1
Computers should Assist kindergarten education.	3.9	1.2
Computers should be Introduced in Primary education.	4.4	1.0
Computers should Assist secondary education.	4.5	1.0

Table 4.13 Views of students on the integration of computers in schools

Teachers view of Integrating computers	**Mean**	**SD**
Curricular-based software should be incorporated.	4.0	1.0
Computers should Assist kindergarten education.	3.9	1.2
Computers should be Introduced in Primary education.	4.2	0.9
Computers should Assist Secondary education.	4.6	0.6

Table 4.14 Views of teachers on the integration of computers in schools

School administrators. According to the responses of the interview with the 65 school administrators (section 4.5), about 75 percent have supported the utilization of learning technologies at all school levels except kindergarten. Most of them responded that they have visions to assist teaching and learning process with technology. Of the remaining twenty-five percent some are not aware of educational technologies while others disagreed because of the high initial investment it incurs.

4.7 Discussion of results

The use of computers in the teaching and learning process has many forms. It includes usage as a tool, tutee, and tutor. Before we discuss which type of usage of computers in education is being practiced in Ethiopian schools, we briefly discuss existing practices and then compare with different models of technology integration in the teaching and learning process.

4.7.1 Existing practices

The distribution of computers in schools varies widely among school levels, school ownership, location and the economic background of the school community. Regarding primary schools and kindergartens, which account for 54.7 percent of the schools in Ethiopia [26], in most of them there are no computers that are accessible by students.

The result of the survey of 40 primary schools and 25 kindergartens in Addis Ababa City justifies this fact.

However, as was discussed in section 4.4, some private and non-government primary schools are providing computer skills to their students with varying experience. Some schools start at grade 3 while others start at second cycle (grade 5). Some of the existing methods of deliveries of computer skills are shown in table 4.15.

Type	Grade	Skills offered	Method
I	1-3	Typing, Paint, files	Support
	4-6	File organization, writing projects	Directed
	7-8	Windows, applications	Mandatory
II	1&2	Free access	Non-guided
	3&4	Theory on computers	Instruction
	5&6	Windows and word processing	Instruction
	7&8	Excel and access	Instruction
III	5	Terms, equipment, windows	Directed
	6	Writing projects	Obligatory
	7	Excel and access	Instruction
	8	Internet	Instruction

Table 4.15 Computer skill offerings of some primary schools

Grade levels nine and ten (first cycle secondary) private and non-government schools have similar trend but students learn more computer applications and in some schools, they are officially required to prepare term papers. However, in most government and public schools they have no access to computers yet.

The preparatory and TVET schools are becoming turning points on the introduction of computers in these schools. This is because of the commencement of the subject Information Technology (IT) in these school levels.

In some schools drawing tools, games and other educational software are also available during free access sessions.

In what we discussed so far, the experience in schools is that they use computers just as a tool for learning computer applications. But, is there any usage of computers as a tool in non computer-related subjects? The data in table 4.4 shows that teachers in some schools prepare their teaching materials assisted by computers and/or Internet. Furthermore, table 4.4 reveals that some teachers encourage their students to utilize computers in their learning; and in some schools students use computers/Internet for non-computer related subjects.

This shows that there is some utilization of computers/Internet as a tool to facilitate the teaching/learning process in any subjects.

Many literatures regard the availability of computer related infrastructure as the base line for the implementation of Computer Assisted Learning. So, what infrastructures exist in Ethiopian schools? To discuss this issue, we consider the student-computer (pupil-computer ratio), connectivity and availability of educational software (section 4.4.2).

In this study, we used the pupil-computer ratio as one of the methods employed to measure the deployment of learning infrastructure in schools. The pupil-computer ratio estimates students' access to computers. In section 4.4, we discussed that primary schools and kindergartens have no computers, which can be accessed by students. But, some private and non-government schools have computers and the pupil-computer ratio range from 5 to 166 and on average 48. This shows that 48 pupils per computer per week may be sufficient to allow a student to have one-hour access in a week's time.

The grade levels 9 and 10 in non-government and privately owned schools tend to have less pupil-computer ratio than the primary counter part, but the government and public schools do not offer computer skills for these grade levels. However, currently, the ministry of education and donors are supplying computers all across the government high schools and accordingly, students at these grade levels will have fertile environment to get access to computers.

The introduction of computers in schools is relatively better at preparatory and TVET. Computers are drawn to these schools with different motives such as supplementing the subject "information technology" with practical sessions, to empower Information Technology departments in some TVETs, and the schoolNet.

The average student-computer ratio for TVET and preparatory schools (section 4.4) was calculated to be 15 and 27 respectively. These values are generally an encouragement figure for possible implementation of Computer Assisted Learning in these schools. The average number of hours a student can have access to computer is estimated 4 hours in TVET and 2 hours in preparatory schools. However, we have found out that one or more of the following factors threaten the existing pupil-computer ratio.

- In some schools, the ratio is high while in others it is low. Since it is impractical to reshuffle computers from one school to the other, the mean pupil-computer ratio may not represent the actual practice.
- The breakdown time of computers is frequent because of lack of maintenance services.
- Scheduling of access hours is not optimal.
- Inappropriate setup of computer-rooms.

- Most government/donor initiative projects distribute computers uniformly, irrespective of the school size.

Regarding connectivity, only 12 percent of the schools, which have computers accessible by students, have local connectivity in the form of peer-to-peer, non-standard[3] LAN, or standard[4] LAN. Internet connectivity in these schools is also poorly exercised. However, the schoolNet project [30] is expected to connect high schools to the Internet.

Regarding the availability of educational software, only 14 percent of the schools have such software.

According to the comments gathered from IT personnel and school administrators, some of the problems that might have contributed for this low technology adoption include the following.

- The school curricula do not motivate the utilization of technology in the teaching and learning process.
- Lack of awareness on the use of technology in education
- Budget constraints

The experience of school administrators, teachers and students on the use of computers in education is generally limited to some applications. The skill of respondents on computers and their attitude on Computer Assisted Learning was discussed in section 4.4. This limited experience has contributed to a limited practice on the integration of CAL in Ethiopian schools.

[3] Less than eight PCs connected with an eight port HUB.
[4] A LAN having more than eight PCs and Network printer.

4.7.2 Comparison with different models

As was discussed in chapter 3, there are different models for the integration of Computer Assisted Learning in schools and methods of adopting educational technologies. Some of the models include Apple Classroom of Tomorrow, CAMI mathematics, Make It Happen! and Evolutionary.

This section discusses the comparison between these models and the Ethiopian schools' practices on integrating educational technologies.

In the Apple Classroom of Tomorrow (ACOT) Model, the goal is to provide understanding how technology would affect teaching and learning and it requires technology rich environment [23]. As their comfort with the technology increases, teachers will be more likely to take the next step to integrate it into classroom lessons [2].

Although schools in Ethiopia are not technology rich, those schools that have acquired some computers as previously discussed are in the Entry phase of the ACOT model and some non-government schools belong to the adoption phase as they support lectures using educational software. Table 4.16 depicts the level of fitness of the schools to the ACOT model.

Phase	Characteristic	Fitness[1]	
		School	**Remark**
Entry	Technology is installed	Preparatory, TVET and some private primary	Most schools have no sufficient technology and most non-IT teachers are unfamiliar
	Staff is unfamiliar	Most schools	
	Use traditional methods	All schools	
Adoption	High computer access	Non-govt. schools	Some non-govt. schools facilitate appropriate tools.
	Drill supplements lecture	Some non-govt. schools	
	Traditional methods	All schools	
Adaptation	Integrated into classroom	Few non-govt. schools	No school belongs to this phase except few innovative teachers.
	New social/cognitive outcome	None [2]	
	Traditional lecture	All schools	
Appropriation	Teachers mastery of computers	None	No school belongs to this phase. But there are few innovative teachers, which satisfy some of the features of this phase.
	Lecture is supported	Few non-govt. schools	
	Cooperative work	None	
	Teachers collaborate	None	
	Self-paced, multi-modal	None	
	Social interaction change	None	
	School timetable changes to accommodate team work	None	
Invention	Students have intensive access to computers	None	No school belongs to this phase.
	CAL induces much interaction between students and teachers		
	Students learn by creating and doing (not by lecture)		

Table 4.16 Comparison of schools technology adoption and the ACOT Model

In the CAMI Mathematics model, the transition from one phase to another is following the change in the skills of teachers and availability of technology. Its initial phase does not require sophisticated technology. However, simple drill and practice should supplement lectures in order to retain recent lectures. Some private and non-government schools may be categorized at the knowledge retention (first) phase of the model. Some non-government schools require term papers and analysis work from their high school students before graduation. These schools are categorized under the knowledge-processing phase. According to the survey, none of the schools can be categorized under the knowledge expansion phase.

Phase	**Characteristics**	**Fitness**	
		School	***Remark***
Knowledge retention	No sophisticated skills are required from teachers.	Most schools	Only few private and non-govt. schools belong to this phase. Most non-IT teachers have no computer skills. The practice of networking computer is also limited.
	Simple drills are use to retain recently taught subjects.	Few private and non-govt. schools	
	The system is networked.	Some private and non-govt. schools	
Knowledge processing	Availability of sufficient productivity software.	All schools having computers	No school belongs to this phase. However, some schools permit their students to write term papers using word processor.
	Skill on computer application	Few private and non-govt. schools	
	Teachers plan and prepare	None	
Knowledge expansion	More hardware and software	None	No school belongs to this phase. But, few innovative teachers have some practices.
	More computer skill	None	
	Organizational planning, and technical skills of teachers	None	

Table 4.17 Comparison with the CAMI Mathematics model

The Make It Happen! Model is aiming at deliberate introduction of technology into education [64]. It requires reorganization of the school to support integration, a team of organized teachers study, experiment and tune the curriculum. The deliberate integration of technology might characterize the schoolNet project, but it does not seem to reevaluate the curricula (table 4.18).

---

[1] Fitness- The schools listed under this column satisfy the respective requirement of the model.
[2] The word "None" implies the indicated item is not yet exercised or achieved.

Phase	Characteristics	Fitness	
		School	Remark
Phase one	Teachers and administrators evaluate the goals of school curriculum	None	No school belongs to this phase. However, there are some practices by ICT-clubs, where students participate in some e-learning activities.
	Select topics for the technology unit		
	Share vision for successful integration		
	Teachers learn inquiry-based learning software.		
	Principal identifies innovative teachers for the team.		
Phase two	The same team continues in the first year.	None	
Phase three	The old team continues to plan, design and evaluate the curriculum	None	
	Adds more teams		
	Mentors the new teams		

Table 4.18 Comparisons with Make It Happen! Model

The Evolutionary model requires teachers to have high access to computers and the schools' plan has to include computer integration. In most government schools, there is no explicit plan as to how technology should be integrated, but since some teachers are trying to integrate computers and teachers are being trained (Appendix G), these schools can be grouped under the introduction phase of the Evolutionary model. Some private and non-government schools can also be categorized under the entry phase as shown in table 4.19.

<table>
<tr><th rowspan="2">Phase</th><th rowspan="2">Characteristic</th><th colspan="2">Fitness</th></tr>
<tr><th>School</th><th>Remark</th></tr>
<tr><td rowspan="4">Introduction</td><td>Technology such as computers, Networks and Internet introduced</td><td>Most high schools</td><td rowspan="4">Few schools belong to this phase.</td></tr>
<tr><td>Teachers understand technology</td><td>Few schools</td></tr>
<tr><td>Plans and training begins</td><td>Govt. high schools</td></tr>
<tr><td>Teachers try to teach with computers</td><td>Few non-govt. schools</td></tr>
<tr><td rowspan="4">Entry</td><td>Teachers start using equipment</td><td>Few private and non-govt. schools</td><td rowspan="4">Few schools belong to this phase. Many IT teachers are also in this category.</td></tr>
<tr><td>Drill and practice supports inst.</td><td>Private and non-govt. schools</td></tr>
<tr><td>Teachers lose their fear by practicing on technology.</td><td>None</td></tr>
<tr><td>Teachers plan to accommodate the small change in class layout</td><td>None</td></tr>
<tr><td rowspan="4">Intermediate</td><td>Both teachers and students use applications as a tool</td><td>Many high schools</td><td rowspan="4">No school belongs to this phase.</td></tr>
<tr><td>Teachers experiment on software</td><td>None</td></tr>
<tr><td>Investigate teaching strategy</td><td>None</td></tr>
<tr><td>Look for new systems and classroom rearrangement</td><td>None</td></tr>
<tr><td rowspan="6">Penultimate</td><td>Team teaching develops</td><td rowspan="6">None</td><td rowspan="6"></td></tr>
<tr><td>Collaboration develops</td></tr>
<tr><td>School timetable rearrangement</td></tr>
<tr><td>More computer skills</td></tr>
<tr><td>Role change teacher to facilitator</td></tr>
<tr><td>Facilitator looks for better tech.</td></tr>
<tr><td>Creation</td><td>Schools have the capacity to decide which technology fits their practices</td><td>None</td><td></td></tr>
</table>

Table 4.19 Comparison with the evolutionary model

In the previous discussions, we have seen some existing experiences of Ethiopian schools on the way to the adoption of ICT infrastructure – availability of computers, connectivity, and educational content. However, the issue of capacity building for successful ICT integration has proven to be not a matter of equipping teachers with the technology skills required to use computers [45]. In other words, there is a difference between the acquisition of an innovation in education (ICT infrastructure) and its deployment for intended purposes (teaching and learning).

Hence, if the goal of technology integration is to encourage and support new teaching practices, then a stage model of teacher development- attitudes, knowledge and skills is useful. In relation to teachers' capacity building, Laferrière [36] offers a tentative six-phased model.

Phase	**Characteristics**	**Fitness**	
		Teachers	**Remark**
Phase one	Create network awareness	Few teachers	
Phase two	Masters Internet/Intranet resources	Some teachers	Only few innovative teachers belong to this phase.
	Teachers practice on applications	Many teachers	
	Communicate with each others using technology	Few teachers	
	Chooses digital resources and web sites	Few non-govt. schools	
Phase three	Imagining new collaborations	None	No school belongs to this phase.
Phase four	Begins to manage heterogeneous classroom	None	
	Create learning environments		
	Manage time		
	Models social and ethical learning behaviors of students		
Phase five	Begins directing project based learning	None	
	Uses varieties of teaching and learning strategies		
	Curriculum encourage – create high student participation		
Phase six	Both teachers and students become knowledge building and experience sharing community	None	
	Become challenges to established educational practice		

Table 4.20 Comparison with the teacher capacity building model

Table 4.20 shows that according to the existing practices, only few Ethiopian school teachers satisfy the first phase of the model. However, existing practices of experts on IT, some subject (IT) teachers, and rare non-IT teachers along with the ongoing effort in the education sector may help reside to the first or second phase in the model.

We conclude this chapter with the following remarks. The practices of Ethiopian schools on the adoption and integration of educational technologies in the teaching and learning process is generally low and it varies among schools. The comparison of the four models for technology integration showed that the existing practices in the sample schools with respect to the rational of each model do not correspond. This is not only because they are at the initial phase, but also there are no clear goals set to achieve the requirements of the next phase.

CHAPTER FIVE

PROTOTYPE: A COURSEWARE FOR THE SUBJECT "INTRODUCTION TO INFORMATION TECHNOLOGY"

In this chapter, the current methods of instruction for the subject "Int. to Information Technology", which is offered at grade eleven is elicited. A discussion on the design and implementation of a courseware for the subject is also presented.

5.1 Current methods of instruction

The goal of the subject "Int. to Information Technology" is to provide students at grade eleven with the basics of Information Technology such as defining what information is, the need for information, evolution and current trend of Information Technologies, and basic operating systems skills.

This subject has been introduced into the high school curricula since the 2000/2001 academic year aiming at providing students with information technology basics.

Two contact periods are allocated for the subject where the duration of each contact period is forty minutes. It has the following five units offered within one-year period.

- Unit 1 introduces information technology
- Unit 2 describes information and data processing
- Unit 3 explains the evolution, types and application of computers

- Unit 4 introduces the different components of the modern computer system
- Unit 5 introduces principles of operating systems and the basics of MS-DOS and Windows

The first four units are entirely theoretical and only part of the last unit requires practical sessions. Accordingly, the experiences of teachers show that about 90% of the course of instruction for the subject is covered theoretically.

The method of instructional delivery for the theoretical part is just the classroom instruction. The teacher provides students with lecture notes during the teaching and students enrich their notes and extend the concepts covered in class by reading their textbook at home and doing the review questions. Sometimes, peripheral devices are demonstrated by taking students to computer rooms.

Similarly, the practical session is carried out by providing short notes such as writing MS-DOS syntax and drawing components of a window on a whiteboard and referring to the textbook. In addition, teachers support the practical sessions through visiting each student; by providing oral guidance on how to apply commands; and by posting pictorial representations (charts- relevant to the current lesson) in the reach of students. The main activities of the teacher are:

- Registers student information at the beginning of the academic year
- Prepares notes for a lesson
- Presents the lesson

- During examination times, he/she prepares and conducts the examination and provides the results to students.
- These activities are repeated until the end of the academic year

An overview of the current flow of instructional delivery is depicted in figure 5.1.

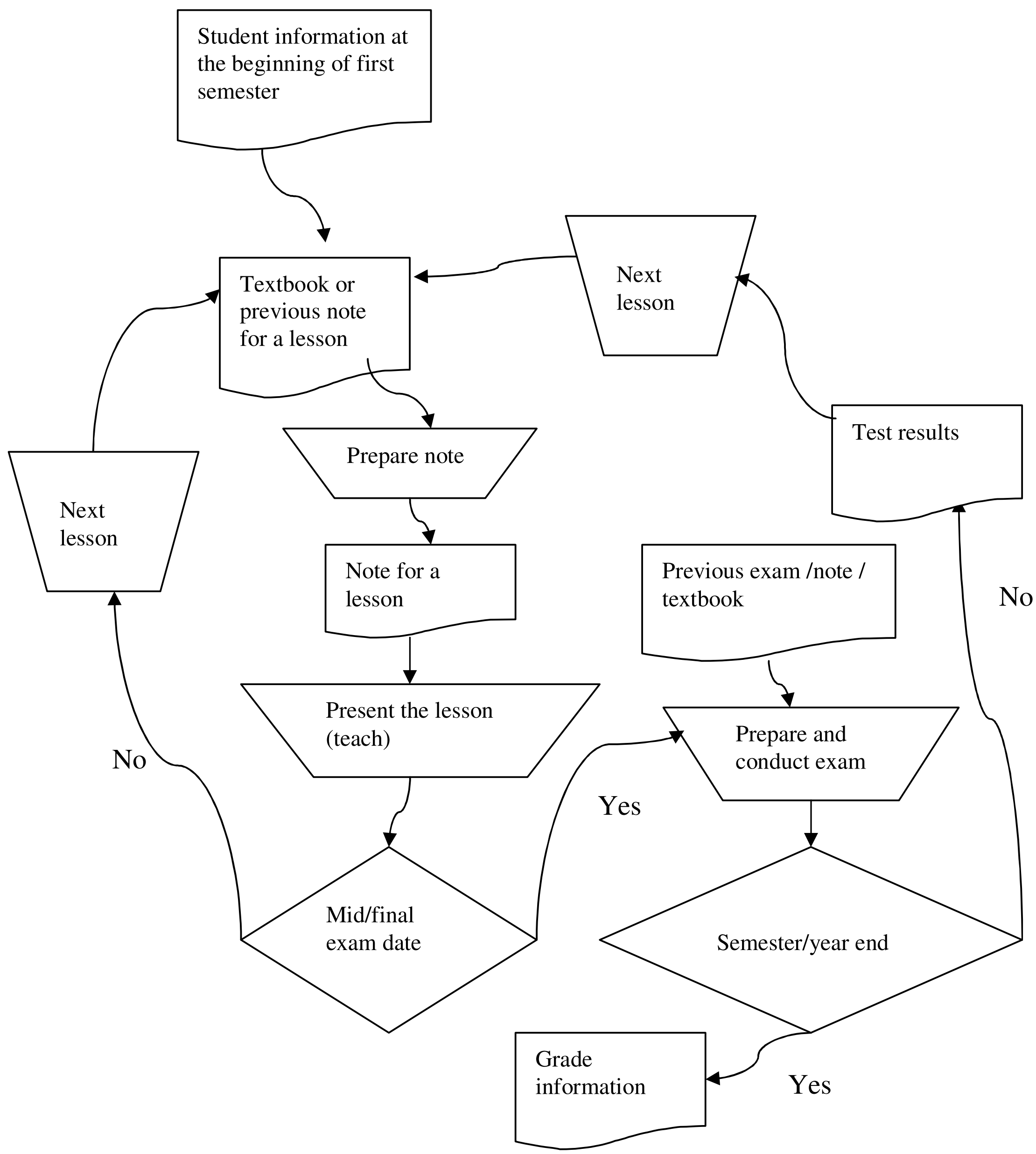

Figure 5.1 Overview of the current flow of instructional delivery

5.2 Drawback of current practices

The current method of instruction for the subject works smoothly; however, students' learning outcome is negatively affected by some of the drawbacks of the following methods of instructional delivery.

- Students have insufficient access to computers. There is only limited access just for the purpose of the last unit.
- Students may not be able to identify the common components of a computer system because of lack of access to devices.
- Preparation and update of lecture note is cumbersome and time taking.
- Writing note on a blackboard is time consuming.
- Students may lose concentration while writing notes.
- Oral guidance on hands on practices may mislead students.
- Preparing charts is time consuming and cumbersome.

Therefore, development of courseware for the subject and integrating it so as to *assist* the current methods of instruction would increase the learning outcome of students by taking the advantages of individualization and interactivity.

5.3 The courseware

In this section, the system development lifecycle and features of the developed system are briefly explained. It includes requirements elicitation, system and detailed design, development goals and functionalities of the developed courseware.

5.3.1 Purpose and scope

The main purpose of the system is to develop a courseware by automating the subject "Introduction to Information Technology" offered at grade eleven and provide an automated means of instruction to the subject in such away that the teacher serves as a guide on the side and he/she can get ample time to provide students with extra curricular exercises. In addition, the courseware provides a control system for the courseware throughout the course of instruction. While using the courseware, students will develop good computer skills.

The system offers dynamic instruction through the following methods:

- The content is presented in the form of a lesson
- At the end of every lesson the system evaluates student performance using random and dynamically generated questions
- Development of test bank
- Test delivery and announcement

5.3.2 Development

The system provides two major functionalities: a courseware for the subject "Introduction to IT" of grade 11, and managing the process of learning, which controls all the instructional processes. The courseware provides the following phases of instruction:

- Lessons
- Exercises
- Tests and evaluation

The learning management

- Controls performance of the student
- Maintains records of students
- Maintains course content, and test bank

At the end of every lesson, questions are presented and the student answers. The student will be given recommendations whether to proceed to the next lesson or to repeat the current lesson based on his/her results.

In addition to the functional capabilities presented above, the system is required to satisfy the following non-functional capabilities:

- The system should have a graphical *user interface* that contains toolbars and dialog boxes to make the interaction easy for students as well as teachers.
- The system should be extensible and modifiable. Question bank should be able to expand.
- After exams have been conducted, any other party including the student should not access students' results. Student performance records should also be secured. Thus the system needs to provide proper securing mechanism of the current schedule database.
- Self-test and examination questions should be dynamically presented and are randomly selected.

From the functional requirements explained above, we can identify three main categories of functionalities- maintain inputs, controlling student performance and automated instruction.

The actors of the system are therefore, a teacher who registers inputs and evaluates student performance and the student who runs the courseware. Some of the scenarios, which are identified, based on the system's functional requirements and these actors are the following.

Name Maintain student information
Actors Teacher
Flow of Events
1. User has initializes the system
2. User activates student information entry form
3. User supplies the necessary student information
4. User repeats steps 3 until all available students entered
5. The system issues a message about successful registration of the student information

Name Maintain test bank
Actors Teacher
Flow of Events
1. User has initializes the system
2. User activates question entry form
3. User supplies the necessary question information along with the course and lesson it resides
4. User repeats step 3 until all available questions entered
5. The system issues a message about successful registration of the test questions

Name Generate test
Actors Teacher
Flow of Events
1. User initializes the system
2. User activates the test generating form
3. User supplies the necessary test parameters such as number of questions, lesson from which it is formed, time and duration.
4. User posts the test
5. The system issues a message about successful generation of the test.

Name	Present lesson
Actors	Student
Flow of Events	1. User initializes the system 2. User activates lesson 3. System delivers the necessary lesson information 4. User interacts by clicking next or previous 5. When a lesson is completed, system evaluates student performance 6. User responds by answering the questions 7. System recommends the user either to proceed to the next lesson or to repeat the current one 8. System records status of a student in relation to lesson coverage 9. System stops when the user logs out or when all lessons of the course are covered

The system will have two subsystems. The first is course administration subsystem (CourseManagement), where the teacher adds students, questions and tracks the performance of students. The other subsystem (LearningInterface) provides learning services like lesson presentation and examinations.

The persistent data stores are Student, Lesson, Questionbank, PastExams, CurrentExam, StudentPerformance, Score, and Administrator information. Database management system has been employed for efficient querying of the data stores.

Because the size of persistent data items (the database) is small and most teachers have some skills with Microsoft Access, it was chosen as the persistent data store for the system.

Data is accessed by means of the Open Database Connectivity and Java Database Connectivity (ODBC: JDBC) bridge.

These subsystems communicate through the persistent data management and the systems architecture is client – server, i.e., client side request and server-side processing. Figure 5.2 shows the architecture of the system.

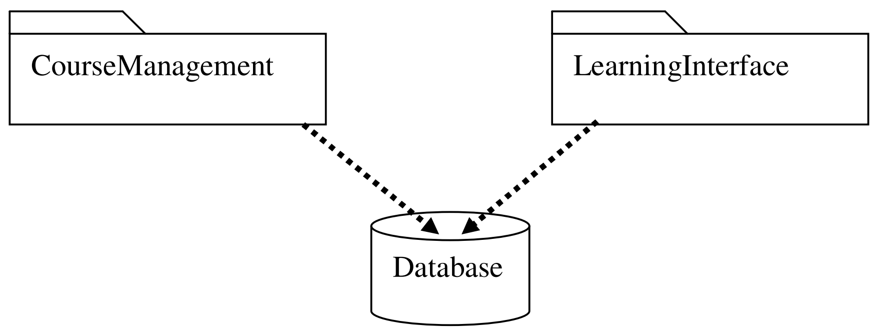

Figure 5.2 Architecture of the courseware

5.3.3 System features

The developed courseware includes the following features: Content presentation, Self-test, Examination, user management, login, question entry, student performance monitoring and evaluation, exam preparation, and announcement. Each of these is explained as follows.

Login. Both students and the teacher are authenticated. As a result, data stores and functionalities are explicitly authorized and username of the current user is kept in order to maintain session records. Figure 5.3 depicts the login user interface and the URL of the courseware.

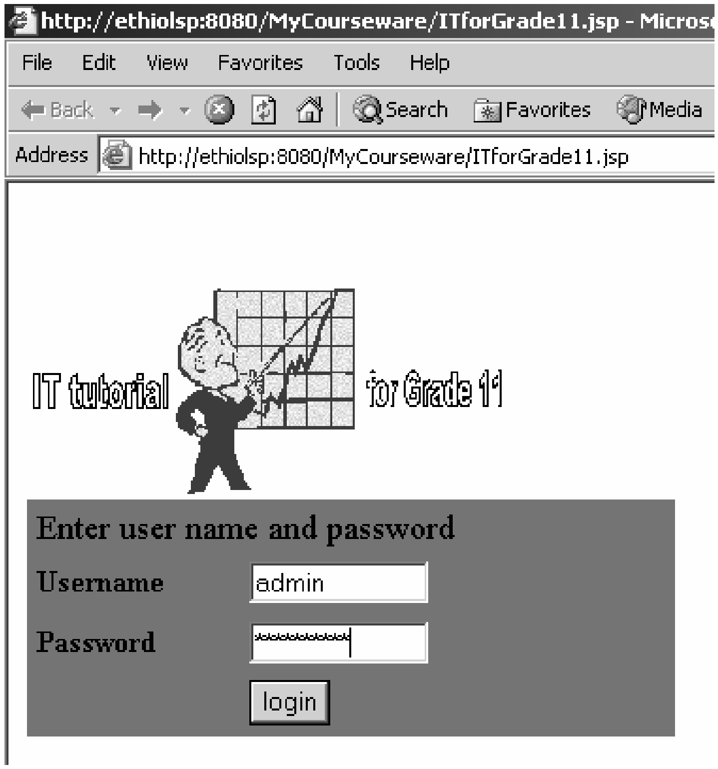

Figure 5.3 login interface and URL of the courseware

After being authenticated, a user is identified as a teacher (administrator) or as a student. Accordingly, a link (figure 5.4) is provided to proceed to the corresponding authorized tasks of the user.

Figure 5.4 a link displayed when the course administrator logs

When the administrator (teacher) clicks this link, the course management interface is displayed. (See figure 5.5)

Course Management Interface. The course management interface provides the teacher with the necessary commands required to manage the course.

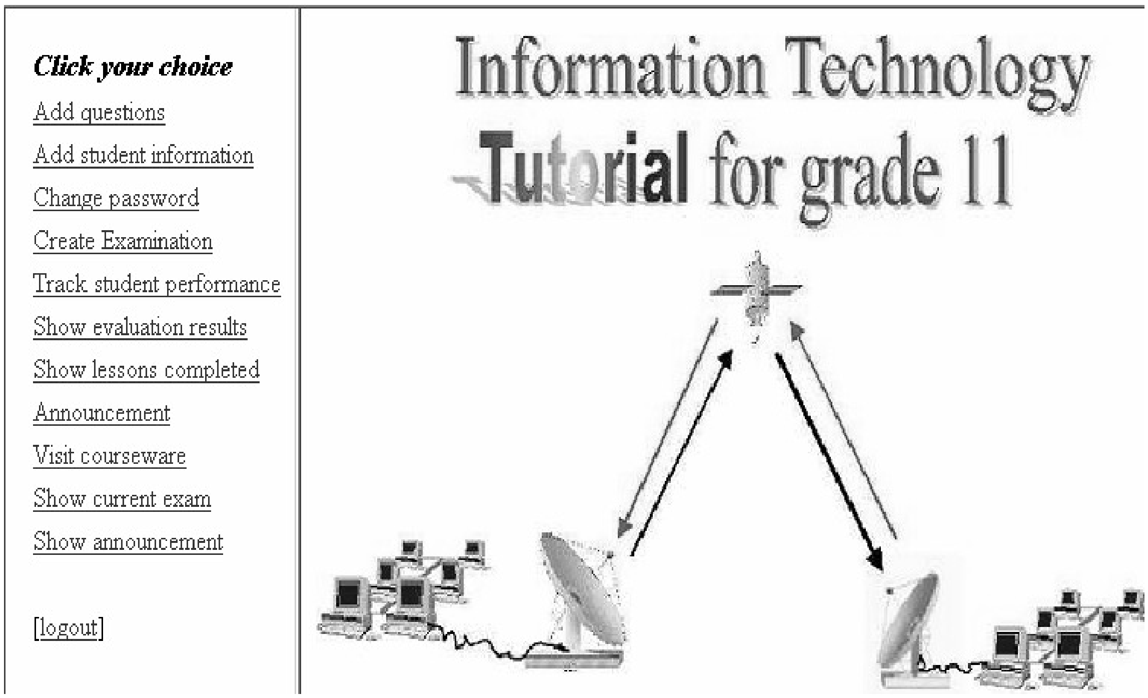

Figure 5.5 Course Management Interface

On the left panel of the window in figure 5.5, links to different functionalities of the course management interface are made available. Some of these functionalities are briefly explained as follows.

Add questions. The add question command allows the teacher to add more multiple choice type questions into the question bank. Figure 5.6 depicts the required attributes of a question.

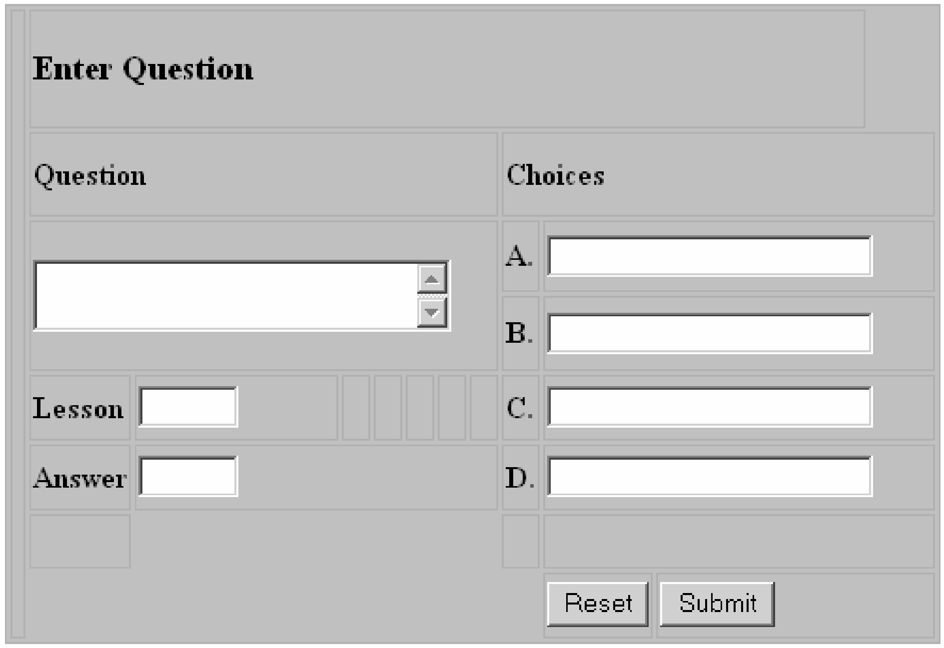

Figure 5.6 Add question form

Add student. This command allows the teacher to collect student information. It is executed at the beginning of the academic year. The required attributes of a student are full name, id number, username, password and section.

Announcement. The announce command allows a teacher to inform his/her students about the lessons, performance or exam schedules. The attributes required for the announcement are the message, title and date. The announcement is displayed as shown in figure 5.7 on request by students.

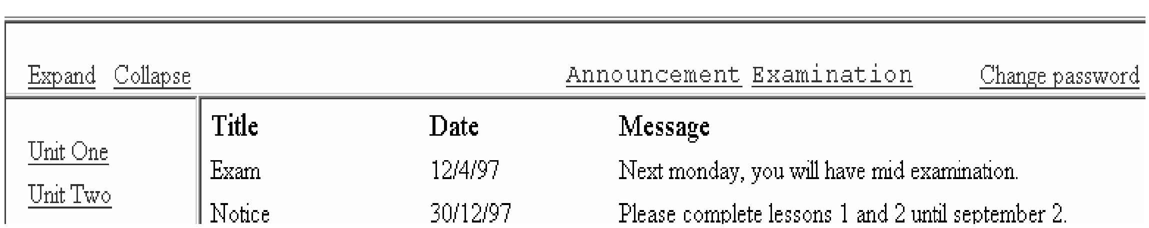

Figure 5.7 Announcement displayed from the student's interface

Create examination. With the help of the announcement feature of the courseware or other means, students are informed and sit for exam. The teacher executes the Create Exam command, which has attributes as shown in figure 5.8. When the submit button is clicked, the system automatically creates the specified number of questions for the necessary lessons. The selection of questions is random out of the specified gallery. This command is executed few minutes before the exam starts.

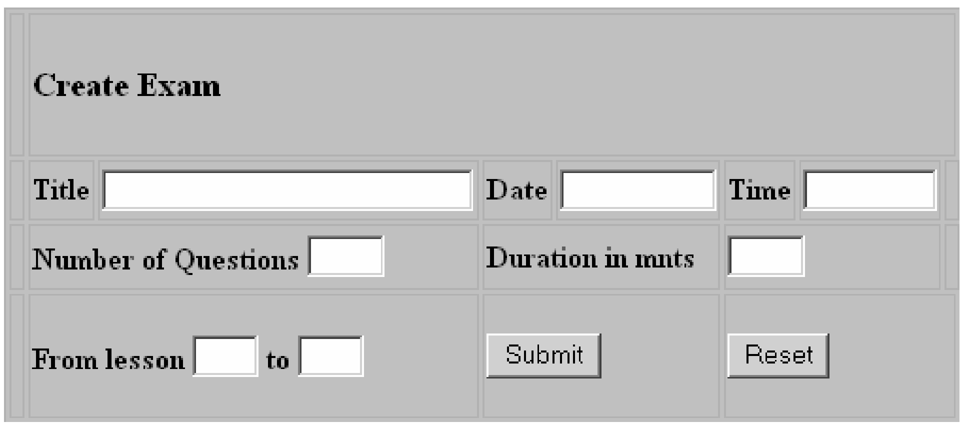

Figure 5.8 create exam form

Examination (show current exam). Once the examination is created as explained above, the teacher and/or students execute this command. An exam will be available only if the teacher creates it. A sample output of this command is shown in figure 5.9. When a student completes the exam he/she clicks the submit button. After that the system provides a student with its scores and immediately updates his/her records.

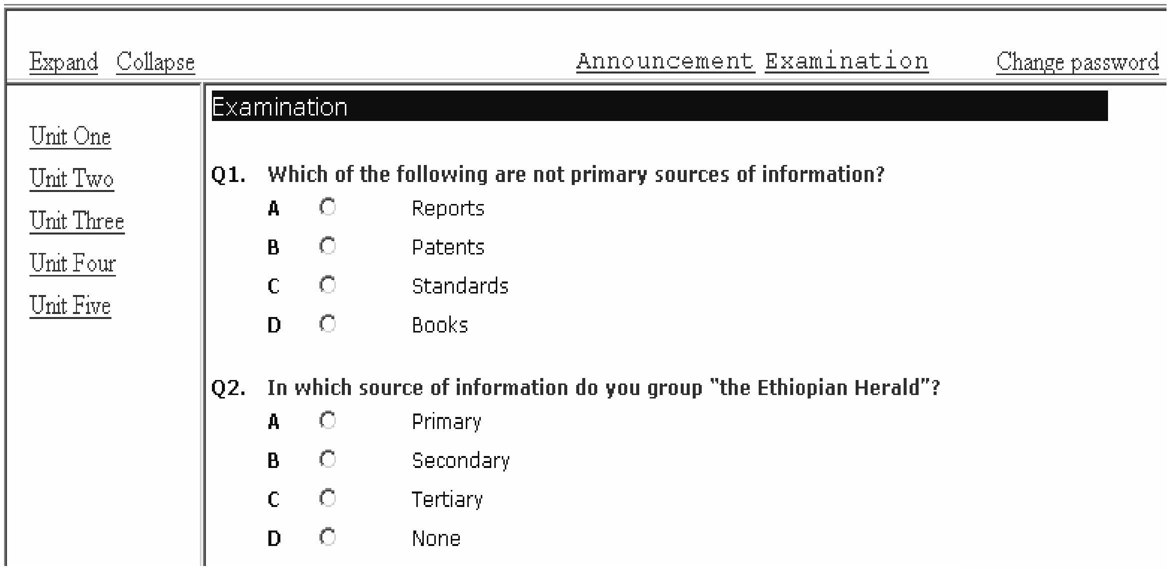

Figure 5.9 Sample result of the examination command

Show evaluation results. This command helps the teacher to keep track of students' performance through visit to examination results. The attribute for this command is either username or ID number. Figure 5.10 depicts this feature.

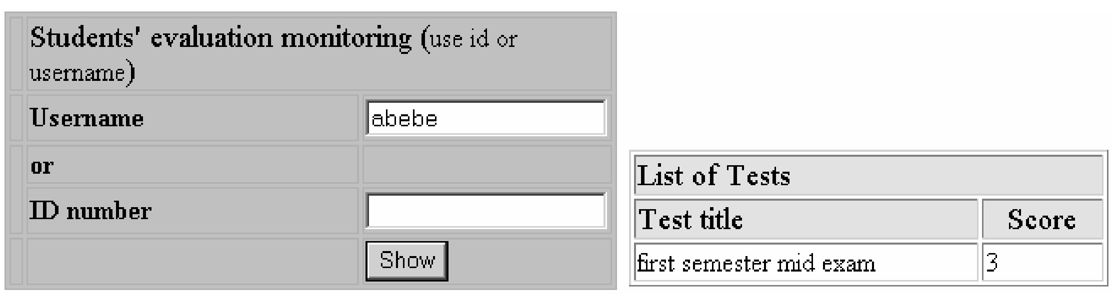

Figure 5.10 Request and result of student performance

Track student performance. In addition to examination results, students' performance is measured by means of randomly generated self-test questions to be completed when a student completes a lesson. Same way as the examination, a student completes self-test questions, gets feedback and an update to student's record is made when the score is satisfactory. A sample result of a self-test is shown in figure 5.11.

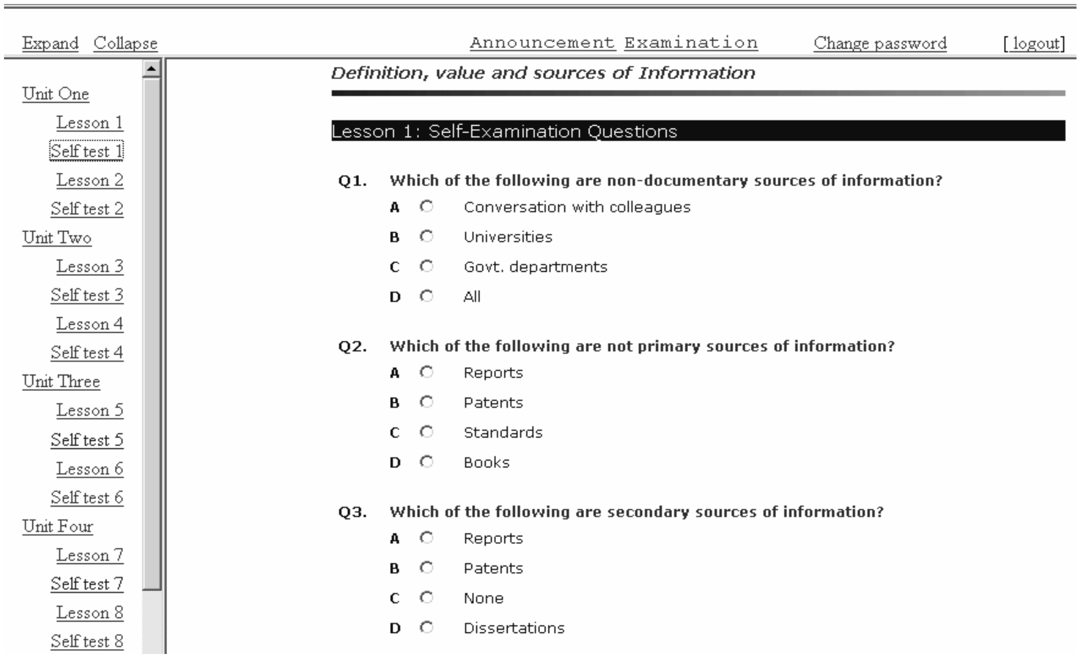

Figure 5.11 Self-test sample result

The teacher executes the *track student performance* command to see lessons, which are completed by a specific student as shown in figure 5.12. *The show lessons completed* command does the reverse task.

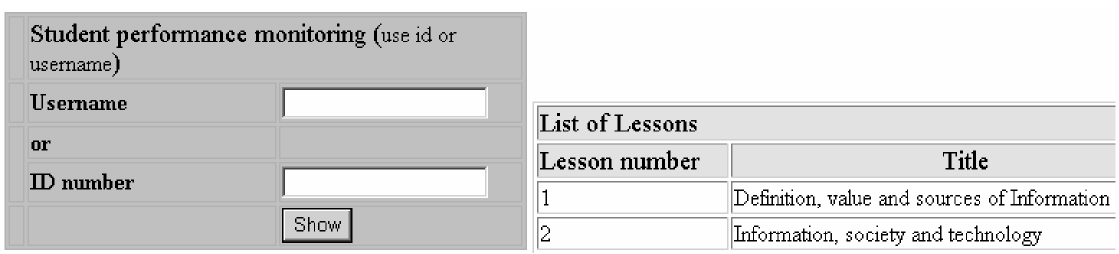

Figure 5.12 Request and result of student performance by lesson completion

The students' learning interface. This user interface provides different commands that are authorized for the student, see figure 5.13. This interface includes content presentation, self-test, examination, and announcement where many of these commands are explained above in connection with the course management interface.

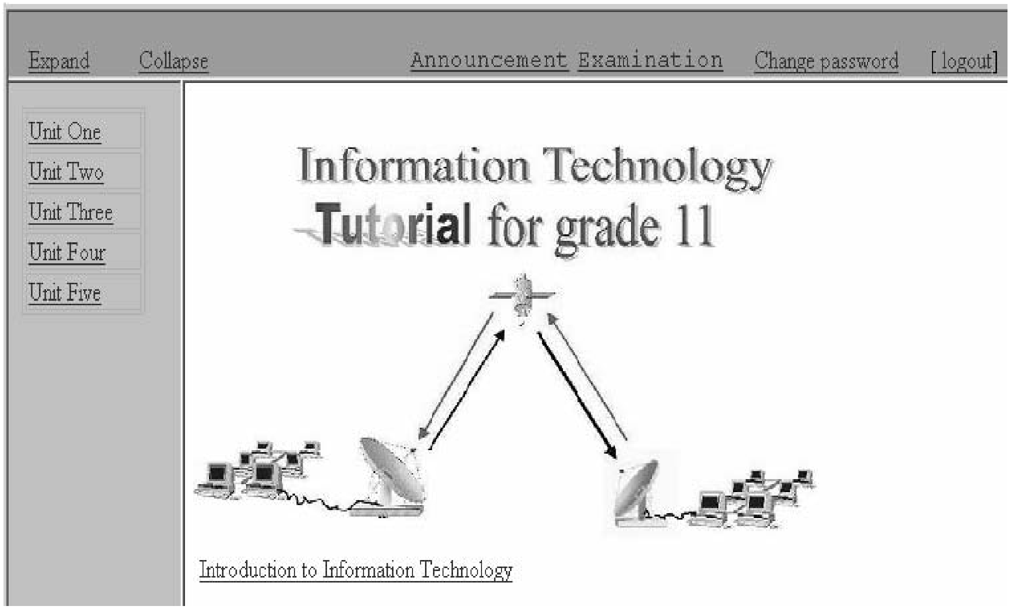

Figure 5.13 The student's learning Interface

5.4 Deployment of the courseware

The courseware is composed of HTML and Java Server Pages (JSP pages). The HTML part covers all the static learning content while the other functionalities such as Examination, and Self-test are JSP pages. Accordingly, the static content can be used in any machine running Internet explorer but the JSP pages require the apache tomcat web server software and the Java development kit (JDK). Therefore, in order to utilize the full features of the courseware, the Internet explorer, JDK and the web server are required.

The courseware can be used in a standalone machine having the apache tomcat web server and JDK; in an Intranet such that apache tomcat web server software runs on a local server machine; and over the Internet where the apache tomcat web server runs on a machine accessible over the Internet.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

This study, based on the survey of schools with relatively better practices on the deployment and utilization of technology (computers and Internet) in the teaching and learning process, examined the infrastructure, usage of computers, views of the school community on the integration of technology in schools, and comparison of current Ethiopian schools' practices with different models. Accordingly, this section presents conclusions on the results of the study under computers, connectivity, digital content, practices, teacher and student development and models.

- **Computers**. As per the requirements of the successful integration of technology in the teaching and learning process, the existing distribution of computers in Ethiopian schools is generally low. However, according to the ICTs capacity building proposal [30] and response from interview (See Appendix G), the ongoing activities especially in government high schools are expected to raise the current student to computer ratio. Moreover, the ratio in some non-government and private schools, where they have relatively smaller number of students is encouraging.

  We have found out that the following factors are threatening the existing student to computer ratio: computers are down because of lack of maintenance services; scheduling of access hours is not optimal; and the setup of computer-rooms is inappropriate.

- **Connectivity**. Similar to the deployment of computers, the existing LAN and Internet connectivity in schools is also low. Only few percentage of the schools, which have computers accessible by students, have local connectivity in the form of peer to peer, non- standard LAN, or standard LAN. Internet connectivity in these schools is also poorly exercised.

- **Digital content**. We found out that there are only few schools that have digital learning contents. This includes PowerPoint slides, Encarta encyclopedia 2004 and or earlier versions, CD-ROMs of the Global Certification of Secondary Education (GCSE), which includes features such as tutorial, drill-practice, and test on subjects such as mathematics, physics and language specific tools. Educational games for learning alphabet and numeric also exist. Although insignificant in number, there are some schools in which students and teachers have links to online digital resources.
- **Practices**. Starting from their introduction, computers are just being learned by teachers and students. The culture of the school community in utilizing the existing computers, connectivity, and digital contents in the actual teaching and learning of subject areas, is not yet developed. But, there are few innovative teachers in few schools who are using computers in teaching their subjects.
- **Teacher and student development**. Most teachers and students in the selected schools are skilled in word processing. Furthermore, most students are found to have skills in spreadsheet application (often Microsoft Excel). However, teachers' and students' usage of computers for the teaching and learning process is low.

The skill of students and teachers on computer basics is among the important factors for the successful integration of computers in the teaching and learning process. Accordingly, we found out that, there is a significant positive correlation between computer-related skills and usage in the teaching and learning process.

The attitude of the school community towards use of computers in education, which is their ambition on the introduction of technology and thereby practicing with it, is encouraging. However, the potential benefits of computers in the teaching and learning process are not yet recognized.

- **Models**. The experiences of schools on the integration of computers in the teaching and learning process were compared with the requirements of the phases of different models for integration. The result showed that almost all schools are either at the initial phase or do not correspond at all.

  All the schools that have been incorporated in the second phase in this study are chosen as they have relatively better practices on the deployment and utilization of technology in the teaching and learning process. Therefore, it is inappropriate to suggest and/or develop a single model for technology integration at schools all across the country. Such a work demands detailed investigation at each school level. Subject to further study at a smaller granularity, i.e., at each school level, we have explained some recommendations in the following sections.

6.2. Implications

In this section we present some of the implications of the outputs of this research work.

- This study showed that, the existing student-computer ratio is almost no computers in primary schools or large number of students per one computer in preparatory and TVET schools. Therefore, schools should take measures to minimize the ratio.

- The existing LAN and Internet connectivity is low. Majority of the schools that have computers do not have LANs. Similarly, most schools that have access to the Internet could not connect their computers to it, often only one-computer access that is caused by the absence of LAN. This implies that the level of awareness on the usefulness of connectivity is low and the technical capacity of schools is not yet matured. Therefore, effort should be exerted to create awareness and IT personnel should be trained on the technical skills on networking and troubleshooting.
- Only fourteen percent of the schools, which have computers accessible by students, reported to have digital resources in the form of CD-ROM and limited number of schools have access to online digital libraries; besides this, the culture of utilizing these existing resources is not yet developed. This implies that there is a need to support schools with learning resources and impart teachers to utilize such tools.
- Students, teachers and administrators were evaluated for their experience on the adoption of learning technologies. Only small percentage of schools have limited experience in productivity tools such as word processing, spreadsheet, etc. (See chapter 4). Although some individuals from the selected schools have certain experience on the incorporation of technology in the teaching and learning process, it is generally very small. Moreover, "computer related skill" and "access to computers" were found to positively correlate with usage. Therefore, it implies that for the successful integration of learning technologies, access provision, skills development and motivation of teachers to use technology in their teaching are necessary.
- The views of the school community on the integration of computers at all school levels were found to be positive. Therefore, during the implementation of learning

technologies, there will not be strong resistance from the side of the school community.

- In this work we found out that schools reside only around the initial phase of the technology integration models and they do not have clear goals set to achieve the requirements of the next phase and hence as such there is no match with any of the models. This implies that schools need to be motivated to integrate technologies and enhance learning outcomes.

6.3. Recommendations

Technology has changed the tools we utilize in teaching and learning. Knowledge is an organic process rather than a finite pool of information to be memorized, and hence the teacher assists students in synthesizing and evaluating information and building upon previously studied material. Therefore, in order to do this, we should take advantage of the most effective technologies in producing results that expand the students' educational opportunities and provide essential employment skills.

In the following successive paragraphs, we present recommendations on different tasks to be conducted for the incorporation of computers in the teaching and learning process in Ethiopian schools.

- Nowadays, integrating computers into the teaching and learning process is common practice. However, technology, the most important among the factors required for the successful implementation of CAL is not sufficiently available in most school levels. But preparatory and TVET schools are relatively better and the ongoing projects [30] are also improving these school levels and the first cycle secondary schools. Therefore, we recommend that the preparatory and TVET schools can integrate CAL in their teaching and learning process and the first cycle secondary can use the technology as supplementary to the existing practices.

- As computer related skills are among the factors for successful integration of CAL in the teaching and learning process, students' skills development is necessary. Therefore, students' skills development must be offered at the primary school level so that they can be prepared to use as an adds-on at first cycle secondary and for the successful utilization of the integrated curricula at preparatory or TVET. The achievements of some private primary schools (chapter 4) in this respect can be adapted with appropriate evaluation.
- Many schools in developed countries have strong learning technology background. Although the development of the respective countries matters, availability of school-based Learning Technologies Projects (LTP) have played great role for they're being supported with technology.

  In some Ethiopian schools, there is a trend to establishing a similar unit in the name of "ICT-club" by innovative teachers. Such school-based LTP (ICT-club) can do different tasks including the assistance for teachers in implementing the technology in their syllabi. Some of the responsibilities of the LTP can be the following:

  - Coordinating and planning for Learning Technologies.
  - Advising staff on hardware and software issues.
  - Administration of the ICT-club at the school.
  - Organizing and coordinating technical support.
  - Develop and maintain local resource center- LANs, Intranet, educational CD-ROMs, etc.

The LTP can provide technical support to all users across the school to ensure that network and workstations function properly and it can be provided in three ways:

- School based or contracted technician.
- Alleviating warranty support for major hardware repair costs.
- Making contracts with companies to undertake repair or upgrades where the scale or scope of the work is beyond the capacity of "in-house" technicians.

Staff will be asked to contact the LTP coordinator if they require technical support. Therefore, it is appropriate for schools to establish such a strong ICT unit.

- A national and/or regional Learning Service Provider (LSP) should be established and thereby exploit the potential of schoolNet. The LSP can provide the following services:

1. Deals with online educational resources around the world and linking them to schools.
2. Establish local, curricula-based online learning resource center (OLRC), through on the shelf organizing or local development of full courseware and/or learning objects.

The first service that the LSP provides is mainly searching for digital learning resources, evaluating them with respect to local needs, and negotiating with the respective stakeholders on licenses and related cases. This service can be provided right after the establishment of the broadband Internet connection.

The second service that the LSP could provide is to develop local, curricula-based online learning resource center (OLRC), through on the shelf organizing or local development of full courseware, similar to the prototype presented in chapter 5, and/or learning objects.

It requires installation of servers and linking to the broadband Internet gateway, installation of Learning Management Systems (LMS), organizing courseware and online delivery. WebCT and Blackboard, which are among the popular LMSs, can be used for the LSP.

- Regarding the digital learning content, we recommend learning-object (LO) for the advantages explained in chapter 2. Web based LOs, in the form of hypertext or applet are more appropriate so that after little training and motivation, teachers can participate in the development of LOs for some modules of their subjects and empower the LSP.

  Having digital learning resource centrally is only one component. In order that learning technologies can play their role in the teaching and learning process, students need to access these resources in any of the following ways:

  - School-based resource centers should be established. According to the ICTs capacity building proposal [30], LANs will be installed at each high school; however, the number of computers should be sufficient enough to accommodate all students in the school.
  - School or public libraries should be modernized so as to include digital resources by supplying with some computers and connecting them to the Internet.
  - Establish telecenters by encouraging private sector and as an extra service of woredaNet.

- A school furnished with technology does not necessarily imply successful technology integration. Schools must reevaluate their curricula, pedagogic and technical services and set requirements for the next phase as a goal and exert the necessary effort.

6.4. Suggestions for further research

- This work focused on the assessment of existing practices to provide a general view of the adoption of technology in teaching and learning process. However, the result of this work reveals that every school needs detailed study. Reevaluation of all subjects across the curricula is required. Therefore, the integration of computers in schools remains potential research area.

- In this work, we have seen that the school community (did not involve parents) shows a positive tendency towards the integration of computers across the school curricula, however, the attitudes- affective, behavioral, and cognitive of the school community on computers are not fully addressed [11]. Alternative strategies can be established to develop attitudes and awareness of teachers, administrators, students and parents, on the use of computers in education.

- The analysis of the comparison of students' learning outcomes, between students who were taught in an integrated and non-integrated computer environment can be conducted. This may involve specific student learning outcomes that are based on knowledge, comprehension, creativeness, and problem solving or skill development.

- The establishment of local, curricula-based, online learning resource center (OLRC) recommended in section 6.3 requires courseware. The subjects offered in the school curricula vary; some need courseware that can be organized from on the shelf learning objects while some need local development to fit the school context. Moreover, localization to the Ethiopian context is also required to fit the local languages. Therefore, this is a big research area where analysis of the existing subjects and development of prototypes is required.

- The LSP recommended in section 6.3, in addition to the management aspect requires the selection of appropriate learning platforms such as webCT [63]; the selection of authoring tools and choosing content technologies either full courses or learning objects (see chapter 2). Furthermore, the LSP can mature and replicates itself so that Virtual Learning Environment (VLE) (see chapter 2) such as virtual schools and distance education with complete learning, evaluation and certification management of remote learners can mushroom. Therefore, the architectural framework for VLE needs to be worked out in relation to the ongoing ICT backbone.
- The focus of this work was in schools, however, similar work can be conducted on the integration of Computers Assisted Learning in adult education, tertiary levels, life-long learning and on demand training in Ethiopia.
- The models explained in chapter 3 are based on the experiments made in some schools contexts. Therefore, since the existing practices of Ethiopian schools can be in a different school context, new models might be required and it needs further investigation.

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Appendix A: Questionnaire: Completed by teachers- Type I

PART A: Personal details

Instruction: Please read the statements carefully and circle your response number.

1. Highest qualification:

   1 Certificate 2 Diploma 3 Degree 4 Master and above

2. Teaching experience:

   1 Less than 5 years 2 5 to 10 years 3 11 to 15 years

   4 more than 15 years

3. What level are you currently teaching:

   1 High school 2 Junior high school 3 Elementary 4 Kindergarten

   (Please specify the subject you are currently teaching) ________________

4. Status of your school:

   1 Private 2 Government 3 Community 4 Mission 5 Other (please specify) ___________

5. How do you get access to computers? (Select more than one if necessary.)

   1 No access 2 at home 3 at school 4 telecenter

   5 other (please specify) __________

6. Your computer-related qualification:

   1 diploma 2 certificate 3 none

   4 other (please specify)_________________

PART B: Computer related Skills

Instruction: Please read the description section carefully and circle the level number that best describes your computer-related skills.

Description:

High (1): I have good experience on it.

Medium (2): I have some experience on it.

Low (3): I have limited experience on it.

None (4): I have no experience on it or I don't know the item.

	High	Medium	Low	None
1. Using word-processing applications like Microsoft Word	1	2	3	4
2. Using spreadsheet applications like Microsoft Excel	1	2	3	4
3. Using database systems like Microsoft Access	1	2	3	4
4. Using email	1	2	3	4
5. Using search engines	1	2	3	4
6. Using online learning materials	1	2	3	4
7. Using educational CD-ROMs like Encarta encyclopedia	1	2	3	4
8. Using Learning Management Systems	1	2	3	4
9. Web page development	1	2	3	4
10. Publishing a web page	1	2	3	4

PART C: Usage of computers in Teaching

Instruction: Please read the list carefully and circle the number that describes how often you are currently using the indicated technology in your teaching. Please circle only one.

Description:

1: Very Often **2**: Often **3**: Sometimes **4**: Seldom **5**: Never

1. Providing students with PowerPoint slides	1	2	3	4	5
2. Using Word Processing applications	1	2	3	4	5
3. Using spreadsheet applications	1	2	3	4	5
4. Using educational CD-ROMs	1	2	3	4	5
5. Using email for academic matters	1	2	3	4	5
6. Using online learning materials	1	2	3	4	5
7. Using LAN for Collaborative work	1	2	3	4	5
8. Using Computer based Simulation and/or games	1	2	3	4	5
9. Using Computer based Tutoring	1	2	3	4	5
10. Using courseware authoring tools	1	2	3	4	5
11. Using Learning Management Systems	1	2	3	4	5
12. Using the Internet as the main source of materials	1	2	3	4	5

PART D. Teachers' Views of Integrating Computers in Teaching

Instruction: Please carefully read each of the statements in the list below and select your opinion based on your experience on the Integration and/or use of Computers in your teaching. Please circle only one number.

Description:

1: Strongly Agree **2**: Agree **3**: Disagree **4**: Strongly Disagree **5**: Undecided.

1. Computers can improve quality of education.	1	2	3	4	5
2. Computers can provide self-paced learning.	1	2	3	4	5
3. Internet can provide collaborative learning.	1	2	3	4	5
4. Computers can provide equal opportunity to the "haves" and "have not" learners.	1	2	3	4	5
5. Online learning resources help for self-empowerment.	1	2	3	4	5
6. Computers can help teachers to teach better.	1	2	3	4	5
7. Computer-based tutorials can improve learning.	1	2	3	4	5
8. Computer-based simulations can improve learning.	1	2	3	4	5
9. Curricular-based software should be incorporated.	1	2	3	4	5
10. Computers should Assist kindergarten education.	1	2	3	4	5
11. Computers should be Introduced in Primary education.	1	2	3	4	5
12. Computers should Assist Secondary education.	1	2	3	4	5

PART E. Please use this part if you have any comments.

Please feel free to give any other comments and suggestions.

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Appendix B: Questionnaire: Completed by students -Type II

PART A: Personal details

Instruction: Please read the statements carefully and circle the number of your response.

1. Your grade level:

   1 high school 2 preparatory 3 technic (TVET) 4 other

2. Your stream (if appropriate):

   1 science 2 art 3 other (please specify) ________________

3. Status of your school:

   1 Private 2 Government 3 Community 4 Mission

   5 other (please specify) ___________________

4. How do you get access to computers? (Select more than one if necessary.)

   1 No access 2 at home 3 at school 4 telecenter

   5 other (please specify) ________________

5. Your computer-related qualification:

   1 diploma 2 certificate 3 none

   4 other (please specify)_____________________

PART B: Computer related skills

Instruction: Please read the description section carefully and circle the level number that best describes your computer-related skills.

Description:

High (1): I have good experience on it.

Medium (2): I have some experience on it.

Low (3): I have limited experience on it.

None (4): I have no experience on it or I don't know the item.

	High	**Medium**	**Low**	**None**
1. Basic windows operations	1	2	3	4
2. Using word-processing applications like Microsoft Word	1	2	3	4
3. Using spreadsheet applications like Microsoft Excel	1	2	3	4
4. Using database systems like Microsoft Access	1	2	3	4
5. Using email 1	2	3	4	
6. Using search engines	1	2	3	4
7. Using educational CD-ROMs like Encarta encyclopedia	1	2	3	4
8. Using online learning materials	1	2	3	4
9. Web page development	1	2	3	4
10. Publishing a web page	1	2	3	4

PART C: Usage of computers in Learning

Instruction: Please read the list carefully and circle the number (one number for each) that describes how often you are currently using the indicated technology in your learning.

Description:

1: Very Often **2**: Often **3**: Sometimes **4**: Seldom **5**: Never

1. Reading from PowerPoint or related slides	1	2	3	4	5
2. Reading from Acrobat reader or related tools	1	2	3	4	5
3. Using Word Processor for academic purposes	1	2	3	4	5
4. Using spreadsheet programs to analyze your data	1	2	3	4	5
5. Using email for academic matters	1	2	3	4	5
6. Using educational CD-ROMs	1	2	3	4	5
7. Using Online Learning materials	1	2	3	4	5
8. Using LAN for collaborative work	1	2	3	4	5
9. Using Computer based simulation	1	2	3	4	5
10. Using Computer based educational games	1	2	3	4	5
11. Using Computer based Intelligent Tutoring	1	2	3	4	5
12. Using the Internet as main source of learningmaterials	1	2	3	4	5

PART D. Impact of computers on Students' Learning

Instruction: Please carefully read the following statements and circle your response in support or opposition of the Impact of the indicated technology in your learning.

Description:

1: Strongly Agree **2**: Agree **3**: Disagree **4**: Strongly Disagree **5**: Undecided.

1. Word processors simplified my writing (compilation).	1	2	3	4	5
2. Spreadsheet programs helped me to analyze my data.	1	2	3	4	5
3. The Internet allowed me to cooperate with other students on academic matters.	1	2	3	4	5
4. The Internet helped me to get materials that I couldn't afford to buy.	1	2	3	4	5
5. Computers allowed me to learn on my own pace.	1	2	3	4	5
6. Computer-based tutorials improved my learning.	1	2	3	4	5
7. Computer-based simulations improved my learning.	1	2	3	4	5
8. Computers have improved my Learning.	1	2	3	4	5
9. Computers should be integrated in all subjects.	1	2	3	4	5
10. Computers should Assist kindergarten education.	1	2	3	4	5
11. Computers should be Introduced in Primary education.	1	2	3	4	5
12. Computers should Assist secondary education.	1	2	3	4	5

PART E. Please use this part if you have any comments.

Please feel free to give any other comments and suggestions.

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Appendix C: Raw Data of Questionnaires Completed by Teachers

	Part A						Part B										Part C												Part D											
t1	3	4	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	4	4	4	5	4	5	4	3	4	5	4	1	2	2	3	2	2	2	2	2	2	2	1
t2	3	4	1	2	5	1	1	1	2	3	3	4	3	4	4	4	5	3	3	3	3	5	5	4	5	5	5	3	5	5	2	4	5	5	5	5	5	5	5	5
t3	3	4	1	2	3	2	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	2	3	3	4	3	3	3	3	2	3	3	2
t4	4	4	1	2	3	2	3	3	2	2	3	3	3	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	1	2	2	4	5	2	1	1	1	1	2	2
t5	3	4	2	2	3	4	1	2	2	1	3	4	4	4	3	3	5	4	5	5	3	5	5	2	5	5	5	3	1	2	2	5	4	5	5	5	5	5	1	1
t6	3	4	1	2	3	2	2	2	2	3	2	2	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5	1	2	2	2	1	1	1	2	1	2	1	1
t7	2	4	1	2	3	1	1	2	2	1	1	1	1	4	3	3	5	5	5	5	4	4	4	5	3	5	5	3	1	1	1	5	1	1	1	1	1	1	1	1
t8	3	1	1	2	3	2	2	3	3	1	3	3	4	4	4	4	5	3	4	5	3	5	5	5	5	5	5	3	5	2	1	5	2	2	2	2	5	1	2	2
t9	4	4	1	2	3	2	3	4	4	3	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	1	1	1	2	2	2	2	2	1	2	1	1
t10	3	4	1	2	3	2	2	2	3	3	4	4	4	4	4	4	4	5	5	5	4	5	5	5	5	5	5	5	2	2	2	3	5	2	2	5	5	2	2	1
t11	3	1	1	1	2	2	1	2	2	1	3	3	2	3	4	4	5	1	5	5	2	5	5	5	5	5	5	4	1	2	1	3	2	2	2	2	2	3	5	1
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Appendix D: Raw Data of Questionnaires Completed by Students

	Part A	***Part B***	***Part C***	***Part D***
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Appendix E: Interview response: Institute of Curriculum Development and Educational Research

Purpose: Incorporation of Computer Assisted Learning in the High School Curriculum

Date: March 10, 2004

1. What are the duties and responsibilities of the institute?

A. *The duties of the institute are research, plan, control and execution of Ethiopian education curriculum.*

2. What is the current teacher to student ratio in each of the cycles of education? Kindergarten, elementary, junior, senior, preparatory, and vocational

A. *You can find in the educational statistics in our library. However, our focus is on pupil-section ratio instead of pupil-teacher ratio because pupil-section ratio is good indicator of efficiency.*

3. How do you evaluate the teacher qualification?

A. *Majority of secondary school teachers is below qualification. About 60% of high school teachers are below qualification. The second cycle elementary (5-8) is also facing similar problem.*

4. How do you rate the current quality of education at schools?

A. *It is poor. This is because, teacher training, school standards, libraries and laboratories are not satisfactorily exercised.*

5. What is the educational coverage of Ethiopian schools? How is literacy level defined?

A. *65% school age children are enrolled. Literacy according to our standard is defined as those who complete grade 4 are considered to be literate.*

6. Would you please give general information regarding the curriculum for Preschool education, First cycle, and 2nd cycle?

A. *Preschool: this level is fully under the responsibility of private and community development.*

First cycle: consists of grades 1-4. Integrated subjects, self contained, and medium of instruction is nationality language. The expected outputs are writing, reading, environment, life skills, and health awareness.

Second cycle: linear subjects such as physics, history, etc. this is also nationality language based, but there are some regions using English as a medium. But English language is given as a subject to all. The motive of this cycle is to prepare students for secondary education.

7. Do you have any experience/plan on the integration of computers into the curriculum?
   - Application software integrated in a course. E.g. word processing in English writing classes; spreadsheet applications in accounting, etc.
   - Special software integrated in a course. E.g. frog dissection simulator in Biology; Newtonian principles simulator in physics; drills in mathematics, etc.

A. *We have no experience or plan but IT as a subject is provided for preparatory students.*

8. Do you have any plan to incorporate schoolNet in the curriculum?

A. *Yes, it is already incorporated. It will commence this year. You can find details descriptions about the integration process from EMA.*

9. How do you see the motives such as collaborative, self-paced etc. for better learning?

A. *Yes, that is interesting. Our motive is active learning: doing and participating. The collaboration is also there. However, regarding the self-paced learning, our curriculum is planned, not flexible for gifted student even. Simply seating for national exam without sequentially following all the levels is not yet reached.*

10. Do you think integrating CAL in school curriculum is feasible?

A. *Currently, CAL is not feasible because many problems such as electricity, infrastructure, large number of students, limited number of computers, teacher training, and less priority. The priority goal government is by 2015 education for all.*

11. What about with the preparatory schools? They have owned some computers.

A. *Even there, it not feasible to do so. Of course we have 140 preparatory schools, each having 40-50 computers. However, there are no qualified teachers, no technicians. The majority doesn't even know the terms.*

12. Would you please give suggestions, comments, etc?

A. *Integrating CAL in to the curriculum at this situation is ambitious; rather we can have options like telecenter, and/or pilot schools. The UNESCO as already exercised telecenter for community development at different regions. Therefore, telecenter for educational purpose can be established so that the school community can use it as supplementary.*

Appendix F: Interview response: Ethiopian Telecommunications Corporation

IXP-ETC office

Purpose: **SchoolNet as an infrastructure for the implementation of CAL in High school**

Date: March 18, 04

1. How many sites are there in the schoolNet?

A. *The schoolNet encompasses more than 600 high schools.*

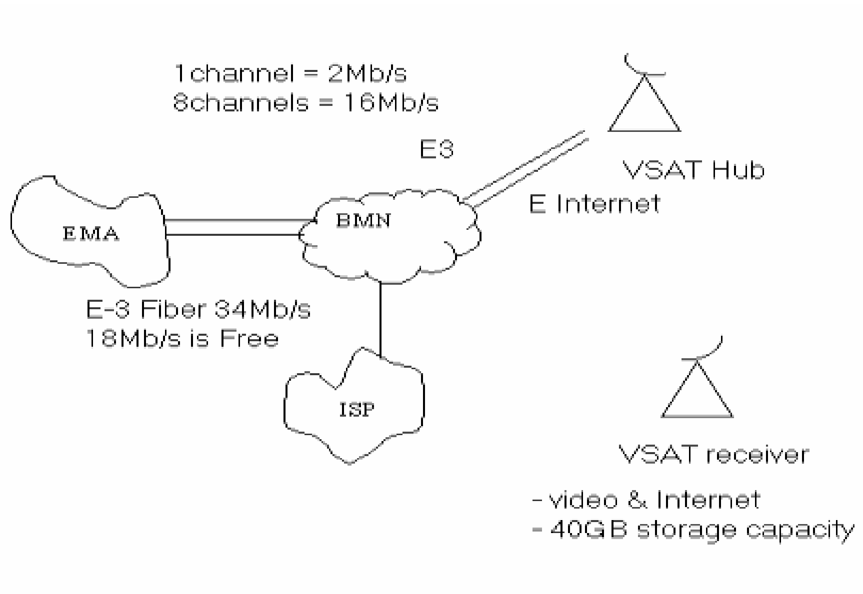
2. Does it include all high schools in Ethiopia?

A. *Yes it includes. At this first stage, all high schools are involved. The digital television is about to start.*

3. What does the network architecture look like?

A. *Let's consider the following four units that are involved in the schoolNet architecture. These are the educational media agency (EMA), Internet service provider (ISP-ETC), VSAT Hub (silulta), and VSAT receivers at schools. The EMA is responsible for providing learning contents (digital television).*

The ETC as an ISP provides Internet services. Both are connected to the VSAT Hub at silulta using the broadband multimedia network (BMN). The VSAT located at schools, down streams video and Internet.



4. What are the services that it provides? Does it provide television? How many channels does it provide? Is it one way or two ways?

A. *It provides digital video through 8 channels each requiring 2 Mb/s bandwidth. The downlink is very high but up link is limited. For the purpose of interactivity, the audio is two-way. The video is one-way. However it can be upgraded to two-way. The infrastructure has 18 Mb/s free that can be consumed by services other than the digital video. The total bandwidth of the infrastructure is 34 Mb/s.*

5. How are the servers implemented?

A. *Servers are not yet implemented.*

6. What about woredaNet?

A. *WoredaNet is a hierarchical communication infrastructure with the following levels. Federal, Regional government, and woreda.*

   The federal and regional levels use the BMN while the woreda mainly uses VSAT except those located in areas where the BMN infrastructure is accessible.

   The architecture allows interactions such as region-region, federal-region, woreda-woreda, and region-woreda.

   The services it provides are video conferencing, IP telephony (IPT), and Internet; when it matures it will result to e-government.

7. How do you think that telcentres can be established?

A. *It can be established in schools or at woreda mainly providing services such as Internet and IPT.*

Appendix G: Interview response: Educational Media Agency

Purpose: Incorporation of computers as educational media

Date: march 10, 2004

1. What are the educational media that you are currently using?

A. Previously we had the radio but now, we are establishing the satellite based multi-channel interactive TV.

2. What tasks have been accomplished so far regarding the satellite TV?

A. The ICT background is almost finalized. Currently we are undergoing installation of the necessary tools

- *plasma television set installation*
- *installing TV circuit to all rooms*

3. Who prepares the content?

A. The Ministry of Education develops draft scripts of the programs here and gives to the South African Company. Then the Company does the necessary modifications and sends it back for approval. Then it develops the contents based on the script and gives it back to EMA. Finally the EMA launches.

4. Isn't it possible to develop here by EMA?

A. The content is out sourced to the South African company, because currently the EMA doesn't have the capacity to prepare about 2978 programs.

5. How is it synchronized with the curriculum?

A. *The script is based on the existing curriculum. The television will be the major teaching tool. This technology induces a difference in the responsibility of students and teachers. While a teacher follows up programs, controls its proper execution in a class, arranges students for active learning, and checks students exercise and related tasks, students will have a lot to do and as a result, they gain a lot. For this purpose, manuals are prepared and distributed.*

6. Are there any activities on the establishment of computer-mediated learning or support?

A. *Computer servers are required to download contents so that it can be replayed. In addition to that, Internet can be used as a supplementary. However, there is no activity made by EMA on this area.*

   For the time being, the project has a plan to distribute some programs to schools in DVD so that it can be replayed.

7. Do you provide any training opportunity for teachers?

A. *Currently we are providing training on*

   - *Installation guide*
   - *Training of technicians for the TVs and receivers*
   - *How to prepare for the programs*

   In addition we have regular training programs to teachers.

8. Do you have any plan to incorporate primary education?

A. *The radio program will be supportive for primary education. Gradually, all school levels will be involved.*

The thesis is my original work. It has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Candidate's signature

Gebremariam Mesfin ______ ____________

The thesis has been submitted for examination with my approval as university advisor:

Dr. Dida Midekso ______ ____________