DEVELOPMENT AND IMPLEMENTATION OF A MATHEMATICAL MODEL OF DISTANT EDUCATION SYSTEM

BY

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Declaration

I declare that the work in the dissertation entitled 'DEVELOPMENT AND IMPLEMENTATION OF A MATHEMATICAL MODEL OF DISTANT EDUCATION SYSTEM' has been performed by me in the Department of Mathematics under the supervision of Dr. O. S. Adewale.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at any University.

Olugbemi, Morenike Omowumi	________________	April, 2008
Name of Student	**Signature**	**Date**

Certification

This project thesis entitled DEVELOPMENT AND IMPLEMENTATION OF A MATHEMATICAL MODEL OF DISTANCE EDUCATION SYSTEM by OLUGBEMI, Morenike Omowumi meets the regulations governing the award of the degree of Master of Science in Computer Science of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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Dedication

To God Almighty,

The Shepherd of my Soul

Abstract

In recent years, educators have witnessed the rapid development of computer networks, dramatic improvements in the processing power of personal computers, and striking advances in magnetic storage technology. These developments have made the computer a dynamic force in distance education, providing a new and interactive means of overcoming time and distance to reach learners.

In this work, a web-based system was designed to further enhance the accessibility of distance education. The system also used a combination of e-learning and assessment techniques to deliver the prototype.

The system was built around a *three-tier architecture* model consisting of the server side and the client side connected through the Internet.

The system was implemented with Apache as the web server, Microsoft Internet explorer as the web browser to achieve a secure client-server communication and MySQL as the database management system. The scripting engine uses server-side PHP functions to communicate with the database.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Distance education, structured learning in which the student and instructor are separated by time and place, is currently the fastest growing form of domestic and international education. What was once considered a special form of education using nontraditional delivery systems is now becoming an important concept in mainstream education.

Distance education traces its origins to mid-19th century in Europe and the United States. The pioneers of distance education used the best technology of their day, the postal system, to open educational opportunities to people who wanted to learn but were not able to attend conventional schools. People who most benefited from such correspondence education included those with physical disabilities, women who were not allowed to enroll in educational institutions open only to men, people who had jobs during normal school hours, and those who lived in remote regions where schools did not exist.

The invention of educational radio in the 1920s and the advent of television in the 1940s created important new forms of communication for use in distance education. Educators used these new technologies to broadcast educational programmes to millions of learners, thus extending learning opportunities beyond the walls of conventional teaching institutions.

The development of reliable long-distance telephone systems in the early 1900s also increased the capacity of distance educators to reach new student populations. But telephone systems never played a prominent role in education until the introduction of new teleconferencing technologies in the 1980s and 1990s. Teleconferencing systems made it possible for teachers to talk with, hear, and see their students in real time—that is, with no delays in the transmissions—even if they were located across the country or around the world.

Distance education increasingly uses combinations of different communications technologies to enhance the abilities of teachers and students to communicate with each other. With the spread of computer-network communications in the 1980s and 1990s, large numbers of people gained access to computers linked to telephone lines, allowing teachers and students to communicate in conferences via computers. Distance education also makes use of computer conferencing on the World Wide Web, where teachers and students present text, pictures, audio, and occasionally video. A conferencing method known as one-way video/two-way audio uses television pictures that are transmitted to particular sites, where people can reply to the broadcasters with a telephone call-in system. Television pictures can also be transmitted in two directions simultaneously through telephone lines, so that teachers and students in one place can see and hear teachers and students in other places. This is called video-conferencing.

The research carried out by (Clara-l Pena, et al., 2001) showed the use of adaptation techniques involved in an e-learning system that considers students' learning styles and students knowledge states. In this work, the technique of evaluating student assessments is only through free choice assignments and exercises given, which does not accrue enforcement on the part of learning. This could not give an optimal performance in the learning process. This led to a proposal of a new model of active learning system that uses new additional evaluating parameters/technique in assessing the students, in order for them to achieve optimal study performance.

In Nigeria, distance learning is seen as part of the legitimate and effective means of acquiring formal education qualifications since the colonial days. A sizeable number of Nigerians acquired their university through correspondence study (Omolewa, 1985).

Higher education in Nigeria is amazing as the country has more than one hundred and fifty tertiary institutions made up of universities, polytechnics and colleges of education. Nigerians' desire for education dates back to the pre-independence period, when the colonial government in 1887 requested that university of London extends its examination facilities to Nigerian candidates (Omolewa, 1981). Early graduates in Nigeria went through the university of London correspondence matriculation examinations. Most Nigerians in this period also passed through correspondence courses offered by British institutions such as Rapid Result College and Wesley hall to obtain their general certificate in education, which is a pre-requisite to university admission.

Another distance education outfit at the tertiary level of education is the virtual digital library project (NUC, 2001). This is the widening of access for library users with a view of improving teaching and research in the nation's existing universities. A major component of this is the creation of web sites where all academic publications will be accessible to all.

1.2 Research Motivation

Rapidly rising costs of printed materials have led many institutions to invest in relatively cost-effective online resources. Increasingly, universities have computer facilities for searching the library's collections, reading CD-ROMs, accessing the Internet, and researching online databases.

Within a context of rapid technological change and shifting market and economic conditions, the education system is challenged with providing increased educational opportunities without increased budgets. Many educational institutions are answering this challenge by developing distance education programmes. At its most basic level, distance education takes place when a teacher and student(s) are separated by physical distance, and technology (i.e., voice, video, data, and print), often in concert with face-to-face communication, is used to bridge the instructional gap. These types of programmes can provide adults with a second chance at a college education, reach those disadvantaged by limited time, distance or physical disability, and update the knowledge base of workers at their places of employment. This thesis, therefore, aims to develop a distance education system that will:

- Reach a wider student audience
- Meet the needs of students who are unable to attend on-campus classes
- Involve outside speakers who would otherwise be unavailable
- Link students from different social, cultural, economic, and experiential backgrounds

1.3 Research Objectives

Distance education has created a major shift in how educators and students think about teaching and learning. The objective of the study is to design an Internet-based distance education system that will:

(i) allow students to learn in more convenient locations and often at more convenient times.

(ii) open educational opportunity to unreached population of students who do not have opportunity to attend conventional universities.

(iii) enable more people to extend the period of their education from a limited number of schooling years to a lifelong learning process.

1.4 Research methodology

The research methods adopted for the purpose of this study are;

- Journals and textbooks related to this topic.
- Online materials from the internet.

Distance Education System, a web-based system was developed using apache as a web server, PHP as the scripting language and MySQL as the database management system (DBMS) to manage to the data used in the system. The operating system platform is windows XP.

1.5 Organization of the Thesis

This work is divided into five chapters;

Chapter one gives a general introduction and background of the study, research motivation, research objectives and the research methodology.

Chapter two contains review of related literatures on distance education and its components, distance education theory and distance learning technologies, future directions and emerging technologies.

Chapter three contains the research methodology, system models and implementation.

Chapter four emphasizes the system implementation, software, hardware requirements and installation.

Finally, chapter five focuses on summary and conclusion of the project.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Distance Education is not a new concept. In the late 1800s, at the University of Chicago, the first major correspondence Programme in the United States was established in which the teacher and learner were at different locations. Before that time, particularly in pre-industrial Europe, education had been available primarily to males in higher levels of society. The most effective form of instruction in those days was to bring students together in one place and one time to learn from one of the masters. That form of traditional educational remains the model today. The early efforts of educators like William Rainey Harper in 1890 to establish alternatives were laughed at. Correspondence study, which was designed to provide educational opportunities for those who were not among the elite and who could not afford full time residence at an educational institution, was looked down on as inferior education. Many educators regarded correspondence courses as simply business operations. Correspondence education offended the elitist and extremely undemocratic educational system which characterized the early years in this country (Pittman, 1991). Indeed, many correspondence courses were viewed as simply poor excuses for the real thing. However, the need to provide equal access to educational opportunities has always been part of our democratic ideals, so correspondence study took a new turn.

As radio developed during the First World War and television in the 1950s, instruction outside of the traditional classroom had suddenly found new delivery systems. There are many examples of how early radio and television were used in schools to deliver instruction at a distance. Wisconsin's School of the Air was an early effort, in the 1920's, to affirm that the boundaries of the school were the boundaries of the state. More recently, audio and computer teleconferencing have influenced the delivery of instruction in public schools, higher education, the military, business and industry. Following the establishment of the Open University in Britain in 1970, and Charles Wedemeyer's innovative uses of media in 1986 at the University of Wisconsin, correspondence study began to use developing technologies to provide more effective distance education.

2.1.1 Correspondence Study to Distance Education

In 1982, the International Council for Correspondence Education changed its name to the International Council for Distance Education to reflect the developments in the field. With the rapid growth of new technologies and the evolution of systems for delivering information, distance education with its ideals of providing equality of access to education, became a reality. Today there are distance education courses offered by dozens of public and private organizations and institutions to school districts, universities, the military and large corporations. Direct satellite broadcasts are produced by more than 20 of the country's major universities to provide over 500 courses in engineering delivered live by satellite as part of the National Technological University (NTU). In the corporate sector, more than 40 billion dollars a year are spent by IBM, Kodak, and the Fortune 500 companies in distance education programmes. What, exactly, are the prospects and promises of distance education? Desmond Keegan (Keegan, 1980) identified six key elements of distance education:

- separation of teacher and learner
- influence of an educational organization
- use of media to link teacher and learner
- two way exchange of communication
- learners as individuals rather than grouped
- educators as an industrialized form

Distance Education has traditionally been defined as instruction through print or electronic communications media to persons engaged in planned learning in a place or time different from that of the instructor or instructors. The traditional definition of distance education is slowly being eroded as new technological developments challenge educators to re-conceptualize the idea of schooling and lifelong learning. At the same time, interest in the unlimited possibilities of individualized distance learning is growing with the development of each new communication technology. Although educational technologists agree that it is the systematic design of instruction which should drive the development of distance learning, the rapid development of computer related technologies has captured the interest of the public and has been responsible for much of the limelight in which distance educators currently find themselves. Although the United States has seen rapid growth in the use of technology for distance education, much of the pioneering work has been done abroad.

2.1.2 Open Learning in the United Kingdom

The establishment of the British Open University in the United Kingdom in 1969 marked the beginning of the use of technology to supplement print based instruction through well designed courses. Learning materials were delivered on a large scale to students in three programmes; undergraduates, postgraduates and associate students. Although course materials were primarily print based, they were supported by a variety of technologies. No formal educational qualifications have been required to be admitted to the British Open University. Courses are closely monitored and have been successfully delivered to over 100,000 students. As a direct result of its success, the Open University model has been adopted by many countries in both the developed and developing world (Keegan, 1986). Researchers in the United Kingdom continue to be leaders in identifying problems and proposing solutions for practitioners in the field (Harry, Keegan, & Magnus, 1993). The International Centre for Distance Learning, at the British Open University, maintains the most complete holdings of literature in both research and practice of international distance learning. Research studies, evaluation reports, course modules, books, journal articles and ephemeral material concerning distance education around the world are all available through quarterly accessions lists or online.

2.1.3 Distance Education in the United States

The United States was slow to enter the distance education marketplace, and when it did, a form of distance education unique to its needs evolved. Not having the economic problems of some countries or the massive illiteracy problems of developing nations, the United States nevertheless had problems of economy of delivery. Teacher shortages in areas of science, mathematics, and foreign language combined with state mandates to rural schools produced a climate, in the late '80s, conducive to the rapid growth of commercial courses such as those offered via satellite by the TI-IN network in Texas, and Oklahoma State University. In the United States, fewer than 10 states were promoting distance education in 1987. A year later that number had grown to two-thirds of the states and by 1989 virtually all states were involved in distance learning programmes. Perhaps the most important political document describing the state of distance education has been the report done for Congress by the Office of Technology Assessment in 1989 called Linking for Learning (Office of Technology Assessment, 1989). The report gives an overview of distance learning, the role of teachers, and reports of local, state and federal projects. It describes the state of distance education programmes throughout the United States in 1989, and highlights how technology was being used in the schools. Model state networks and telecommunication delivery systems are outlined with recommendations given for setting up local and wide area networks to link schools. Some projects, such as the Panhandle Shared Video Network and the Iowa Educational Telecommunications Network, serve as examples of operating video networks which are both efficient and cost effective.

2.1.4 The Nigerian Open University

In May 1980, the then Honorable Federal Minister of Education, Dr I. C. Madubuike, inaugurated the Presidential Planning Committee on:

"Open University System for Nigeria"

By July 22, 1983, the National Open University Act was signed into the Law Books of Nigeria. However, on April 25, 1984, while delivering a National Broadcast on the 1984/85 budget, the then Military Head of the Nigerian States, announced the suspension of the operations of the National Open University of Nigeria. Before the announcement of the suspension, the University had developed Foundation Year Courses leading to the award of Bachelors Degrees in Humanities and Sciences. The University was mandated to execute its plans by "*tuition carried out mainly by correspondence and closely supplemented by lectures, broadcasts by radio and television as well as occasional seminars, tutorials …*"

Eighteen years later, the provisions of that law merely represented a starting point for the current wider and noble government objectives of the fullfledged National Open and Distance Education Commission. The Law for the National Open University was revised to reflect current developmental needs in Nigeria. Another reason for the review of the provisions of that law is the need for the application of developments in the field of Information Communication Technology (ICT), which has completely revolutionalised the techniques and methods of production and delivery of open and distance education materials.

The Open University was to enable the nation through its open and distance education system to:

- Provide access to tertiary education through teaching and learning which is not limited by time, space, place, pace and medium.
- Provide pedagogically sound collaborative learning approaches with learning groups and learning teams.
- Guarantee learning opportunities that will replace or at least check the proliferation of the low quality, and exploitative outreach campuses of tertiary institutions.
- Encourage networking and electronically support learning environment using the infrastructure for distance education being established in Nigeria.
- Provide the basis for future automation of several activities such as computer-based grade books, notification of events, results,

tracking of individual and class activities and status, automatic routing, categorization and organization of assignments.

Because of the economies of size and distribution, both industrialized, and developing countries have embarked upon distance education programmes. In the early 1980's, record numbers of students in developing countries have gained access to higher education through distance education programmes (Rumble and Harry, 1982). In many cases, local experts are not available to develop original programmes in the language and culture of the people. For this reason, the majority of educational programmes is either used intact from the host country or is superficially translated with very few adaptations to the local culture. When this is done, the results are often unsuccessful. The cultural values of the programme designer become dominant, desirable, and used as the standard. There are many examples of programmes from North America, Australia, Great Britain, and Europe that were purchased but never used in Africa and Asia because the material was not relevant in those countries. Because the appropriate design of instructional material is a critical element in its effectiveness, the issue of "who designs what and for whom" is central to any discussion of the economic, political, and cultural dangers that face distance educators using information technologies (McIsaac, 1993). There have been a variety of efforts to identify theoretical foundations for the study of distance education. Thus far, there has been little agreement about which theoretical principles are common to the field and even less agreement on how to proceed in conducting programmatic research.

2.2 Theory

The development of new technologies has promoted an astounding growth in distance education, both in the number of students enrolling and in the number of universities adding education at a distance to their curriculum (Garrison, 1990). While the application of modern technology may glamorize distance education, literature in the field reveals a conceptually fragmented framework lacking in both theoretical foundation and programmatic research. Without a strong base in research and theory, distance education has struggled for recognition by the traditional academic community. Distance education has been described by some (Garrison, 1990; Hayes, 1990) as no more than a hodgepodge of ideas and practices taken from traditional classroom settings and imposed on learners who just happen to be separated physically from an instructor. As distance education struggles to identify appropriate theoretical frameworks, implementation issues also become important. These issues involve the learner, the instructor and the technology. Because of the very nature of distance education as learner-centered instruction, distance educators must move ahead to investigate how the learner, the instructor and the technology collaborate to generate knowledge.

Traditionally, both theoretical constructs and research studies in distance education have been considered in the context of an educational enterprise which was entirely separate from the standard, classroom-based, classical instructional model. In part to justify, and in part to explain the phenomenon, theoreticians like Holmberg, Keegan and Rumble explored the underlying assumptions of what it is that makes distance education different from traditional education. With an early vision of what it meant to be a non-traditional learner, these pioneers in distance education defined the distance learner as one who is physically separated from the teacher (Rumble, 1986) has a planned and guided learning experience (Holmberg, 1986), and participates in a two-way structured form of distance education which is distinct from the traditional form of classroom instruction (Keegan, 1988). In order to justify the importance of this non-traditional kind of education, early theoretical approaches attempted to define the important and unique attributes of distance education.

Keegan (1986) identifies three historical approaches to the development of a theory of distance education. Theories of autonomy and independence from the 1960's and 1970's, argued by Wedemeyer (1977) and Moore (1973), reflect the essential component of the independence of the learner. Otto Peter's (1971) work on a theory of industrialization in the 1960's reflects the attempt to view the field of distance education as an industrialized form of teaching and learning. The third approach integrates theories of interaction and communication formulated by BŠŠth (1982), Sewart (1987), and Daniel &

Marquis (1979). Using the post-industrial model, Keegan presents these three approaches to the study and development of the academic discipline of distance education. It is this concept of industrialized, open, non-traditional learning which, Keegan says, will change the practice of education.

Wedemeyer (1981) identifies essential elements of independent learning as greater student responsibility, widely available instruction, effective mix of media and methods, adaptation to individual differences, and a wide variety of start, stop and learn times. Holmberg (1989) calls for foundations of theory construction around the concepts of independence, learning, and teaching. "Meaningful learning, which anchors new learning matter in the cognitive structures, not rote learning, is the centre of interest. Teaching is taken to mean facilitation of learning. Individualization of teaching and learning, encouragement of critical thinking, and far-reaching student autonomy are integrated with this view of learning and teaching" (Holmberg, 1989 p.161) Holmberg summarizes his theoretical approach by stating that, "Distance education is a concept that covers the learning-teaching activities in the cognitive and/or psycho-motor and affective domains of an individual learner and a supporting organization. It is characterized by non-contiguous communication and can be carried out anywhere and at any time, which makes it attractive to adults with professional and social commitments" (Holmberg, 1989). Garrison and Shale (1987) include in their essential criteria for formulation of a distance education theory, the elements of non contiguous communication, two-way interactive communication, and the use of technology to mediate the necessary two-way communication.

2.2.1 Theoretical Constructs

Recently, a wider range of theoretical notions have provided a richer understanding of the learner at a distance. Four such concepts are transactional distance, interaction, learner control and social presence.

2.2.1.1Transactional distance

Moore's (1990) concept of "transactional distance" encompasses the distance which, he says, exists in all educational relationships. This distance is determined by the amount of dialog which occurs between the learner and the instructor, and the amount of structure which exists in the design of the course. Greater transactional distance occurs when an educational programme has more structure and less student-teacher dialogue, as might be found in some traditional distance education courses. Education offers a continuum of transactions from less distant, where there is greater interaction and less structure, to more distant where there may be less interaction and more structure. This continuum blurs the distinctions between conventional and distance programmes because of the variety of transactions which occur between teachers and learners in both settings. Thus distance is not determined by geography but by the relationship between dialog and structure.

Saba and Shearer (1994) carry the concept of transactional distance a step further by proposing a system dynamics model to examine the relationship between dialog and structure in transactional distance. In their study, Saba and Shearer concluded that as learner control and dialog increase, transactional distance decreases. It is not location which determines the effect of instruction, but the amount of transaction between learner and instructor. This concept has implications for traditional classrooms as well as distant ones. The use of integrated telecommunication systems may permit a greater variety of transactions to occur, thus improving dialogue to minimize transactional distance.

2.2.1.2 Interaction

A second theoretical construct of recent interest to distance educators, and one that has received much attention in the theoretical literature, is that of interaction. Moore (1989) discusses three types of interaction essential in distance education. Learner-instructor interaction is that component of his model that provides motivation, feedback, and dialog between the teacher and student. Learner-content interaction is the method by which students obtain intellectual information from the material. Learner-learner interaction is the exchange of information, ideas and dialog that occur between students about the course whether this happens in a structured or non-structured manner. The concept of interaction is fundamental to the effectiveness of distance education programmes as well as traditional ones. Hillman, Hills and Gunawardena

(1994) have taken the idea of interaction a step farther and added a fourth component to the model, learner-interface interaction. They note that the interaction between the learner and the technology which delivers instruction is a critical component of the model which has been missing thus far in the literature. They propose a new paradigm which includes understanding the use of the interface in all transactions. Learners who do not have the basic skills required to use a communication medium spend inordinate amounts of time learning to interact with the technology and have less time to learn the topic. For this reason, instructional designers must include learner-interface interactions which enable the learner to have successful interactions with the mediating technology.

2.2.1.3 Control

A third theoretical concept which is receiving attention in the distance education literature is that of independence and learner control. Studies which examine locus of control (Altmann and Arambasich, 1982; Rotter, 1989) concluded that students who perceive that their academic success is a result of their own personal accomplishments have an internal locus of control and are more likely to persist in their education. Students with an external locus of control feel that their success, or lack of it, is due largely to events such as luck or fate outside their control. Thus, externals are more likely to become drop-outs. Factors of control which influence drop-out rate have been of concern to distance educators as they search for criteria to predict successful course completion. Baynton (1992) developed a model to examine the concept of control as it is defined by independence, competence and support. She notes that control is more than independence. It requires striking a balance between three factors; a learner's independence (the opportunity to make choices), competence (ability and skill), and support (both human and material). Baynton's factor analysis confirms the significance of these three factors and suggests other factors which may affect the concept of control and which should be examined to accurately portray the complex interaction between teacher and learner in the distance learning setting.

2.2.1.4 Social context

Finally, the social context in which distance learning takes place is emerging as a significant area for research. Theorists are examining how the social environment affects motivation, attitudes, teaching and learning. There is a widespread notion that technology is culturally neutral, and can be easily used in a variety of settings. However media, materials and services are often inappropriately transferred without attention being paid to the social setting or to the local recipient culture (McIsaac, 1993). Technology-based learning activities are frequently used without attention to the impact on the local social environment. Computer-mediated communication attempts to reduce patterns of discrimination by providing equality of social interaction among participants who may be anonymous in terms of gender, race and physical features. However, there is evidence that the social equality factor may not extend, for example, to participants who are not good writers but who must communicate primarily in a text-based format (Gunawardena, 1993). It is particularly important to examine social factors in distance learning environments where the communication process is mediated and where social climates are created that are very different from traditional settings. Feenberg and Bellman (1990) propose a social factor model to examine computer networking environments that create specialized electronic social environments for students and collaborators working in groups.

One social factor that is particularly significant to distance educators is social presence. Social presence is the degree to which a person feels "socially present" in a mediated situation. The notion is that social presence is inherent in the medium itself, and technologies offer participants varying degrees of "social presence" (Short, Williams, & Christie, 1976). Hackman and Walker (1990), studying learners in an interactive television class, found that cues given to students such as encouraging gestures, smiles and praise were social factors that enhanced both students' satisfaction and their perceptions of learning. Constructs such as social presence, immediacy and intimacy are social factors which deserve further inquiry.

2.3 Distance Learning Technologies

Until the advent of telecommunications technologies, distance educators were hard pressed to provide for two-way real time interaction, or time-delayed interaction between students and the instructor or among peers. In the correspondence model of distance education, which emphasized learner independence, the main instructional medium was print and it was usually delivered using the postal service. Interaction between the student and the instructor usually took the form of correspondence of self-assessment exercises that the student completed and sent to the instructor for feedback. Formal group work or collaborative learning was very rare in distance education even though attempts have been made to facilitate group activities at local study centers. Also, traditionally, distance education courses were designed with a heavy emphasis on learner independence and were usually self-contained. With the development of synchronous (two-way, real time interactive technologies) such as audio teleconferencing, audio graphics conferencing and videoconferencing it is now possible to link learners and instructors who are geographically separated for real time interaction. However, the type of interaction that takes place is usually on a one-to-one basis, between one learner and another and between one learner and the instructor at one particular time. These technologies are not very suitable for promoting cooperative learning between groups of learners located at different sites. Also, the synchronous nature of these technologies may not be suitable or convenient for many distance learners.

The asynchronous (time-delayed) feature of computer-mediated communications (CMC), on the other hand, offers an advantage in that the CMC class is open 24 hours a day, seven days a week to accommodate the time schedules of distance learners. Although CMC systems may be either synchronous (real-time), or asynchronous (time-delayed), it is asynchronous CMC, because of it's time independent feature that is an important medium for facilitating cooperative group work among distance learners.

Current developments in digital communications and the convergence of telecommunications technologies exemplified by international standards such as ISDN (Integrated Services Digital Network), make available audio, video, graphic and data communication through an ordinary telephone line on a desk top workstation. Therefore, as we look at distance learning technologies today and look to the future, it is important to think in terms of integrated telecommunication systems rather than simply video versus audio, versus data systems. More and more institutions that teach at a distance are moving toward multi-media systems integrating a combination of technologies both synchronous and asynchronous that meets learner needs. Therefore, while in the 1970's and 1980's many distance education institutions throughout the world used print as a major delivery medium, by the year 2000 many institutions will probably have adopted telecommunications-based systems for the delivery of distance education. This does not necessarily mean that print will no longer be used in distance education. It is more likely that print will be used as a supplementary medium in most telecommunications-based systems, and better ways of communicating information through print will be investigated and incorporated into the design of study guides and other print-based media.

In order to describe the technologies used in distance education, "The 4-Square Map of Groupware Options" that was developed by Johansen et. al. (1991) which is based on recent research in groupware, is discussed. The 4-Square Map of Groupware Option model is premised on two basic configurations; time and place. Teams or groups of people who work together on a common goal deal with their work in the same place at the same time as in face-to-face meetings, and sometimes they must work apart in different places and at different times as in the use of asynchronous computer conferencing. They also need to handle two other variations: being in different places at the same time as in the use of telephones for an audio teleconference, and at the same place at different times as in workplaces, study centers or laboratories. Based on these configurations, the four square model classifies four types of technologies that support the group process:

1. Same Time/Same Place,
2. Different Time/Different Place
3. Same Time/Different Place
4. Same Place/Different Time.

These four categories are used for describing technologies that currently support distance teaching and learning.

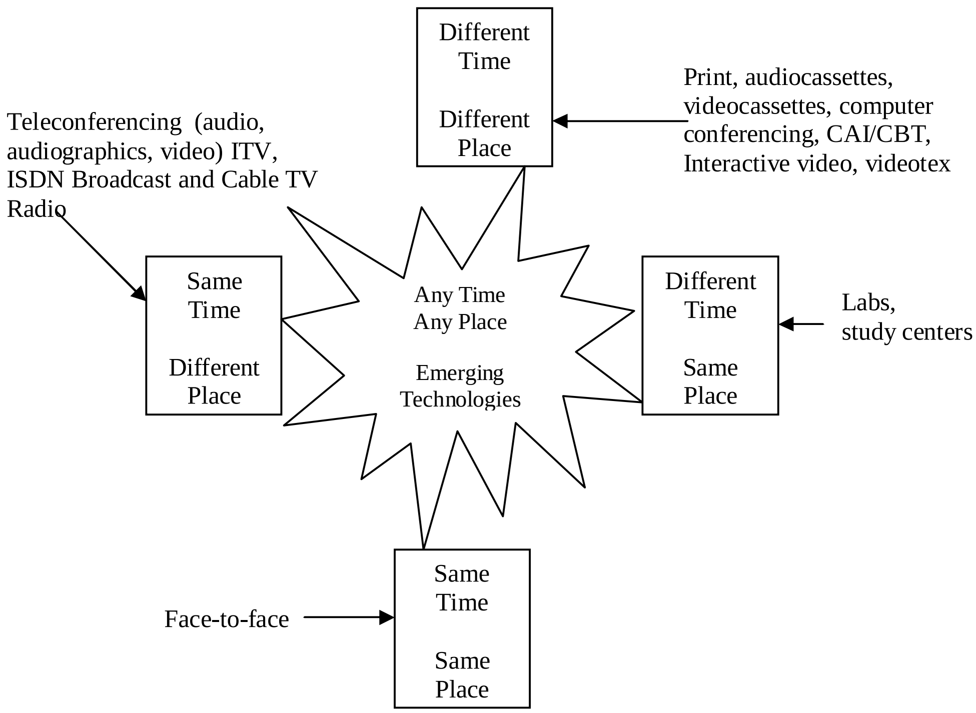

Fig. 2.1: The Four Square Map of Distance Education Technology Options (Adapted from R. Johansen, et. Al. 1991)

2.3.1 Same Time/Same Place Instruction

Same Time/Same Place group interaction is the most familiar format of face-to-face meetings. Certain objectives in distance education programmes can only be met by meeting face-to-face. The British Open University, which teaches entirely at a distance, brings students on campus during the summer to participate in laboratory experiments. When course objectives require the careful demonstration, observation, practice and feedback of life threatening procedures such as a surgical procedure, it is important to organize face-to-face meetings. In a face-to-face setting accepted practices are only modified slightly to accommodate electronic media. Basic technologies that facilitate a face-to-face meeting involve an overhead projector, a flip chart, electronic blackboard or a projection system that displays computer screens via a LCD monitor. At the more sophisticated end are desk top workstations for each group member which run on special software that helps the group to brainstorm, generate ideas, rank solutions and vote.

2.3.2 Same Time/Different Place Instruction

There are two kinds of Same Time/Different Place Instruction:

1. A meeting through a telecommunications medium or teleconferencing where participants who are separated by geographic distance can interact with each other simultaneously.
2. The use of non-interactive media such as open broadcast television and radio to instruct a vast number of students at the same time without the ability for the students to call back and interact with the originators of the Programme.

Teleconferencing can be classified into four separate categories depending on the technologies that they use: audio teleconferencing, audiographics teleconferencing, video teleconferencing and computer conferencing. There are two types of computer conferencing: synchronous computer conferencing when two or more computers are linked at the same time so that participants can interact with each other and asynchronous computer conferencing when participants interact with each other at a time and place convenient to them.

2.3.3 Different Time/Different Place Instruction

The technologies used in this category are further classified as those that transmit one-way information such as print, audio and video cassettes, and those that provide for interaction. Technologies that provide for interaction are divided into two groups: those that permit interaction between the instructor and the learner, and among groups of learners such as computer-mediated communication (CMC); and those that provide learner-machine interaction as in Computer Assisted Instruction (CAI)/Computer Based Training (CBT).

Print

Until the beginning of the 1970s and the advent of two-way telecommunications technologies, print and the mail system were the predominant delivery medium for distance education. Correspondence study relied primarily on print to mediate the communication between the instructor and the learner. Currently many distance education institutions in developing countries use print based correspondence study as the main distance education medium as the use of communications technologies is often cost-prohibitive. Garrison (1990) refers to print based correspondence study as the first generation of distance education technology. It is characterized by the mass production of educational materials and Peters (1983) describes it as an industrial form of education. The difficulty with correspondence education has been the infrequent and inefficient form of communication between the instructor and the students. Also, it was difficult to arrange for peer interaction in correspondence based distance education. The development of broadcast technologies and two-way interactive media has mitigated the limitations of correspondence study, especially in relation to facilitating two-way communication. However, print remains a very important support medium for electronically delivered distance education. Printed study guides have become a very important component of electronic distance education. In a survey of distance teaching institutions in the United States that use television as a main delivery medium, Gunawardena (1988) found that a majority of institutions cited the study guide which provides printed topic materials and guidelines for studying, the most important form of support for distance learners. A study guide can steer and facilitate the study of correspondence texts, television programmes, and other components in a distance education course. A study guide, if well-designed, can provide the integration between various media components and activate students to read and or listen to presentations of various kinds, to compare and criticize them, and to try to come to conclusions of their own. In a study guide or correspondence text, simulated conversation can be brought about by the use of a conversational tone, advance organizers, mathemagenic devices such as directions, and underlining, self-assessment and self remediation exercises.

Audiocassettes

Audiocassettes afford the learner control over the learning material because learners can stop, rewind, and fast forward the tape. They offer great flexibility in the way they can be used, either at home or while driving a car. Since audiocassettes are a fairly cost-effective medium they are easily accessible to students. Audiocassettes can be used to tape lectures or can be specially designed with clear stopping points in order to supplement print or video material. For example, audiocassettes can be used to describe diagrams and abstract concepts that students encounter in texts in order to facilitate student learning. An audiocassette can be used to record the sound portion of a television programme if a videocassette recorder is not available, and an audiocassette can provide a review of a television programme in order to assist students to analyze the video material. They can also be used to provide feedback to student assignments and is a very useful medium to check student pronunciation when teaching languages at a distance. Audiocassettes can be an excellent supplementary medium to enrich print or other media and can provide resource material to distance learners. Since they can be produced and distributed without much cost, audiocassettes are also a very cost-effective medium for use in distance education.

Videocassettes

Videocassettes are like broadcast television in that they combine moving pictures and sound but unlike broadcast television are distributed differently and viewed in different ways. An institution using videocassettes for distribution of video material to distant learners can use them as;

- a copy technology for open-broadcast, satellite, or cablecast programming;
- a supplementary medium--for instance, providing the visual component for educational material carried over audio teleconferencing networks;
- a specially designed video programme that takes advantage of the cassette medium such as its stop/review functions, so that students can be directed at the end of sequences to stop and take notes on, or discuss, what they have seen and heard.

Computer-mediated Communication (CMC)

CMC supports three types of on-line services: electronic mail (e-mail), computer conferencing, and on-line databases. In e-mail systems, a message is routed by the system to the addressee's mailbox on the host computer and remains there till it is read by the addressee. This message can be read, replied to, left in the mailbox for later perusal, and saved to the hard disk on the microcomputer, deleted, or forwarded to someone else. Most e-mail systems have a bulletin board feature which allows users to read and post messages and documents to be seen by all. However, the messages in the bulletin board system are not linked to each other and provide for only a very limited form of group communication.

Computer conferencing systems, on the other hand, provide a conferencing feature in addition to e-mail, which supports group and many-to-many communication. In these systems, messages are linked to form chains of communication and these messages are stored on the host computer till an individual logs on to read and reply to messages. Most conferencing systems offer a range of facilities for enhancing group communication and information retrieval. These include directories of users and conferences, conference management tools, search facilities, polling options, cooperative authoring, the ability to customize the system with special commands for particular groups, and access to databases (Kaye, 1989). Databases can be made available on the same host computer which is used for an e-mail or computer conferencing system, or, users can access public or private databases resident on other computers.

2.4 Future Directions and Emerging Technologies

The field of distance education is in the midst of dynamic growth and change. The directions that distance education takes will depend on such factors as the development of new media and computing technologies, different methods of group learning and information gathering, and the development of government telecommunications policies.

While the phenomenal growth of electronic networks (exemplified by recent public attention to the Internet) has provided the primary technological thrust, several other emerging technologies also promise to drastically change the landscape of education in general, and distance education in particular.

2.4.1 Electronic Networks

The past few years have produced an explosion of electronic information resources available to students, teachers, library patrons, and anyone with a computer. Millions of pages of graphics and text-based information can be accessed directly online through hundreds of public, private and commercial networks, including the biggest network of all: the Internet. The Internet is, in fact, a collection of independent academic, scientific, government and commercial networks providing electronic mail, and access to file servers with free software and millions of pages of text and graphic data that even thousands of elementary and secondary students are now using (McIsaac and Barnard, 1993).

For example, Mosaic and Netscape are two applications that have been made available on the Internet by the World Wide Web project, enables users to browse around databases and supercomputers on the Internet using a hypermedia format. The World Wide Web project is a distributed hypermedia environment that originated at CERN with the collaboration of a large international design and development team that continues to work informally on the project to bring about new innovations on the Internet. Mosaic and Netscape, World Wide Web applications, are Internet-based global hypermedia browsers that allow you to discover, retrieve, and display documents and data from all over the Internet. For example, using these interfaces, learners can search the databases in museums all over the world that are connected to the Internet by navigating in a hypermedia format. Browsing tools such as these help learners explore a huge and rapidly expanding universe of information and gives them the powerful new capabilities for interacting with information.

The ultimate goal of electronic networks is, as Christopher Dede (1991) puts it, to "widen the bandwidth of communication" between people regardless of their locations. Virtual communities of learners and educators are already sharing information resources which are growing exponentially over the Internet and will grow even faster with a more extended international information infrastructure. Global "virtual libraries" are now emerging through connections between university research libraries (Rossman, 1992). These shared online public databases form the beginning of a comprehensive worldwide knowledge resource that is becoming available to anyone with access to a network gateway.

2.4.2 Computers / Microprocessors

Personal computers are not new as technology but they are rapidly evolving into new areas. During the past decade PC's have been used in education to run tutorials and teach students to use the big three: word processing, database management, and spreadsheets. Now personal computers (and the microprocessors that provide their data handling power) are poised to explode into new areas.

PC's will provide the hub for new electronic information appliances. These will control incoming video over cable and fiber optic lines, handle both incoming and outgoing electronic mail over the Internet and the newer National Information Infrastructure, and even search globally for text, audio, graphic and video files needed by the user. Children in many schools are already piloting some of these computer-based uses by navigating the Internet to find files, downloading information from the networks and electronically copying and pasting reference material from network resources to their papers. They are also discovering the ease of communicating with their peers around the world through their computers.

As more people migrate to laptop computers the additional portability makes it possible to carry all files, papers, financial records, and any other text based materials. New software is making communication, writing, publishing and learning easier.

Further miniaturization and increased power of microprocessors will help control everything from cooking to telecommunications. As protocols are standardized so that they can work together one personal network can become seamless as processors control fax, copying, and telecommunications functions as well as environment and power utilization. Combining them with data storage devices like CD-ROM makes it possible to create more educational support for personal computers.

These new technologies can lead to more empowerment and thus more learner control of instruction for distance education students who have access to them. New telecommunications avenues such as satellite telephone service could open channels at reasonable cost to even the remotest areas of the world. One very encouraging sign from the Internet's rapidly developing history is not only the willingness, but the eagerness with which net workers share information and areas of expertise. Networks have the potential of providing a broad knowledge base to citizens around the world, and will offer opportunities for expanded applications of distance education. Research is just beginning to indicate how these newer technologies can benefit learners.

Finally, distance education ought to be regarded as education at a distance. All of what constitutes the process of education when teacher and student are able to meet face-to-face also constitutes the process of education when teacher and student are physically separated.

CHAPTER THREE

3.1 SYSTEM MODELS

In a distance education system, it is essential to have an effective electronic means for managing, delivering, processing and presenting educational materials. This system is built on learning model based on curriculum sequencing approach. The learning material is presented in a dynamic web page suitable to the learner. The system evaluates/monitors the trends of the learning activities of the learner to show both the study and overall performances.

Let c_{ik} be courses to be learned by the learners where i = 1, 2, 3, 4, 5 (learner's year of study) and k = 1, 2, .., n (k is the course number registered for). For easy learning and representation each course syllabus is split into topics (t_l) which in turn are split into subtoptics (s_{lm}) where necessary with l, m = 1, 2, 3, …. But in case c_{ik} is a final year project, c_{ik} are split into chapters rather than topics. (Adewale, 2007)

Furthermore, let l_q represents the various learners of the c_{ik}, q = 1, 2, 3, …; y_{wz} represents the l_q's learning performance with j, w, z = 1, 2, 3, …; and w_d represents y_{wz}'s percentage contributions to the overall learning process such that $\sum_{d=1}^{n} w_d = 100\%$ where y_{11} represents learning/study performance; y_{21} represents review performance; y_{wz} represents assessment where w = 3, 4, ….

Therefore, let

$$learning = F(c_{ik}, l_q, y_{wz}, w_d) \tag{3.1}$$

The structure of c_{ik} is as shown in (Fig. 3.1).

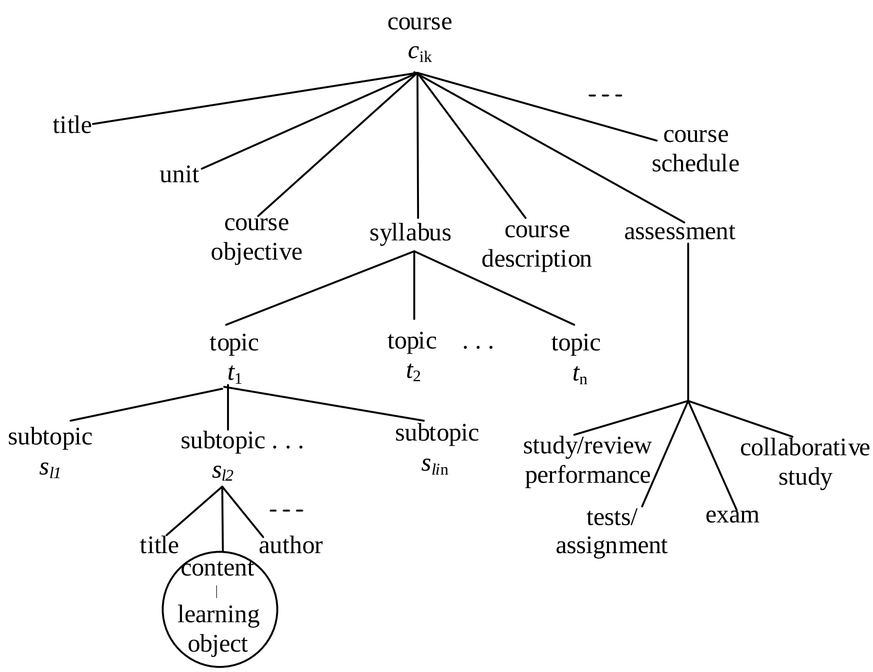

Fig. 3.1 – Course tree structure (Adewale, 2007)

Learning objects are often used as components to assemble larger learning modules or complete courses, depending on different educational needs. The assembly of these learning objects is also known as *content packaging* and provides a standardised way (metadata standards) of exchanging digital learning resources between different learning systems. Packaging of learning objects of low granularity (for example, a web page) into larger granularity objects (such as a chapter/topic), using learning objects to construct subtopics, topics of modules, and eventually curriculum, is analogous to the approach in (Fig. 3.2).

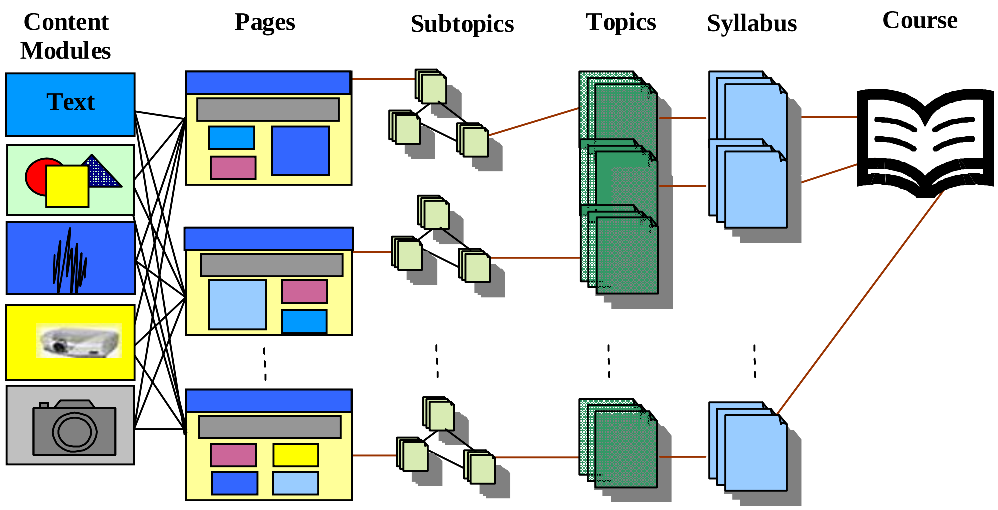

Fig. 3.2 – From learning objects to complete curriculum

As shown in Fig. 3.2, the learning objects support the principle that multiple representations of the content can be presented. Furthermore, learning objects can be used to represent structured, semi- or ill-structured domains and, therefore, such approaches would support a flexible instructional method for students with individual differences. Since learning objects are normally decontextualised chunks of information, they can be easily reused and applied in different learning contexts such that they support activities centered on the construction of knowledge and not merely the transfer of knowledge.

Each t_l or s_{lm} is presented to learner using a web page for easy learning. It is assumed that one or more t_l or s_{lm} shall be covered within a lecture schedule.

In order to measure the overall performance of the learner l_q on course c_{ik} during and at the end of a particular semester various parameters such as study performance (y_{1z}), review performance (y_{2z}) and assessments (assignments (y_{3z}), tests (y_{4z}), final examination (y_{5z}), collaborative study (y_{6z})) are employed. Each t_l or s_{lm} is associated with a minimum time p_{lm} in which learner l_q of various categories ought to have properly learn t_l or s_{lm}. p_{lm} has an optimal value of 1 and as learner l_q moves away from this optimal point, his score decreases at the rate shown in Fig. 3.3.

Hence, study performance is obtained as follows;

$$y_{11} = \frac{1}{m} \sum_{l=1}^{m} p_{lm}(s_{lm}) \tag{3.2}$$

$$y_{21} = \frac{1}{m} \sum_{l=1}^{m} r_{lm}(s_{lm}) \tag{3.3}$$

where

$$p_{lm} = \begin{cases} 1.00 \;\; for \;\; 45\,\text{min} \le p_{lm} \le 60\,\text{min} \\ 0.75 \;\; for \;\; 35\,\text{min} \le p_{lm} \le 44\,\text{min} \\ 0.50 \;\; for \;\; 25\,\text{min} \le p_{lm} \le 34\,\text{min} \\ 0.25 \;\; for \;\; 20\,\text{min} \le p_{lm} \le 24\,\text{min} \\ 0.00 \;\; for \;\; p_{lm} < 20\,\text{min} \end{cases} ; \quad r_{lm} = \begin{cases} 0.100 \;\; for \;\; 45\,\text{min} \le r_{lm} \le 60\,\text{min} \\ 0.075 \;\; for \;\; 35\,\text{min} \le r_{lm} \le 44\,\text{min} \\ 0.050 \;\; for \;\; 25\,\text{min} \le r_{lm} \le 34\,\text{min} \\ 0.025 \;\; for \;\; 20\,\text{min} \le r_{lm} \le 24\,\text{min} \\ 0.010 \;\; for \;\; r_{lm} < 20\,\text{min} \end{cases} \tag{3.4}$$

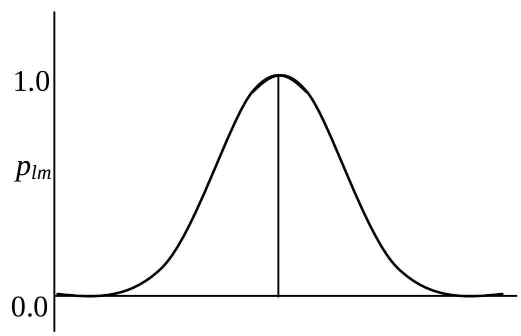

Figure 3.3 – How studied values are updated based on the time spent reading it

Learners would be subjected to various assessments ass_w both in tests, assignments and final exam, which cover all the concepts learned in the course c_{ik}. The assessment gives the direct information about the students' knowledge. This shows how much knowledge the student has acquired and if indeed getting on well with the learning styles. The lecturer is liable to subject students to as many assessments as possible.

$$ass_w = \sum_{w=3}^{n} M(y_{wz}) \tag{3.5}$$

where M is a function that returns the score associated with y_{wz}.

Furthermore, collaborative tools have been used in educational contexts for supporting communication and collaboration among students, discussions about topics, cooperative problem resolution, knowledge sharing and collaborative knowledge construction. A proper use of these tools reduces student isolation in web-based courses and facilitates the development of personal and social skills. Collaborative learning-work occurs in the context of a group with a common mission or agreed-upon-purpose. The work involves the structuring and restructuring of conceptual knowledge. The final product is a message, an external representation or "artifact" of the group knowledge at a particular point in time, which communicates the knowledge of the group. The goal of collaborative learning work is the creation of a mutual knowledge structure which is derived from group consensus. For example, a work group engaging in the process of design would ideally need to pool their individual knowledge in order to create a new product. They will eventually want to create a shared meaning, which would allow them to take action together to carry out the design.

Hence, students/learners l_q who registered for the course c_{ik} are automatically formed into small groups (g_{ij}) of four students/learners per group for collaborative studies. Let tot_i be the total number of students/learners that registered for the course c_{ik}, then

$$rem = tot_i \bmod 4;\ gp = tot_i - rem$$

For $gp \geq j * 4$; $j = 1, 2, 3, \ldots$ obtain

$$g_{ij} = \left\{ l_m ; m = r(r+3)1 \right\}; i = 1(4)1; k = j, j+3, j+6, \ldots; r = k \qquad (3.6)$$

While $rem == 0$; no additional group g_{ij} can be formed; otherwise if $rem == 1$; the remaining student l_q will be added to the previous group g_{ij} to make a group of five students; otherwise a new group g_{ij+1} with 2 or 3 students is formed.

Learners with different skills and backgrounds should also collaborate in tasks and discussions in order to arrive at a shared understanding of the truth in a specific topic. Most social constructivist models, such as that proposed by Duffy and Jonassen (1992), also stress the need for collaboration among learners, in direct contradiction to traditional competitive approaches.

Each l_q's collaborative study performance y_{6z} in the group g_{ij} is obtained as follows

$$y_{6z} = M\left(g_{ij}\left(c_{ik}, l_q, \ problem, z_i \right)\right) \qquad (3.7)$$

where z_i are the critical attributes of a collaborative group (interdependence, synthesis of information and independence respectively), M is a function that return the collaborative score by the student/learner l_q according to his contribution in the group g_{ij}.

Therefore, combining all these parameters, equation (3.8) is obtained as the l_q's overall performance on course c_{ik} at the end of a semester.

$$\text{overall performance} = 0\% \leq \sum_{d=1}^{n} w_d \sum_{w=1}^{n} y_{wz} \leq 100\% \qquad (3.8)$$

3.2 Course Material Organization and Delivery

In a Distance Education System, it is essential to have an effective electronic means for managing, delivering, processing, and presenting educational materials. Achieving these goals requires an approach that is not only extensible into the future but also adaptable to incorporate new technologies and requirements. To ensure broad adoption, the technology selected needs to be widely and freely available as an open standard.

In this project, an innovative approach based on active HTML (Hypertext Markup Language) documents for organizing and delivering course materials was adopted. Courses materials are decomposed into small components, corresponding to topics, around the subjects to be learned. Topics are ``smart'' HTML documents, namely HTML documents that carry not only contents but also code. Subtopics can be dynamically assembled to cover course topics according to individual student's progress. By using standards for accessing HTML documents with style information, topics can be cataloged, searched, exchanged, and viewed.

This approach is enabled by the four complementary and powerful technologies: HTML, PHP Scripting Language and web browser and the

DBMS (MySQL). Each component adds unique tools that leverage the other pieces.

(a) HTML provides the foundation. HTML brings with it all the rich capabilities and transport layers of the Web and the Internet in general. Representing the course materials as HTML documents makes searching, archiving, reading, and navigating the documents simple.

(b) PHP Scripts provide codes that serve as the glue that holds the whole interactive learning process together. The codes are referenced or travel along inside the HTML as a special section, and can be easily read and interpreted. The browsers supporting HTML allow for the topics to be viewed exactly the way the user wants it.

(c) The web browser interprets the PHP codes to perform the task needed and may interact with the user to create a new code for each new specific task, or look up and attach the right code for an existing job. Topic agents on the Web browser can obtain updated information and instructions from the server agent and can also provide feedback to the server agent for statistical analysis and data mining.

(d) The DBMS provides the storage for topics, student models, and other components involved in the learning process. New topics can be dynamically added to the repositories with little interruption to the ongoing learning activities. The repositories also allow for indexing, automatic lookup, and sharing of topics among different learning systems.

topics contain both the HTML documents and the instructions (codes) on how the documents should be processed or displayed. The internal elements of topics and the framework for intelligent delivery of courses on the Internet are shown in Figure 3.4.

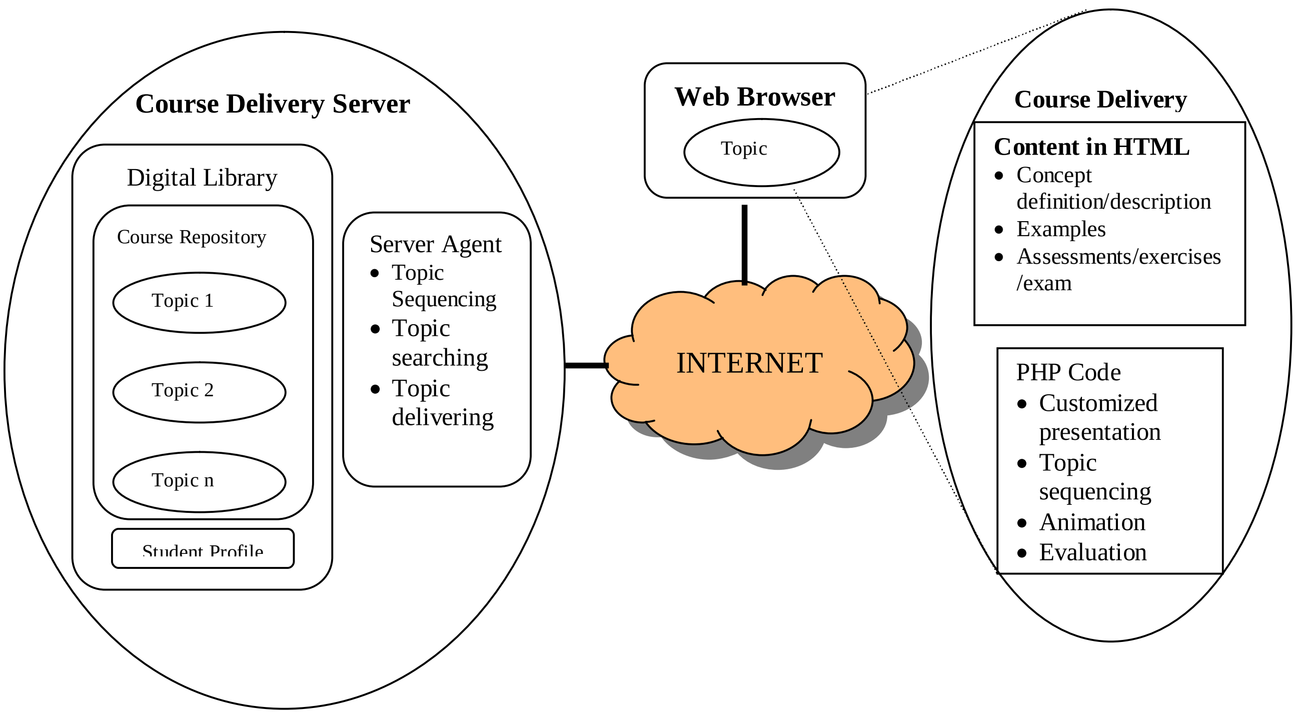

Figure 3.4: The framework for the delivery of Course materials

The system is able to use the many search tools that are being adapted for HTML. The course delivery framework will allow for the search of educational materials in various ways. In addition to the keyword-based search, the objects in HTML documents allow for more intelligent searches such as content-based search.

The system provides an interactive learning environment that combines the visual presentation of course information, class notes, and executable components of learning materials. In learning a subject, the topic agent is essentially a teaching agent. The topic agent obtains the system model from the course server and updates the model by observing the student's learning process. The topic agent contains a system model, a simple subject-unit sequencing module and an assessment component. A topic on a subject usually contains a collection of basic subtopics. The assessment component records the usage of the learning system, the performance of students on the exercises and quizzes. The assessment data will be uploaded to the server when the current session is finished. A course is composed of a collection of topics. The server agent on the course server manages topics/subtopics and their relationships. It configures the topics into a coherent course sequence based on the course objective and the target audience. It collects student performance data from learning system.

CHAPTER FOUR

SYSTEM DESIGN AND IMPLEMENTATION

4.1 System Design

Due to large flexibility of information delivery over the internet, the system is designed as a standard internet application. The client side simply requires the standard internet browser installed on the local computer while the main application functionality is assured by the server side.

The system is built around a *three-tier architecture* model shown in Fig. 4.1. At the base of the application is the *database tier*, consisting of the database management system that manages the database containing the data which users create, delete, modify, and query and MySQL is used to provide the required functionality. Built on top of the database tier is the complex *middle tier*, which contains most of the application logic and communicates data between the other tiers. The web server is apache and it is running under Microsoft Windows XP operating system which is used to achieve a secure client-server communication. The scripting engine uses server-side PHP functions to communicate with the database. PHP scripts are used to co-ordinate all the procedures in the system. PHP handles data which are passed from the html forms in the way that structured query language formed are sent to the database and then the results of the queries are processed and passed back in an html document format. On top is the *client tier*, usually the web browser software that interacts with the application.

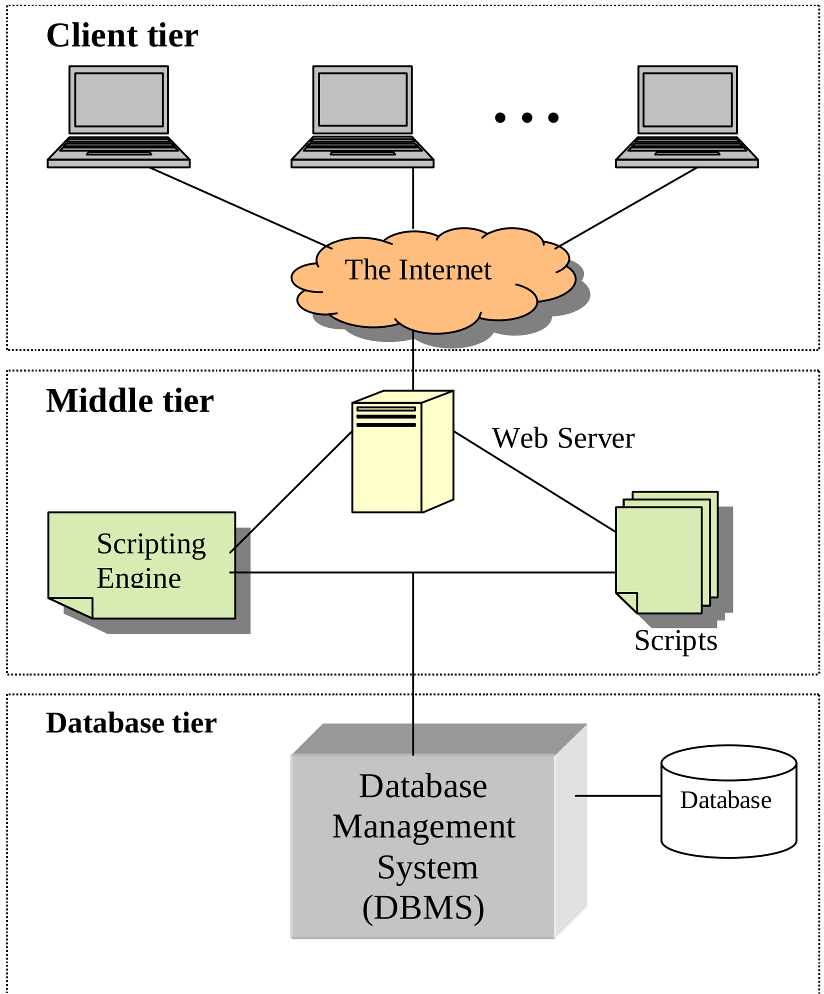

Fig. 4.1: Distance Education three-tier architecture model.

The home page of the Distance Education System is shown in Fig. 4.2. This consists of six main modules namely: About, Services, E-learning, How to …, Theses/Final Year and Administration modules.

Fig 4.2: The Home Page of the Distance Education System

4.2 The Architecture for Distance Education System

The distance education learning system architecture (Fig 4.3) presents the main components which perform the functions of learning materials to meet individual student/learner's learning requirements.

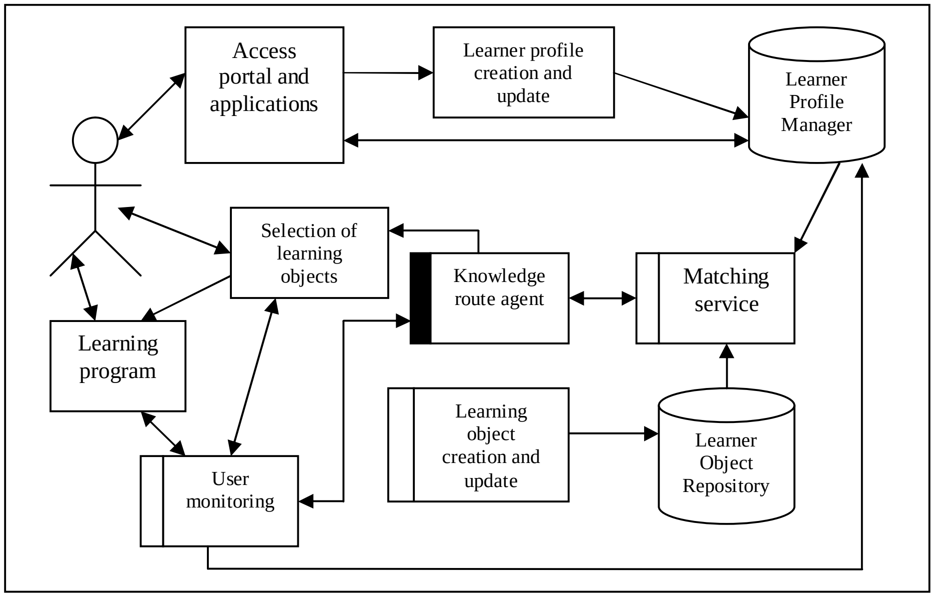

Fig. 4.3: Architecture of Distance Education Learning System

Both access portal and application, selection of learning objects and learning program perform the functions that allow learners to interact with the system by giving or obtaining information through their use. The learning system builds a learner's profile based on prior-knowledge.

After proper authentication via access portal and application, the learner's level of prior knowledge of the course is obtained by his/her answers to a test. The result of this test will indicate the type of learner and his level of prior-knowledge of the course. This information constitutes the basis of each learner's profile which is stored in learner profile manager database, and will be used subsequently by the matching service to provide materials for each learner.

The matching service retrieves a specific learner's profile form learner profile manager database and carries out a mapping procedure. The results of this process will determine a selection of learning objects from the learning object repository and their sequencing for the learning package. The knowledge route agent basically is a piece of software which receives the matching outcome from matching service and manages the current knowledge path of the learner. This architecture provides the software environment for learners to interact with their learning process and materials that allow them to engage learning with their learning experiences.

4.3 Learning Performance Measurement

The main interaction that learners have with the system course C_{ik} is through reading and listening to the course material. Therefore, there is a need to develop a way to judge how much comprehension the learner has gained. The system also determines if a student reads and understands the material that is displayed.

Each course syllabus has been split into topics which in turn have been divided into various subtopics. Subtopic(s) are/is scheduled to be covered on weekly basis throughout a semester. Since the policy is to display at most one subtopic per page, possibly using multiple pages to teach a full subtopic, there is the need to judge how well all pages for a subtopic have been studied.

The two factors in determining how well a subtopic has been studied are the use of audio and the time spent studying the material. In general, if a page's associated audio is played, the student will gain more information than if just the text is read. However, there is still no indication that the student has understood the information presented either in the audio or in text.

If the audio for the page has not been played, then we need another way of judging how well the material has been studied. One way of doing this is to consider the time spent on each page. Spending too little time or too much time, reading through a page implies that full comprehension has not been reached. The method used for rating the amount of time spent is to have an optimal time per page that a learner should spend. This is calculated based on the content actually displayed. The studied rating on each topic ranges from 0 to 1. If the learner spends this optimal amount, then the rating for the page is 1. As he moves away from this point, his score decreases, at the rate shown in Fig. 3.3.

To compute a study rating for a topic, the scores for each of the pages in that topic is summed up and then divided by the number of pages needed to fully explain the topic and this score is obtained using equation (3.2).

The review score on a topic records how many times the student has returned to visit the topic again. If he is reviewing frequently, then he is not retaining information sufficiently, and thus he has not learned the material. The review score records how many times the student has reviewed, as well as how much of the material he views each time. This score is computed using equation (3.3). Using equation (3.8), overall learner's performance in the c_{ik} by the learner l_q is obtained at the end of the semester and this value is store in the class score register.

Finally, the overall performance of the learner l_q on course c_{ik} is measured by equations (3.1) – (3.8).

4.4 Collaborative study

The concept of collaborative learning-work was first presented in the 1980s by Charles Findley as part of his research on future trends and directions. Collaborative learning refers to processes, methodologies and environments in which professionals engage in a common task, in which individuals depend on and are accountable to each other. Many facets of learning dialogue are augmented or conducted exclusively in a virtual, computer-supported mediated environment.

Collaborative learning occurs in the context of a group with a common mission or agreed-upon-purpose. This involves the structuring and restructuring of conceptual knowledge. The final product is a message, an external representation or "artifacts" of the group knowledge at a particular point in time, which communicates the knowledge of the group. The message might take the form of a software program, a report, a strategy document, a diagram, a drawing, and the like. Learning involves the cognitive processes of assimilation (intake of information from the environment, accommodation), restructuring to fit new into the old, present structure, and integration (directly fitting information into existing structure). And most importantly it involves the resolution of conflict between old and new knowledge structures, which can lead to innovation.

The goal of collaborative learning is the creation of a mutual knowledge structure which is derived from group consensus. For example, a collaborative group engaged in the process of design would ideally need to pool their individual knowledge in order to create a new product. They will eventually want to create a shared meaning, which would allow them to take action together to carry out the design.

4.5 Collaborative Study Performance

Most web servers automatically record logs of their activities, and, in turn, many web-based discussion board programs automatically track usage statistics for those who sign on (Ingram, 1999-2000). The analysis of these logs is the usual way in which online participation is evaluated (Mason, 1992). Among the relevant data are the dates and times that the participants logged on and off, the order in which the messages are posted, and the threads in which the messages are placed. Individual student participation can be evaluated by determining the number and length of accesses and messages. These data can be used to analyse the threads of the messages, which may reveal the structure of the conversation. This step does form the basis for a more detailed content analysis of the written comments. In addition, analysing the thread of messages as entered by the students and generated by the logs may be inaccurate and actually misleading. Students do not necessarily place messages and responses in the correct sequence. That is, a message that responds to the ideas in a previous message may be placed in a completely different thread, leaving the readers to make the connections on their own.

Content analysis is an accepted method of studying text documents in communication (Silverman, 1993). It involves identifying categories and counting the number of items in the text that appear in the categories. The categories adopted in this subsection focus on the collaboration process. They were selected from the prior literature and were made uniform and consistent (Silverman, 1993). A summary of the three characteristics of collaboration and the categories used to evaluate these are shown in Table 4.1.

Table 4.1 – Characteristics of collaboration

Characteristics of collaboration	Categories Used to Evaluate Characteristics
Interdependence	Participation and Interaction
Synthesis	Interaction and Final Project
Independence	Participation and Interaction

Rourke et al. (2001) discussed the methodological issues in using content analysis for computer-mediated communication. A key step is to find or develop a protocol or coding scheme designed to examine the variables of interest. Researchers interested in collaboration must use a scheme specific to that construct. Three potential drawbacks of many current coding schemes have been identified. The first point may appear self-evident but is often overlooked. That is, a coding scheme may not be designed to measure collaboration but some other construct. For example, Qing (2001/2002), measured interactivity, not collaboration among young school children. Other research in computer-mediated communication has analysed very specific aspects of the discussion, such as problem-solving techniques among engineering students, and the perception and satisfaction of the participants in the process (Jonassen and Kwon, 2001).

The second issue is that the measurement model may be based on questionnaires that measure perceived degree of communication or interactivity (Gallini and Barron, 2001-2002). This method allows for quick and easy data collection; however, it does not measure the discussion directly. It only measures opinions and attitudes to the quality of the discussion and the outcomes. Using less subjective categories avoids the self-presentation biases that occur with coding schemes that rely on self-report measures, as in Jonassen and Kwon (2001).

The third aspect of current models that limits their usefulness is that they may be based on face-to-face collaboration rather than on online collaboration. Models that compare face-to-face and computer-mediated communication (Bennett and Dunne, 1991; Jonassen and Kwon, 2001; Hawkes and Romiszowski, 2001) have shortcomings in analysing collaboration in computer-mediated communication, because the coding schemes were created for face-to-face collaboration. Thus online collaboration is measured in terms of the qualities of face-to-face interaction it possesses or lacks, and not as a distinct process in its own right.

Bennett and Dunne (1991) developed a model to study face-to-face interaction in groups. The categories they proposed for direct discussion of a topic applied to face-to-face collaborative learning and were not entirely appropriate for computer-mediated communication. Models for face-to-face interaction emphasize the social and nonverbal aspects of communication and its interpretation. For example, face-to-face conversation is often in fragments with incomplete sentences and with one idea being completed by different people (Wild and Braid, 1997). This rarely occurs in asynchronous computer-mediated communication. Models of interaction that are used to code face-to-face situations place a heavy emphasis on the coding of social or off-task behaviour into a number of categories. As it happens, this is unnecessary in asynchronous computer-mediated communication because such behaviour forms an insignificant percentage of the interactions. Computer-mediated communication may eliminate or change some of the social aspect of interaction and all of the non-verbal communication. The lack of nonverbal communication makes coding such conversations less vulnerable to the vagaries of interpretation. Verbal social communication can be coded separately outside the issue of collaboration (Polhemus and Swan, 2002).

A model for studying collaborative learning in a computer-mediated communication environment was proposed by (Henri, 1992), but this model was of limited use to the e-learning system because she emphasised measuring learning, rather than collaboration. She did identify the importance of the social aspect of computer-mediated communication but did not clearly distinguish between statements that formed part of the on-task social or management discussion and the off-task social discussion. This model distinguished between explicit and implicit interaction. In this model explicit interaction is in the form of either a direct response or a direct comment, in which the participant referred to a question or comment by mentioning it, and implicit interaction is in the form of either an indirect response or an indirect comment, in which the question or comment was not specifically mentioned. Because threaded discussion software usually allows students to place responses to messages where they think appropriate, such transitional phrases as “in response to message…” are largely meaningless. There is an implied direct response by message placement.

Equation (3.6) and equation (3.7) are adopted for the asynchronous computer-mediated communication in the e-learning system because all the communications between members of the group are in text form. The analysis of text is more objective than the analysis of face-to-face communication where facial expressions and other forms of nonverbal communication are open, interpret the same expressions differently. Measuring computer-mediated communication comments depends less on the researcher’s understanding of the context and is, therefore, more straightforward.

Table 4.2 and Table 4.3 show a detailed schematic of the categories used in the e-learning system. They are adapted from (Bennett and Dunne, 1991; Henri, 1992; Mason, 1992; Ingram and Hathorn, 2004). Each statement is coded three times to measure the three characteristics of collaboration: participation, interaction and patterns of discussion.

Table 4.2 – Categories reflecting characteristics of collaboration

Categories	*Detail of Categories*			
Participation	Individual	Number of statements	Number of messages	To Instructor
	Group			
Interaction	Off task	Negative and positive comments unrelated to the discussion, e.g introduction		
	On task	Social and management of the group	Comments about the discussion that promote or inhibit it. Procedural tasks and technology problems and advice.	
		Direct discussion of the scenario	Comments further coded into patterns of discussion	

Table 4.3: Patterns of discussion

Independent Statements	Independent statement		
Interaction	Length of the thread		
	To whom		To educator
			To student
	Connections to previous messages	Direct response	Simple agreement, repeating a statement or answering a direct question
		Direct comment	Adding information or comments to the interaction
		Indirect comment	New idea or comment added to the interaction but connection to prior interaction is not clear.
	Quality of interaction	Simple agreement	Repeating information, simple agreement or disagreement.
		Adding information	Adding to the statement, disagreeing or adding new information
		Synthesis of information	Synthesising the information. Creating a new idea.

All discussion on the threaded web discussion on a particular problem are transcribed and coded. Messages are arranged chronologically by date and time and then each message divided into statements. A statement is a complete sentence or a complete idea within a sentence. Complex sentences can contain more than one statement. It is important to divide messages into statements, because, in computer-mediated communication discussion, one message can reply to one or many messages, as well as discuss various other topics that may or may not be related. The goal of the coding is to identify all of the ideas discussed as well as the true structure of the discussion threads. Next, statements are coded according to the three specific characteristics that determine collaboration.

Interdependence requires that each member actively contribute to the group discussion. At a superficial level, it requires simple participation by each member. Measuring participation is important in the analysis of both interdependence and independence. Participation forms the skeleton that supports interaction. It is being measured by counting the number of messages and statements made by individuals to the other participants and the instructor within a group. Individuals within groups can be compared in their levels of participation. Table 4.4 (Ingram and Hathorn, 2004) shows the analysis of participation in a particular group.

Table 4.4: Message and statement

<table>
<tr><td rowspan="2">Participants</td><td colspan="4">Number of messages</td><td colspan="5">Number of statements</td></tr>
<tr><td>To Ins</td><td colspan="2">To individuals in group</td><td>Total</td><td>To Ins</td><td colspan="2">To individuals in group</td><td>To entire group</td><td>Total</td></tr>
<tr><td rowspan="2">l_4</td><td rowspan="2">0</td><td colspan="2">1</td><td rowspan="2">15</td><td rowspan="2">16</td><td colspan="2">11</td><td rowspan="2">123</td><td rowspan="2">134</td></tr>
<tr><td>1</td><td>0</td><td>11</td><td>0</td></tr>
<tr><td rowspan="2">l_5</td><td rowspan="2">0</td><td colspan="2">2</td><td rowspan="2">5</td><td rowspan="2">7</td><td colspan="2">13</td><td rowspan="2">145</td><td rowspan="2">158</td></tr>
<tr><td>2</td><td>0</td><td>13</td><td>0</td></tr>
<tr><td rowspan="2">l_6</td><td rowspan="2">0</td><td colspan="2">2</td><td rowspan="2">5</td><td rowspan="2">7</td><td colspan="2">14</td><td rowspan="2">90</td><td rowspan="2">106</td></tr>
<tr><td>0</td><td>2</td><td>0</td><td>14</td></tr>
<tr><td>Total</td><td>0</td><td colspan="2">5</td><td>25</td><td>30</td><td colspan="2">38</td><td>358</td><td>398</td></tr>
<tr><td>Mean</td><td>0</td><td colspan="2">1.67</td><td>8</td><td>10</td><td colspan="2">12.33</td><td>119.33</td><td>132.33</td></tr>
<tr><td>Instructor (Ins)</td><td></td><td colspan="2">0</td><td>1</td><td>1</td><td colspan="2">0</td><td>8</td><td>8</td></tr>
<tr><td>Total with Instructor</td><td>0</td><td colspan="2">5</td><td>25</td><td>31</td><td colspan="2">38</td><td>366</td><td>406</td></tr>
</table>

Once participation has been established, next is to dig deeper to see whether the learners are genuinely interacting. How much the individuals contributed to solving the problem is indicated by the interaction in the group on the content of the problem. To a lesser extent, interdependence is also indicated by positive and negative comments about the scenario, and by off-task comments that create the social context in which the group interacts.

The analysis of interaction forms the foundation of all the characteristics of collaboration. Statements are classified first into the broad categories of off-task or on-task behaviour. Off-task statements may include community building statements that are important in creating an environment that supports collaboration, such as introductions, references to status or experience or similar statements.

On-task statements are divided into the categories of social and group management and direct discussion of the scenario. Group management statements include discussion about the problem and do not contribute directly to solving the problem. They do, however, set the environment for the discussion. Management may also include allocating tasks and deciding on the procedure for the discussion. Social aspects include community building comments that refer to the problem, such as positive supportive statements, complaints about the task or negative comments that inhibit the discussion. The management aspect of discussion about the scenario includes allocating tasks and deciding on the procedure for the discussion. Comments that are classified as direct discussion of the scenario include all those statements that contribute directly to the actual topic of the discussion. These statements may be further coded into patterns of discussion.

Once the statements have been categorised into functional groups, they are coded to determine the patterns of interaction that occur in the discussion. Standalone comments are independent statements. They do not lead to further discussion, and they neither respond to a comment nor generate a response. A large number of independent statements might characterise a cooperative group but not a collaborative group. Collaboration requires more than just the exchange of information that occurs in a series of independent statements. Independent statements may contribute to the task, since they enable others to add information and learn from the group, but they are not true interaction and thus are not part of the collaborative effort.

Interaction requires at least a comment and a response to the comment, thus it is partly determined by the length of the dialogue. The response must refer to a previous statement, either implicitly or explicitly. In order for the interaction to be collaborative, there needs to be a third step to this process, so that there is a comment on the content, a response and a final answer that is a synthesis of all the responses (Kaye, 1992). The pattern of a thread is depicted by the number of responses and who made them. Discussion that involves the instructor is coded separately, to help assess independence.

Comments or answers to questions that require little insight are direct responses. Participants may agree with statements without giving reasons; they may repeat other's ideas by rewording their statements or they may answer a direct question. Direct comments occur when participants attempt to take the interaction further. These comments add new information or insights to the interaction and are based on the prior discussion. Indirect comments are comments that are on topic, but the connection to prior interaction on the subject is not clear.

Synthesis requires that new information be created. There are two ways in which this can be measured. The first is by the interaction pattern of the discussion that occurs when a student within a group contributes a statement, another student then extends the idea and a subsequent message synthesizes the information. Thus, a synthesizing thread in a discussion requires at least three messages from a minimum of two group members. To evaluate this, one has to look closely at the individual threads in a discussion. The assessment of synthesis is carried out by examining the relationship between the original comments and the final product. Does the final product take into consideration the contributions of the individual group members; does it consist primarily of the work of one student or can individual work within the group product be identified?

4.6 Implementation

The developed system is implemented using PHP so that the system can run on heterogeneous platforms. It consists of interface module, personal module, teaching module and course module.

The system was also developed to work in hardware environment consisting of high-performance workstations and storage devices connected via high-bandwidth, low-latency networks. The modules run concurrently on the servers and workstations in the distributed environment with operating system level support for software modules. The courses and student profile database are stored in MySQL. The multimedia courseware is in the form of HTML documents and organized as a flexible, extensible, and scalable digital library. The Web-based interface acts as a bridge between the student and System. This interface interacts with the HTTP Web server for adaptive delivery of electronic courses over the WWW, assignment submissions, and student learning assessment.

The implementation consists of the server side and the client side connected through the Internet. The server side consists of the intelligent modules, the student profiles, and the topics that can be sent dynamically to the client and can be dynamically updated. The server agent is responsible for delivering these topics to the client and handling all kinds of requests from the client. The learning is responsible for teaching the topics.

The presentation of the topics is quite simple. The HTML file is placed on the Web server. According to the student's request, the Web server responds appropriately. The response is generally a method invocation on the PHP scripts.

There are a number of aspects that are essential to build a reliable learning system. They include security on the client side to prevent the student from printing off the test/quiz and others, effective topic search techniques, effective student modeling to model student performance, and a dynamic question set for each quiz/exam every time it is retaken by the student. In addition, we need to do more research to further increase the intelligence of the learning system.

4.7 Challenges

Due to (i) the fact that demand for higher education grossly outstrips the provision of places, (ii) the huge numbers of drop-outs from schools of those who are yet to receive formal education and require a second chance, and (iii) the prohibitive cost in attendant to educating everyone through the face-to-face classroom-bound mode of education, it has become necessary for government to seek a cost-effective alternative.

To finance the nation's total demand for the education sector with a view to providing education for all is colossal and would over-stretch all the available resources. Indeed, no country has yet been able to meet the demand for education for all through the formal classroom bound system of education. As has been done in most developed and developing countries of the world, the education sector must explore cost-effective means to deliver education to all our people. The answer, from the abundance of experience of many countries including the United Kingdom, Australia, Canada, South Africa, India, Tanzania and Zimbabwe, lies in open and distance education.

The challenge, however, is building intellectual infrastructures for distance education. These include techniques for using electronic information in teaching and learning. A digital library for publishing, retrieving and managing research, teaching and learning material in multiple undergraduate courses and disciplines is in itself a compelling goal. When coupled with procedures for supporting individual lecturers to build and archive their own multimedia research, teaching and learning materials and the presentation of the already stored materials, it promises to be valuable natural resources for undergraduate education. Huge investments are being made to offer internet-based courses as part of asynchronous digital library initiatives, however, it is not yet clear how an internet-based course that has been offered will be archived along with the students' related materials such as assessments, projects and the like for future use. Tools for building and accessing courses must be easy to use. The file structure employed by a lecturer must reflect the lecturer’s personal model for the organisation of the course material. The ease of use of any library archiving or retrieval tools will depend, in large part, on the degree to which they support or are compatible with the lecturer’s existing personal model. Tools should not require lecturers to significantly rearrange their preferred delivery organisation. Therefore, an automated aid should be provided for capturing lecturer’s data structure, organisation of the study materials, as well as tools for searching and retrieval based upon terms familiar to lecturers such as lectures notes, assessments, syllabus, and the like, as well as the preservation of the content. The automated aid will consist of a broad variety of tools that permit lecturers to construct digital library repositories of courses and tools by which students could use these virtual digital libraries in creative ways to increase the effectiveness of teaching and learning in undergraduate education. It is important to stress that building and archiving of these materials will also be beneficial to the lecturers offering these courses in the future by having templates of the courses.

Teachers must learn how to create learning objects and teach with multimedia resources and to share informational with students. Designing activities that take advantage of digital library resources requires time and effort to examine what is available and integrate information into modules and sequences appropriate to the students and curriculum. Furthermore, modelling the research process for students requires teachers to grapple with problems on-the-fly, make mistakes, recover, react to dead ends, and demonstrate all the other uncomfortable and frustrating aspects of problem solving.

Just as teachers must learn new strategies for using electronic tools in teaching, students must learn how to learn with multimedia (both actively and passively) and how to take increased responsibility for directing their own learning. For instance, in the observations of students in classrooms where Perseus was used, students expressed concerns about taking notes because a screen of text, a screen of vases, and the instructor's verbal comments were concurrently available, they did not know what to write down. Although better technological tools such as networked laptop computers may solve the technical problem, the issues of what to attend to and how multiple streams of information should be integrated require new combinations of perceptual, cognitive, and physical skills for learning, that is, building intellectual infrastructures requires intellectual, emotional, and social breakthroughs for teaching and learning.

At the centre of physical and intellectual infrastructure is the interface to the digital library. Tools for finding, managing, using, and publishing electronic information must be both powerful and easy to use. Digital libraries must provide a mix of software and people to provide reference assistance and question answering services. The staff in the digital library will go beyond reference assistance to serve as teachers on demand. These humans must be aided by software that shunt “typical” questions toward pathfinders or frequently-asked-question services. Thus, digital libraries will extend what has been the most beneficial feature of electronic networks to teaching and learning settings. Good interfaces will allow learners to take advantage of digital resources equally well in classrooms, homes, and offices.

CHAPTER FIVE

CONCLUSION, RECOMMENDATION AND FUTURE RESEARCH

5.1 Conclusion

The web-based Distance Education System was designed with the aim of eliminating some of the difficulties encountered during the study period of the beneficiaries of distance education.

Effort was made by the designer of the system to make the assessments of the learners easier for the users of the system. The issue of interaction among students/learners was also addressed with the use of some collaborative study performance evaluation techniques.

In order to make e-learning content portable across different hardware and software systems, a new way of developing e-learning content was used. This new approach assumes that e-learning content can be organized and disseminated in a uniform format as small chunks of learning materials commonly referred to as learning objects. It seems that developing and delivering learning content as objects will promote reusability, interoperability and content sharing between different training vendors and educational institutions. When combined, the learning objects, due to their reusability in different learning scenarios may form educational resources that can be used in different environments by different individuals.

Furthermore, each learning object was organized such that, it has a description that enables learners to search for and find the right objects for the right topic.

Security of data is also ensured by the use of passwords and usernames which must be applied to the system by any user before access is gained. The access level also ensures protection of data from corruption and illegal or unauthorized use.

5.2 Recommendations

In developing or adapting distance instruction, the core content remains basically unchanged, although its presentation requires new strategies and additional preparation time. Suggestions for planning and organizing a distance delivered course include:

- Hands-on training with the technology of delivery is critical for both teacher and students. A pre-class session in which the class meets informally using the delivery technology and learns about the roles and responsibilities of technical support staff should be considered.

- Government or the organizers of the Distance Education System should make sure each site is properly equipped with functional and accessible equipment. A toll-free "hotline" for reporting and rectifying problems should also be provided.
- Government should make cyber cafes available at each local government areas to facilitate the use of the Distance Education System.

Meeting Student Needs

To function effectively, students must quickly become comfortable with the nature of teaching and learning at a distance. Efforts should be made to adapt the delivery system to best motivate and meet the needs of the students, in terms of both content and preferred learning styles. The following strategies for meeting students' needs can be considered:

- Students can be assisted in becoming both familiar and comfortable with the delivery technology and prepare them to resolve the technical problems that will arise.
- Learn about students' backgrounds and experiences. Discussing the instructor's background and interests is equally important. This can be a future research area.
- Be sensitive to different communication styles and varied cultural backgrounds. For example, students may have different language skills, and humor is culturally specific and won't be perceived the same way by all.

- Be aware that student participants will have different learning styles. Some will learn easily in group settings, while others will excel when working independently.

Improving Interaction and Feedback

Using effective interaction and feedback strategies will enable the instructor to identify and meet individual student needs while providing a forum for suggesting course improvements. To improve interaction and feedback, the following can be considered:

- The use of pre-class study questions and advance organizers to encourage critical thinking and informed participation on the part of all learners.
- Early in the course, students can be required to contact instructors and interact among themselves via electronic mail, so they become comfortable with the process. Maintaining and sharing electronic journal entries can be very effective toward this end.
- Telephone office hours using a toll-free number can be arranged. Evening office hours can be set since most of the students may be workers during the day.
- A variety of delivery systems for interaction and feedback, including one-on-one and conference calls, fax, E-mail, video, and computer conferencing can be integrated.

5.3 Future Research

Finally, in the next years, a full scale implementation and adaptation of web-based university digital libraries for automating library services such as cataloguing, circulation, acquisition and for providing tools that enable graduate students to build, archive and distribute theses and dissertations in a creative way should be carried out. The idea is to gather as much of the intellectual contents of the academic and research community and the internet as possible in an easy-to-search online collection. It is important to point out that traditional libraries will exist side by side the University Digital Library at least for the foreseeable future. Therefore, what we will have are hybrid libraries, a combination of traditional and digital libraries. Such hybrid libraries will be extremely useful in developing countries like Nigeria, where the objective should be to build digital libraries in niche areas to complement the traditional library services. In addition, the development of a full scale university digital libraries adaptive, personalised e-learning system should be embarked upon.

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