

**DESIGN OF A LEARNING MANAGEMENT SYSTEM WITH LEARNING AIDS
SUITABLE FOR VISION IMPAIRED UNIVERSITY STUDENTS**

BY

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DECLARATION

I certify that this Dissertation does not incorporate without acknowledgement any material previously submitted for the Degree or Diploma in any University, and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text

Date:

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The undersigned, have supervised the dissertation entitled **DESIGN OF A LEARNING MANAGEMENT SYSTEM WITH LEARNING AIDS SUITABLE FOR VISION IMPAIRED UNIVERSITY STUDENTS** presented by U.S.U.K.Rodrigo, a candidate for the degree of Masters in Information Systems Management, and hereby certify that, in my opinion, it is worthy of submission for examination.

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TITLE

Design of a Learning Management System with Learning Aids Suitable for Vision Impaired
University Students

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ABSTRACT

Every individual, irrespective of race, gender, nationality, ethnic or social origin, religion or political preference, age or disability has an equal right for education. Vision impaired students are no exception. In this Information Age, use of computers as assistive technology in education has become vital. Even though this is true for the developed world, In the Sri Lankan context most of the vision impaired students are not in a position to use Information Technology for their educational purposes due to many reasons.

This study focuses mainly on the process of developing a Learning Management System (LMS) for vision impaired university students in order to enhance their quality of education. This study focuses on How a Learning Management System with Digital Accessible Information System (DAISY) technology, Sinhala Digital Talking Books and a Sinhala Text to Speech Converter can be developed to facilitate the teaching and learning problems of vision impaired university students. Finally developing a Framework that can be used as a guide to develop such advanced LMSs for vision impaired university students is presented.

The main objective of this study is to develop a framework to guide the designing of Learning Management Systems for Vision impaired students. First the researcher designed a model based on 3 stages, Firstly the objectives of a Learning Management System, secondly qualitative characteristics of the Learning Management System for vision impaired students and components of the Learning Management System for vision impaired students. Based on these 3 stages the researcher identified 32 characteristics and grouped these into 3 categories (System Design, Content Design and Service Design). The overall success of

Learning Management Systems initiatives depends on the attainment of success at each of these stages of Learning Management Systems development. This research study attempts, what is trying to be done is to underline the importance of each aspect of a Learning Management System which directly effects the overall success and learner's satisfaction. The developed Framework can be used as a guide in developing such advanced LMSs for vision impaired university students.

Key words: Learning Management System, Digital Talking Books, DAISY

Abbreviations

ADA	Americans with Disabilities Act
CAST	Center for Applied Special Technology
COM	Component Object Modeling
CSS	Cascading Style Sheets
DAISY	Digital Accessible Information System
DTB's	Digital Talking Books
GUI	Graphical User Interface
HCI	Human-Computer Interface
HTML	Hypertext Markup Language
ICT	Information and Communication Technology
ISO	International Standards Organization
IT	Information Technology
LMS	Learning Management System
NCX	Navigation Control Center
SAPI	Sound Application Programming Interface
SGML	Standard Generalized Markup Language
SMIL	Synchronized Multimedia Integration Language
TTS	Text to Speech
URL	Uniform Resource Locator
W3C	World Wide Web Consortium
WAI	Web Accessibility Initiative
WWW	World Wide Web
XML	Extensible Markup Language

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1. CHAPTER ONE – INTRODUCTION

This chapter explains the background of the study, the statement of the problem, the research questions, objectives of the study, scope and assumption of the study, limitation of the study, terminology and the organization of the study.

1.1. Background of Study

The right to receive education is a fundamental human right. Every individual, irrespective of race, gender, nationality, ethnic or social origin, religion or political preference, age or disability, is entitled to receive education in this world. Irrespective of the degree of disability, every vision impaired child has the right to receive education. Equity and equality of education can be brought about only if a quality learning environment is assured to vision impaired students (Waddell, J.D. 1999).

A good education must empower its students with knowledge, skills and attitudes to overcome the challenges of the Information Age in which we live. Vision impaired students are not an exception. Rather than providing the much needed information technology to vision impaired students, Sri Lanka just as any other developing country, provides them with only a basic education.

In the developed world, computers are used by vision impaired persons to carry out various activities not confining it to mere word processing activities. In these countries, the computers are used to enable a person with vision impairment to be independent in his educational, vocational, recreational and day-to-day activities, irrespective of his profession.

By the use of computers to listen to talking books, vision impaired persons will have the opportunity to acquire basic computer skills moreover with the help of screen readers, they will also be encouraged to gain proficiency in other computer applications. Such proficiency, with the availability of resources, will enhance their capacity to function on equal terms with their colleagues in both studies and employment. So the time has come for vision impaired students in Sri Lanka to use computers as an assistive technology.

The vision impaired communities of Sri Lanka are mainly Braille readers. Braille has been the primary medium of information and instruction since the commencement of education for the blind in Sri Lanka. This was introduced during the British rule in the country, in the form of a residential system, at the School for the Deaf and Blind, Ratmalana, which was established in 1912 as a missionary school by Mary F. Chapman.

Even though Braille is, and will continue to be, an essential medium of taking down notes and communication, it is not a very efficient medium of information. Braille documents are bulky, expensive and time consuming to produce, and is usable only by those who are Braille literate. The number of people who are print disabled far exceeds the Braille users. Hence, a method had to be devised to make information available even to these persons.

Owing to these limitations of the Braille System, Long-playing Vinyl disks, reel tapes and cassette tapes have been used as substitutes for Braille. But all these media have their own disadvantages. They have a tendency to deteriorate over time and with the constant use. The sound quality also deteriorates with sometime. The greatest drawback of these instruments is that the lack of navigability. Many users of cassette and vinyl talking books would have had the frustrating experience of attempting to locate a particular spot on a cassette with repeated forwards and backwards cuing.

In order to overcome the limitations of the Braille system and analog information media, producers of talking books have turned towards digital technology. It did not take them much time to realize that digital technology was the answer to the problems of producing and disseminating information in Braille and analog formats. Digital technology provided the opportunity to make available information in a layout that is relatively inexpensive, compact, durable, easily navigable and rich in sound quality.

The need for a more compact, durable and easily navigable medium began to be felt, and interest in digital talking books (DTB's) produced according to the DAISY (Digital Accessible Information System) standard has been aroused in recent times with the establishment of DAISY Lanka Foundation in 2004. With advanced technologies like digital talking books and screen readers, the opportunities available to visually impaired persons could be increased dramatically.

There are 30 vision impaired undergraduates at the University of Sri Jayewardenepura in the Faculty of Arts. These students find it difficult to take down notes, refer recommended text

books and use Learning Management Systems (LMS) as their fellow students. The only option available for them is to get the other students to read to them the recommended books and get the main points brailed. Even when the lesson materials are uploaded to the Learning Management System, they are not able to read it as the other students, as it is usually uploaded as Word or Excel documents. Therefore, it is clear that though both groups study the same course, a gap has been created between the two groups as there is no equity with regard to the availability and use of study guides and learning materials.

In this context, this research attempts to bridge this gap between the vision impaired students and the other students of the Faculty of Arts by developing a system of learning that would address the needs of the vision impaired students and Develop a Framework that can be used as a guide in developing such advanced Learning Management Systems for vision impaired university students. This new system is expected to be introduced with the aid of DAISY, Sinhala Digital Talking Books (DTBs), Sinhala Text to Speech Convertor (TTS) and LMS technologies. Having explained the background of the study the research problem and the objectives of the study will be discussed in the subsequent sections.

1.2. Statement of the Problem

How a Learning Management System with Sinhala Digital Talking Books and a Sinhala Text to Speech Convertor can be developed to facilitate the teaching and learning problems of vision impaired university students.

1.3. Objectives of the Study

1.3.1 Main objective

The main objective of this study is to develop a framework to guide the designing of Learning Management System for Vision impaired students. In order to achieve this objective several specific objectives have been formulated. There are indicated in section 1.3.2

1.3.2 Specific objectives

Under the main objective of the study, the following specific objectives have been identified.

- To examine the requirements and the existing learning facilities of vision impaired university students.
- To identify the components of an advanced LMS for vision impaired university students.
- To develop a Framework that can be used as a guide in developing such advanced Learning Management System for vision impaired university students.
- To develop a prototype Learning Management System (LMS) in line with the requirements of these students.
- To carry out a test run of this LMS and obtain feedback.

1.4. Scope and Assumptions

1.4.1 Scope

This study has been carried out based on the learning requirements identified based on a survey carried out with the vision impaired students of University of Sri Jayewardenepura. It is assumed in the study that these requirements represent the requirements of all vision impaired university students in Sri Lanka. Further, this research mainly focuses on the development of Sinhala Digital Talking Books and Sinhala Text to Speech Converter for vision impaired university students. As explained above, this study consists of two sections. The first section is to design and develop Sinhala Digital Talking Books and introduce Sinhala Text to Speech Converter for the learning system of these students. This system consists of a collection of learning materials such as digital talking books and lesson voice clips etc. Finally a framework will be developed for use as a guide for developing teaching learning system for vision impaired university students.

1.4.2 Assumptions

- It is assumed that vision impaired university students are in a position to use computers with the required assistive technologies and facilities such as screen readers, internet.
- Since the study is carried out considering a sample of 25 vision impaired university students, it is assumed that findings can be generalized to all the vision impaired university students in the country.

1.5. Limitations and Delimitations

1.5.1 Limitations

- 222 Vision impaired university students have passed out from the Sri Lankan Universities. At present there are 70 students following degree courses in Sri Lankan universities. This survey based on 25 students of one university will not give an overall picture of the entire university student population.

- Obtaining copyrights is difficult from the book's authors. High cost Have to be paid in order to obtain copyrights from relevant text books authors.

1.6. Terminology

1.6.1 Digital Accessible Information System (DAISY)

DAISY stands for Digital Accessible Information System. DAISY books are fully accessible digital talking books. Common features of books, such as sections, pages, footnotes, sidebars, and bookmarks are represented in such a way that it allows users to navigate quickly using them.

1.6.3 Digital Talking Books (DTB's)

A Digital Talking Book (DTB) is a collection of recorded electronic files to reading of a book, designed for use by the vision impaired community. Accordance with Digital Accessible Information System (DAISY) standard, When Digital Talking Books are creating, users able to obtained wide range of features such as rapid, flexible navigation, bookmarking and highlighting, keyword searching, spelling of words on demand, and user control over the presentation of selected items (e.g., footnotes, page numbers, etc.). Such features enable readers with visual and physical disabilities to access the information in Digital Talking Books flexibly and efficiently, and allow users with sight but with learning or reading disabilities to receive the information.

1.6.4 Text-to-Speech (TTS)

Text-to-speech refers to the conversion of written words to a voice output .Speech synthesis is the artificial production of human speech. A computer system used for this purpose is called a speech synthesizer, and can be implemented in software or hardware. A text-to-speech (TTS) system converts normal language text into speech. Screen readers can serve a variety of functions besides assisting people who are vision impaired. They can allow auditory learners to access educational material in the way that is most helpful to them.

1.6.7 Screen Reader

A screen reading software attempts to identify the visual display and provides voice output. Most of screen reading software may be stand alone or may be in combined with other assistive technology such as screen magnifiers. Typically, a screen reader, sometimes called a speech output system, works with a speech synthesizer. A speech synthesizer 'speaks' the text sent to it from the screen reading program installed in the computer. The speech synthesizer is usually a software program that works with a sound card. Screen reading software can benefit both persons with learning disabilities as well as those who are blind or severely vision impaired.

1.6.8 Text Browsers

To avoid problems of using the mouse and hypermedia, most visually impaired persons use text based Web browsers that will ignore graphics on web pages and allows the use of the keyboard to activate hyperlinks. However, since many web designers only test their designs on popular browsers such as Netscape and Microsoft's Internet Explorer, they often use features that are not supported by text browsers; blind users often have problems accessing such web sites. Text browsers cannot completely solve the problems of Internet surfing for the blind.

1.7. Organization of Study

The next chapter describes the comprehensive bibliographic literature survey carried out in order to investigate the existing research carried out in the related domains. In the third chapter, the activities carried out, and tools used, methodologies and techniques followed in order to fulfill the overall study objectives are discussed. Chapter four presents explains the way in which the Learning Management System was designed and developed for Vision impaired students. It describe also how to develop a framework to guide in developing a prototype, and recommending software and framework that can be used as a guide in developing such advanced LMSs for vision impaired students.. The final chapter concludes with a summary of findings and recommendations for future research.

2. CHAPTER TWO - LITERATURE REVIEW

2.1. Introduction

The Literature Survey aimed to analyze the research carried out in related domains in order to conceptualize a solution to match the requirement of the vision impaired students. The following areas in relation to the development of a LMS for vision impaired university students have been surveyed:

2.2. The Digital Accessible Information System (DAISY)

According to (Jackson-Sanborn *et al.*, 2001) The Digital Accessible Information System (DAISY) is an international approach to reading materials. That is recognized worldwide as an ultimate approach to making high performance information technology available to vision impaired persons. DAISY standard offer a rich reading experience that may include synchronized audio and structured text along with images for vision impaired persons. DAISY is a multimedia standard that enables content creators to use technology to its greatest advantage. It supports to read traditional presentation of images and text, but it goes beyond this flat approach to include human narration, powerful navigation, and the potential for adding video and animation. Most important feature is ability to navigate, from other stand along systems vision impaired person unable to get this feature.

2.3. Learning Management Systems (LMSs)

An LMS can be defined as a web based application used by institutions and companies that want to get involved in e-learning, either for providing services to third parties or for educating and training their own people (Avgeriou et al., 2003).

The web is evolving into the main delivery mode for a Learning Management System to offer services such as student enrolment, coursework notice boards, lesson materials, assignment submission and online discussion board etc. From Learning Management System, service providers are able to providing the facilities to include text, documents, and files of many types, including MS-Office, audio, video, and images, grade books and assessments methods as well. The facility of inserting hyperlinks, providing discussion boards and forming chat rooms are also available.

Commercial and open sources Learning Management System are existence at present. WebCT, Blackboard, IBM LearningSpace, Moodle, Atutor, etc. Offering integrated services such as the uploading and distribution of on line lesson material, the communication between stakeholders, and the management and between students and teacher of the instruction process etc., thus providing the basic software platform for supporting web-based learning in an easy to use and education flexible manner. (Georgiakakis et al., 2001)

Learning Management System have been used by universities, institutions and instructional designers in order to fulfil certain needs and requirements for effective, fast and pedagogically correct education and training (Georgiakakis et al., 2001)

According to the (Grimes E. B. 2002), there are several advantages and disadvantages of Learning Management Systems.

The advantages his found included, easy formatting and updating of material and customization to individual needs, multiple platform capabilities (PC or Mac), access to material from multiple locations, controllable access only to students enrolled in the course, ability to link to and browse other websites, incorporation of multimedia material, provision at a relatively low cost, reduction in linear teaching format, and promotion of high levels of interactivity between student and instructor.

Disadvantages have been described as restrictions due to bandwidth; slow connection speeds when using sound, graphics, and video files; time required for course development and required Internet access.

(Grimes E. B. 2002) has found out several advantages and disadvantages of Learning Management Systems on student perspective.

A significant advantage perceived by students was access. This access was related to both removal of geographical barriers and continuous access to course materials at times convenient for the student. With Learning Management Systems, students were not restricted to class attendance at times or places set by the institution, thereby allowing them to meet both employment and family commitments while attending to their educational

responsibilities. Coinciding with this increased access was a reduction in travel costs. The next positive attribute of online learning was an increase in computer literacy. In addition, students were excited to have access to global resources through the Internet and found learning through the Internet a stimulating methodology. Further, students greatly appreciated the interactivity with other students and the instructor associated with a well-designed online course. Comprehensive discussions, group activities, and immediate instructor or computer based feedback were also highly valued by students and were viewed as a positive attribute of web based learning.

Disadvantages are technological frustrations, Cost, lack of face to face contact with the instructor and other classmates, a feeling of isolation and disconnection.

In this research one of major components is developing prototype Learning Management System. Therefore the knowledge regarding Learning Management Systems is very important, to develop successful Learning Management Systems. Mean time Characteristics of Learning Management Systems, advantages, disadvantages, methods and usability of Learning Management Systems considered when prototype is designing. Cost can be reduced by using open source software.

2.4.Student Engagement and the Learning Environment

Distance education through web delivery is usually delivered by enterprise wide Learning Management System which have become essential part of university teaching and learning

environments (Rankine et al., 2009). In this study the researcher expecting to deliver lesson materials as Distance Learning using web delivery.

Learning management systems are software systems that produce the functionality of computer mediated communications software and web based methods of delivering course activities and lesson materials (Jennings, 2005).

Learning Management Systems are at the platform of the online technologies making a serious impression on patterns of learning and teaching in higher education (Coates, 2006).

Learning Management System, also commonly referred to as Course Management Systems (CMS) and Virtual Learning Environments (VLE), are becoming necessity at universities. At present even the most traditional academic institutions are also converting to Virtual Learning Environments (Coates et al., 2005). This Course Management Systems (CMS) and Virtual Learning Environments (VLE) are very useful for when developing new learning environment for vision impaired university students.

In a comparatively short time Learning Management System have become perhaps the most commonly used educational tool in higher education, only ranking behind the Internet and common office applications (West, W. 2006) and (Graham, 2006).

Learning Management System being used for presenting online or technology improved lessons and Learning Management System influencing to instructors to creating courses, lesson materials in several ways (Lane, 2009). If LMS are affecting pedagogy, then they are likely to be affecting student study habits, learning and engagement (Coates et al., 2005).

2.5. Traditional Classroom Teaching

Habitual classroom teaching method is teaching and learning only flows in a linear fashion. Traditional teaching methods such as the talk and chalk technique, and classroom lecture, might only allow limited amount of information to flow from lecturers to students depending on the amount of knowledge acquired by lecturers. (Grasha, 1997). Obtaining limited amount of information unable to obtained good education. Nowadays most universities are following knowledge seeking learning method to achieve quality of education. The traditional classroom also provides limited space for learning, within the classroom. Students cannot explore their knowledge. Students can only interact with their course mates and the lecturer who teaches them. Difficult to get benefit of other learning aids by this system. This space can only be expanded if the students themselves take the initiative to interact with people outside the learning boundary (Ishak et al., 2002).

2.6. Blended Learning

This study is based on vision impaired students of university of Sri Jayewardenepura. Up to now they are not using Learning Management System for their studies. In this context how to introduce new learning system and blended learning are very important factors of this study.

A blend is an incorporated strategy for delivering lectures and performance of the students, such as providing lesson materials, participation in an online class, communicating with colleagues, online examinations, reference to a manual, participation in online communities

etc. (Rosset et al., 2003). When introducing blended learning, one of the key issues for converting an existing traditional face to face course to one based on technology is choosing the kind of blend to be used. But with this learning system, learners can avoid limitations of traditional teaching learning system; specially obtaining more information, quality of education can be improved.

The term blended learning is used to describe a learning format that combines several different delivery methods and also to describe learning that mixes various event based activities, such as face to face classrooms, live e learning and self paced learning. Options for blended learning go beyond the classroom. They can be formal and informal, technology- and people based, independent and hospitable, and instruction and finding oriented. They involve a planned combination of approaches, such as online assignment submission, coaching by a supervisor, participation in online classes, face to face tutoring, visiting websites, consulting manuals, attending seminars, workshops, and online communities.

The starting point for the design of a blended learning conversion of an existing higher education program is the set of desired learning outcomes and the breakdown of the key learning points to be covered. Since most of higher education learning systems are heavily classroom based and contain large amounts of information that must be transferred to students. Even Sri Lankan universities are using Traditional classroom method to delivering lectures. This type of learning systems can often be improved using delivery methods supported by a Learning Management System, but information delivery does not have to be

the only reason to use blended learning. Improving the quality of the learning experience, increasing the availability and accessibility of learning materials, supporting collaborative activities and strengthening the feeling of belonging to a community are also important driving forces (Rosset et al., 2003).

2.7. Vision Impaired Persons Education in Sri Lanka.

This research study is mainly focus on vision impaired students. DAISY Lanka Foundation's point of view still in Sri Lankan vision impaired person working with Braille. Braille has been the primary medium of information and instruction since the commencement of education for the blind persons in Sri Lanka. Even though Braille is, and will continue to be, an essential medium of note taking and communication on a personal basis, it is not a very efficient information medium. Braille documents are bulky, expensive and time consuming to produce, and is usable only by those who are Braille literate.

The need for a more compact, durable and easily navigable medium began to be felt, and interest in Digital Talking Books (DTB's) produced according to the DAISY (Digital Accessible Information System) standard has been aroused in recent times with the establishment of DAISY Lanka Foundation in 2004. With advanced technologies like Digital Talking Books and screen readers, the opportunities available visually impaired persons could be dramatically increased.

2.8. DAISY Standards

According to the DAISY Consortium, the DAISY standard was originally developed to benefit people who are unable to read print due to a disability, but the design requirements are intended to serve all readers including the mainstream population. All known character sets are supported through the implementation of International Standards Organization (ISO) character encodings.

2.9. Open, Non-Proprietary Standards

According to the DAISY Consortium web site, The DAISY Consortium set out to use existing standards wherever possible. There are close relationship with the World Wide Web Consortium (W3C), the standards setting body for the Internet. As a result, the DAISY standards are applications of XHTML, XML, and Synchronized Multimedia Integration Language (SMIL), which is what provides DAISY's multimedia support. When researcher is developing Sinhala Digital Talking Books followed DAISY standards.

As an association DAISY Consortium has recommended Open, non proprietary standards that have a verified track record for accessibility. As well as the DAISY standards are completely open nonproprietary and have no royalty associated with the implementation

2.10. Internet Surfing for the vision impaired people

According to the Alfred Loo, Assistant Professor, at Lingnan University, Hong Kong Ming-te Lu, Chair Professor, at Lingnan University, Hong Kong, Chris Bloor, University of Sunderland, Sunderland, UK, on their Research Internet surfing for the blind: a prototype, there are discussing,

Access right of vision impaired people has been ignored, because web pages are designing for the normal people. As a result, many vision impaired people are not enjoying the benefits of the Internet and the improvement in the quality of life and education that Internet use can bring. They were developed Human Computer Interface (HCI) system for vision impaired people. From this system vision impaired people can browse the World Wide Web through Internet.

The main aim of this research is how a Learning Management System with Sinhala Digital Talking Books and a Sinhala Text to Speech Convertor can be developed to facilitate the teaching and learning problems of vision impaired university students. The researcher expecting to fill the gap between visions impaired students and other students.

In Sri Lanka, senses of population has not been carried out after 2008, therefore accurate population on disable cannot be distinguish. Because of 30 years war it should be

considerable amount. According to the Americans with Disabilities Act's web site, in United States it is estimated that there are 54 million people in the United States with a disability.

The Congress of United States enacted the Americans with Disabilities Act (ADA) in 1990 and passed amendments in subsequent years that “prohibit discrimination on the basis of disability in employment, programs and services provided by state and local governments, goods and services provided by private companies, and in commercial facilities”. The accessibility problem has grown significantly because more business and government agencies are relying on the internet to disperse information and services

Web sites and pages are also covered under the ADA. The US Access Board also issues standards for electronic and information technology covered by section 508 of the Rehabilitation Act Amendments of 1998. But many visually impaired people still have access problems with most Web sites. The reason is most web page designers, design web pages based on normal people. According to the information obtained from the Sri Lankan Council of Visually Handicapped Graduates Organization, there are 250 vision impaired graduates passed out from Sri Lankan Universities. At present there are 60 students following degree courses in the Sri Lankan universities. But any university does not use accessible Learning Management System for vision impaired students.

2.11. Developing Framework

The main objective of this study is to develop a framework to guide the designing of a Learning Management System for Vision impaired students. The knowledge obtained by reading research articles was used to develop main framework for the study.

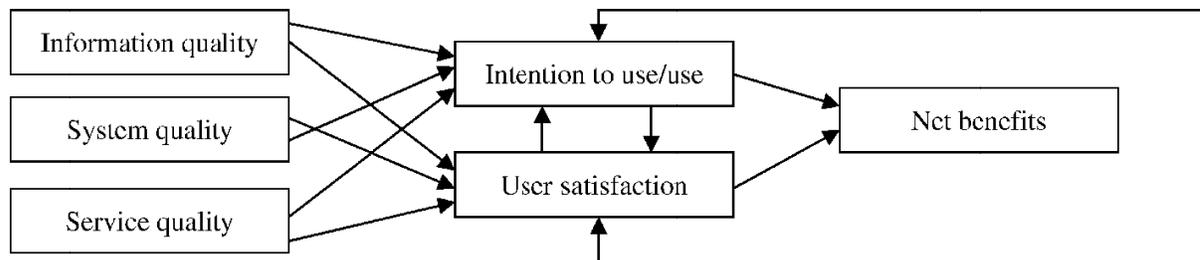
(Liaw et al., 2007), identified three constraints when designing effective e-learning environments. In the learning environments, have to be provided: learner characteristics, instructional structure, and interaction. First they studied about exiting environment before developing e-learning system. And they have identified learner characteristics of target group, such as attitudes, motivation, belief, and confidence. Users have more opportunities for self-directed learning in e learning environments.

According to the (Sevgi et al., 2009) in their research have introduced model for evaluating Learning Management System. That model is Hexagonal e-learning assessment model (HELAM). This is conceptual evaluation model for assessing learner satisfaction with both internet based Learning Management System and blended learning. HELAM has been developed for assessing the e-learning success and effectiveness. This model is based on user satisfaction. Six dimensions of HELAM model are as follows.

1. Technical issues: system quality
2. Technical issues: service quality
3. Technical issues: content quality
4. Social issues: learner perspective
5. Social issues: instructor attitudes
6. Supporting issues

46 criteria are grouped into above 6 categories in HELAM model.

Another important model presented by (DeLone, W.H. 2003) and (McLean, E.R. 2003). (DeLone W.H. 2003) and (McLean, E.R. 2003) developed IS Success model (Figure 2-1). This is extension of their original model (DeLone, W.H. 1992) and (McLean, E.R. 1992). They have identified six dimensions of e learning success factors: system quality, information quality, use, user satisfaction, individual impact, and organizational impact. These were incorporated into their original overall success model shown in Figure 2-2



Source: DeLone and McLean (2003)

Figure 2-2: DeLone and McLean's IS success model

The researcher went through, the Hexagonal e-learning assessment model (HELAM) and IS Success Model) presented by (Sevgi et al., 2009) and (DeLone, W.H. 2003) and (McLean, E.R. 2003), when developing framework to guide the designing of Learning Management System for Vision impaired students.

2.12. Conclusion

The right of vision impaired people to access the internet is simply ignored in many countries as web pages have been designed for normal people. As a result, many blind people are not enjoying the benefits of the Internet and there is no improvement in the quality of life on account of the use of internet. For vision impaired persons to surf the Internet, it is necessary to develop a accessible Learning Management System for vision impaired people.

By reviewing the research on Learning Management System and DAISY technology, the researcher obtained knowledge; information and techniques that could be applied when developing LMS for vision impaired students.

Visually impaired persons and the blind can derive great benefits from DAISY Software. In Sri Lanka DAISY Technology and digital talking books for vision impaired students still have not been properly implemented in. The gap between normal student and vision impaired students can be minimized, if DAISY technology is properly implemented in for vision impaired students

The framework developed by the researcher, to be used as a guide in developing advanced Learning Management System for vision impaired university students based on two specific models, the Hexagonal e-learning assessment model (HELAM) and IS Success Model) presented by (Sevgi et al., 2009) and (DeLone, W.H. 2003) and (McLean, E.R. 2003).

3. CHAPTER THREE – METHODOLOGY

3.1. Introduction

This chapter contains descriptions of activities carried out, tools used and techniques followed in order to fulfil the overall study objectives. To achieve the main objective, the approach was mainly based on case study method. The statistical method was adopted to examine the requirements and the existing learning facilities of vision impaired university students.

3.2. Conceptual Framework of the Study

The Conceptual Framework of the study illustrated in Figure 3-1 consists of five stages. First stage is assessing existing teaching learning facilities of vision impaired university students. During this stage the researcher is expected to identify the existing environment. The second stage examines the learning requirements, learning aids, problems of current learning aids and benefits of new learning techniques. The researcher is expected to assess existing teaching learning facilities of vision impaired university students by examining the above.

The third stage is developing and initial learning management system (LMS) with learning aids for vision impaired university students. After obtaining feedback of the students the researcher will get on to the fourth stage, which is implementing the learning management system with more advanced features for vision impaired university students. Based on the success of stage four and the feedback from the students, finally a conceptual framework will

be developed that can be used as a guide in developing such an advanced LMS for vision impaired university students.

This framework is flexible so that for future developments, anyone can again assess existing teaching learning facilities and follow these stages. The conceptual framework consisting of the above elements is as follows.

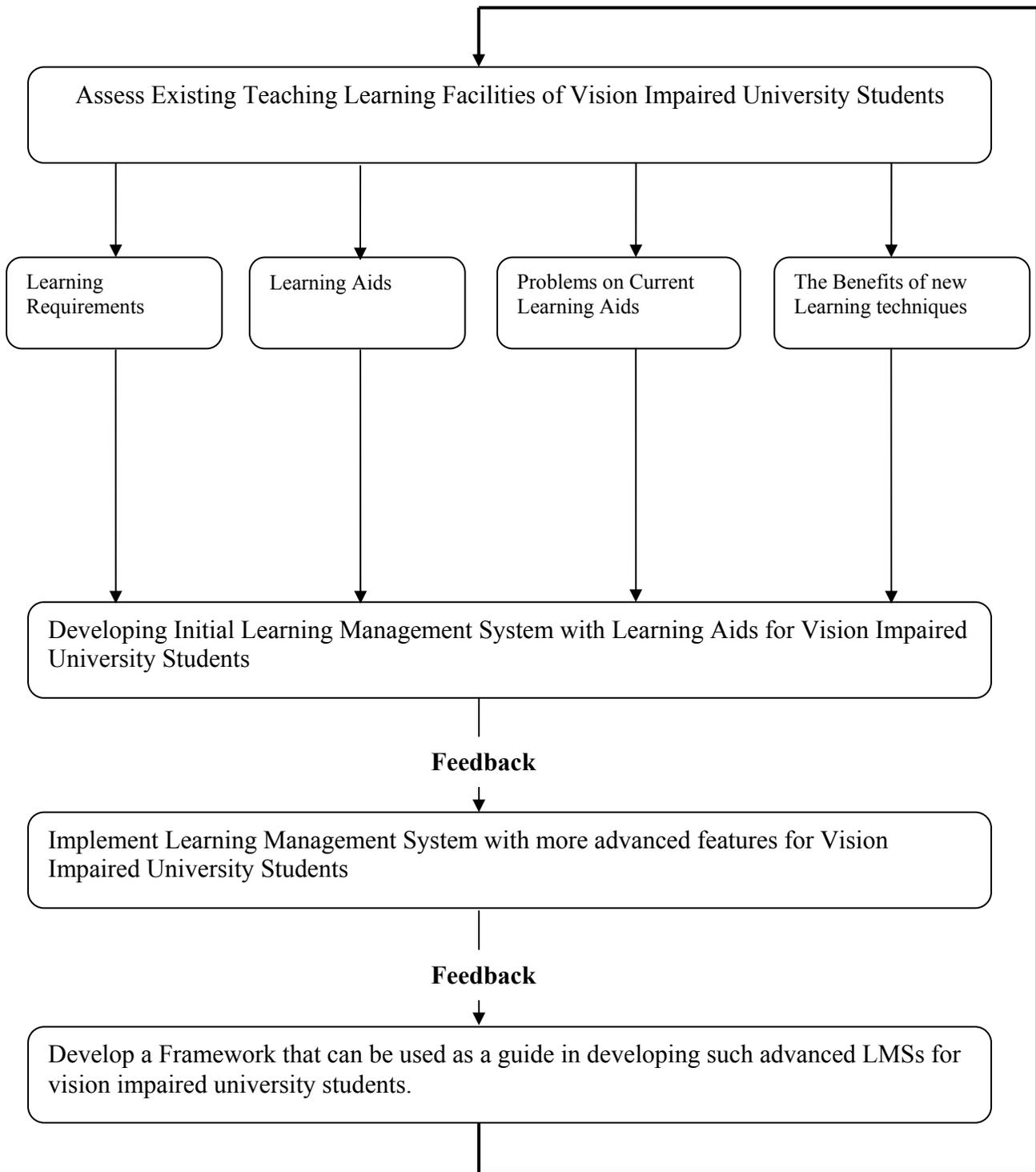


Figure 3-1: *Conceptual Framework*

3.3. Method of Data Analysis

To examine the requirements and the existing learning facilities of vision impaired university students, a questionnaire was designed and distributed to the vision impaired students. Support was obtained from some students to assist the handicapped students to fill the questionnaire. In addition to the questionnaire, the researcher carried out interviews with the course lecturer, computer center coordinator and experts in the relevant field.

(Hautakangas, S. 2006) mentions that quantitative methods, such as questionnaires are user friendly but superficial and that qualitative methods such as of representation are informative, but time consuming. Therefore in the response sheet, opportunity will be provided for the students to give their own views.

This survey will also serve as a formative evaluation, which helps to identify problems and make modifications in the existing system. Statistical methods will be adopted for data analysis. A sampling survey will be carried out to examine the requirements and the existing learning facilities.

3.4. Population

According to the information obtained from the Sri Lankan Council of Visually Handicapped Graduates Organization, there are 250 vision impaired graduates passed out from Sri Lankan Universities. At present there are 60 students following degree courses in the Sri Lankan universities.

University of Sri Jayewardenepura: 36 students

University of Colombo: 13 students

University of Peradeniya: 10 Students

University of Kelaniya: 01 student

However the Sri Lanka Council of Visually Handicapped Graduates Organization does not have information about university students from the North and East. This survey is based on 25 students from the University of Sri Jayewardenepura.

3.5. Sample

This study has been carried out based on the learning requirements identified, by a survey carried out on the vision impaired students from the Faculty of Arts of the University of Sri Jayewardenepura. In this study it is assumed that these requirements represent the requirements of all vision impaired university students in Sri Lanka.

This survey has been carried out selecting the second year students and third year students. There are 16 second year students and 10 third year students studying in various Departments of the Faculty of Arts.

The sample of 25 vision impaired university students were selected from the population of vision impaired students, by using the Judgmental Sampling Method

3.6. Data Collection

The Judgmental Sampling method was used in selecting the sample. The sample size was 25 students. The questionnaire designed was distributed to the vision impaired student sample. Support was obtained from some students to assist these students in filling the questionnaire. In addition to the questionnaire, the researcher carried out interviews with the course lecturer, Computer center coordinator and the experts in Digital Talking Books developers and learning management system developers.

3.7. Data Analysis and Results

3.6.1 Composition of the Sample

The target student group consisted of 16 from the second year and 10 from the third year.

The response rate was 100%.

	Second year	Third Year	Total
Gender - Male	9	6	15
Female	7	4	11
Total	16	10	

Table 3-1: *Composition of sample by gender*

3.6.2 Composition of the Main Learning Requirements

		Frequency	Percentage %
1A	Reading of text books and other learning materials	25	100
1B	Reference reading	25	100
1C	Taking down notes	25	100
1D	Writing assignments	25	100
1E	Making oral presentations	25	100
1F	Other		

Table 3-2: *The main learning requirements*

According to the survey, the learning requirements of students are 100%. All are reading text books and other learning materials, reading references, taking down notes, writing assignments and making oral presentations.

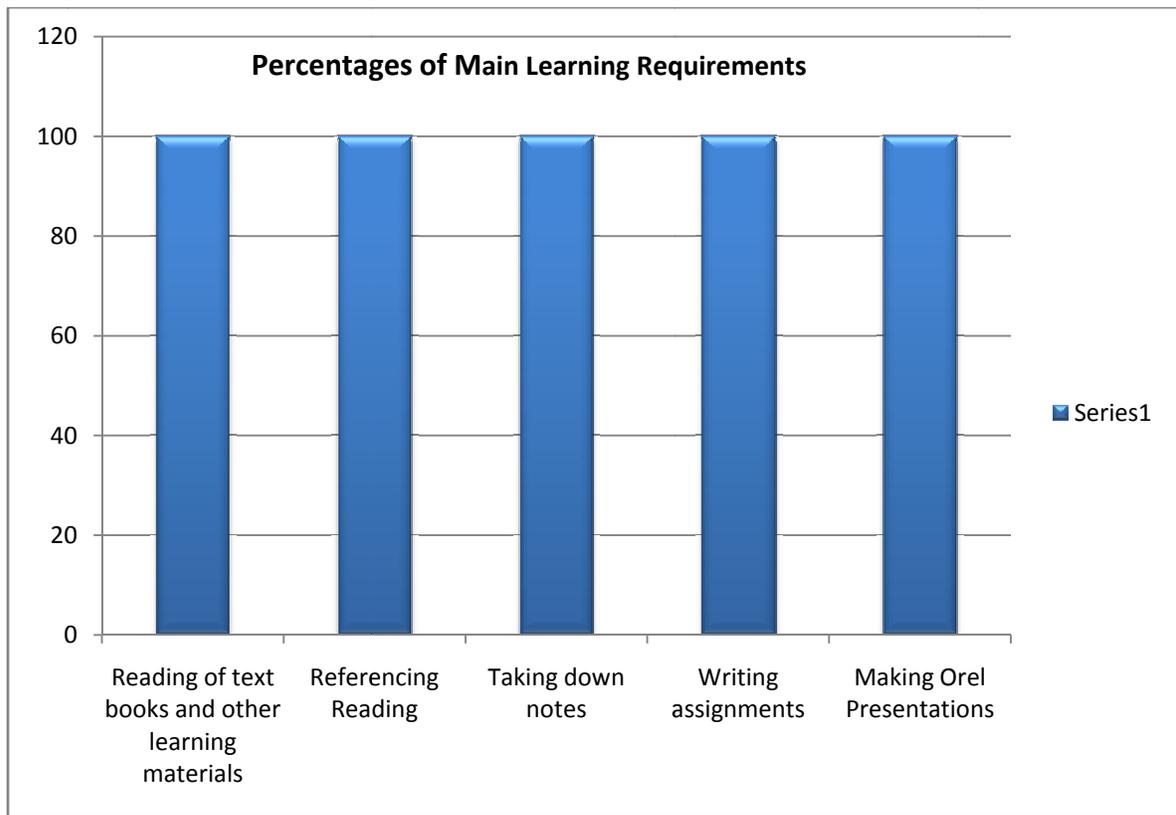


Figure 3-2 :Percentages of Main Learning Requirements

3.6.3 Presently Used Learning Aids

		Frequency	Percentage %
2A	Reading and writing Braille system	25	100
2B	Use of computer Packages	13	52
2C	Use of audio techniques	15	60
2D	Use of Digital Talking Books	0	0
2E	Use of a Learning Management System	0	0
2F	Other		

Table 3-3: *The presently used learning aids*

Considering learning aids, presently used by the students, reading and writing Braille system is used by students, (100%). This is the main learning aid they are using.

The use of computer packages is (52%). Presently they are using Microsoft word, screen reading software and web browsing.

According to (Table 3-3), use of audio techniques is 60%. A considerable percentage is using audio techniques as a learning aid. Especially to record and listen to lectures. Percentage depends on the purchasing power of the students.

According to the survey, use of Digital Talking Books and use of a Learning Management System are (0%). The reason behind this is that, they don't have a Learning Management System and Sinhala Digital Talking books are not yet available.

Following (Figure 3-3) shows this information clearly.

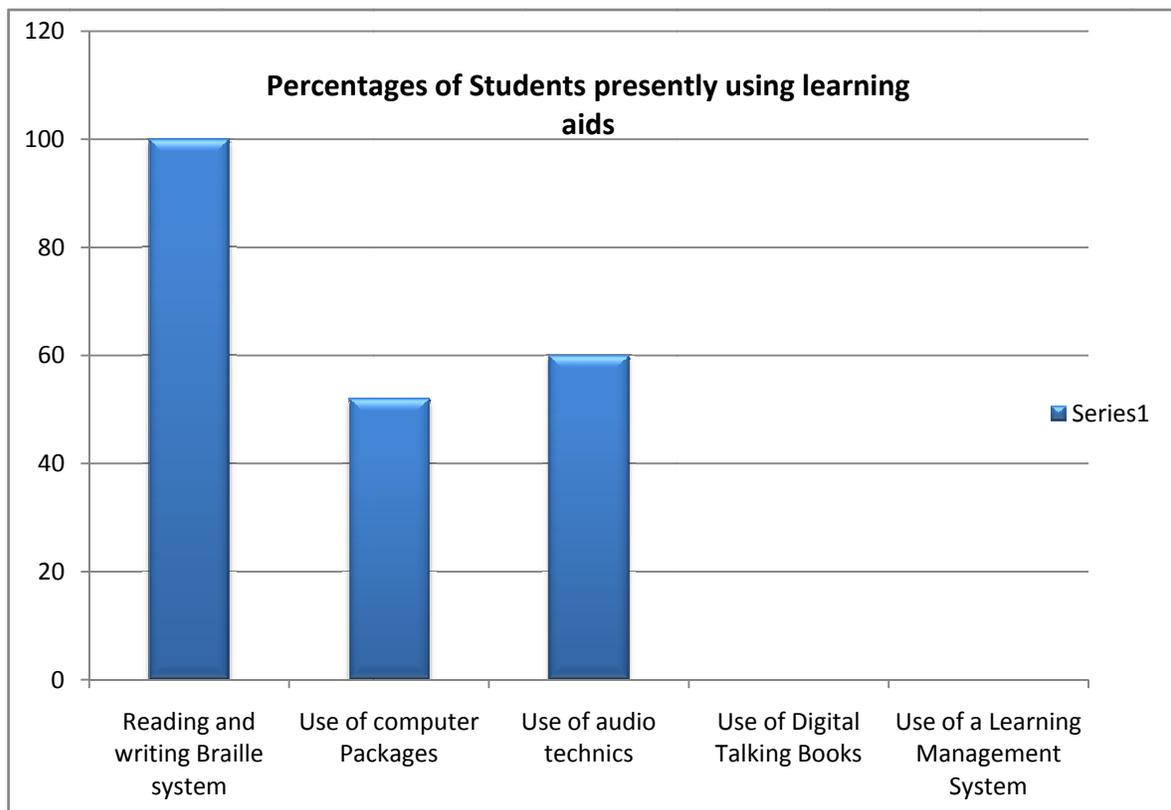


Figure 3-3: Percentage of Students presently using learning aids

3.6.4 Problems That Vision Impaired Students are Facing in the Learning System

By summarizing the responses of vision impaired students given to the questionnaire, can be identified what were the problems faced by vision impaired students, in an existing learning environment, Problems can be summarized as follows.

- Unable to write, and read books
- When referring books, facing difficulties.
- Lack of Braille Books and they can't find out Sinhala Braille Books.
- Recording Equipments is difficult to obtain. Recorded books are not available.
- Not being able to read recommended text books.
- Difficulty in completing assignments, due to the lack of additional readings and Sinhala Braille Books.
- Facing difficulties when recording lectures.
- The shortage of reference in audio form and enlarged writing materials.
- Unable to get information like other students and this affects their final results.

When analyzing these responses we can understand that the existing situation and the need of a new system should be introduced to overcome these problems, for the vision impaired students.

Access right of vision impaired student has been ignored, because web pages and Learning Management Systems are designing for the normal students. As a result, most of vision impaired students are not enjoying the benefits of the Internet and the improvement in the quality of life and quality education that Internet use can bring. Most of the above mentioned problems are expected to be solved by the new system that the researcher has introduced.

3.6.5 How Do These Problems Affect Student's Education?

By summarizing the responses, the following problems could be identified as the problems that affect the students' education.

- Not being able to read relevant recommended text books, and this causes, low quality of education
- Not being able to compete with other students
- Difficulty in writing assignments
- Difficulty in obtaining information
- Obtaining low grades at the final examinations
- Difficulty of handing over assignments on time
- Not being able to get additional knowledge
- Unable to gather additional information and it affects final results
- Quality of answers being very low
- This will have an effect in future

These are the main issues that they are facing, when they are studying and these problems directly affect their education as well as their future.

The Congress of United States enacted the Americans with Disabilities Act (ADA) in 1990 and passed amendments in subsequent years that “prohibit discrimination on the basis of disability in employment, programs and services provided by state and local governments, goods and services provided by private companies, and in commercial facilities”. The accessibility problem has grown significantly because more business and government agencies are relying on the internet to disperse information and services. The main aim of this research is how a Learning Management System can be developed to facilitate the teaching and learning problems of vision impaired university students. The researcher expecting to fill the gap between visions impaired students and other students.

3.6.6 Suggestions to Overcome These Problems

Students have made some suggestions to overcome the above problems. After summarizing, the following suggestions could be listed.

- Convert recommended text books to audio media
- Developing Sinhala Talking Books
- Recording Sinhala recommended books
- Providing recording equipment
- Use new technology
- Providing Sinhala Braille Books
- Obtain Technical equipment to read books
- Using alternative methods to read books
- Books must be in Braille or in audio form as far as possible

Above suggestions of students are helpful to design and develop a more accessible and convenient Learning Management System to facilitate the teaching-learning process of vision impaired university students in order to enhance equality of learning opportunities and quality of their education.

3.6.7 Do Lecturers Know About These Problems?

According to the responses of students 92% have said that lecturers know about these problems and that they have introduced solutions. Summarized solutions are as follows.

- Give additional time at examinations
- Have used a Braille Translator
- Having extra discussions with the vision impaired students
- Extended period for submitting the assignments

They have found some solutions for students to overcome their educational problems but these solutions are not sustainable solutions for their problems. Main Objective is to introduce a system which would give a permanent solution for at least some problems that vision impaired students are facing.

3.8. Assess Existing Learning Environment

According to the conceptual framework the first stage is to assess the requirements and the existing learning facilities of vision impaired university students. The researcher used the questionnaire method and carried out interviews with students and lecturers. The questionnaire designed was given to the vision impaired university students, and the responses were analyzed. The questionnaire was based on the main elements, learning requirements, learning aids, and benefits of new learning techniques. From this the researcher identified learning requirements, learning aids and problems of the existing learning environment.

The researcher considered the computer literacy and ability to work with computers before implementing the proposed system. Hence, if they are not able to work with computers, this system will not be able to be used. To obtain this information the researcher adopted the observation method and interview method.

3.9. Hardware and Software Resources

Before developing a Learning Management System for vision impaired students, the researcher observed the procedure which was usually followed during regular sessions at the lectures and, interviewed lecturers, students and technical staff. Then the teaching difficulties, needs and wants of students and staff were noted. The current operational modes and computer software facilities are available at the University. Most of DAISY software can

be downloaded free of charge, and LMS software and other software are open source software. Therefore the researcher was able to obtain this software. There are several computer centers set up in University of Sri Jayewardenepura and the researcher discussed possible technical solutions with coordinators of those computer centers. The researcher attended a workshop on working with DAISY software 2009 at University of Sri Jayewardenepura, to study the latest available technologies and to explore solutions available for a favorable learning environment. Investigations were further carried out by searching in the internet and these attempts were useful to identify the benchmarking references.

3.10. Developing Initial LMS with Learning Aids

In order to get an idea of the degree courses and course units, the researcher discussed with lecturers and referred the Faculty Prospectus, (2010), Faculty of Arts, University of Sri Jayewardenepura.

At the initial stage, a Learning Management System was developed as a prototype to deliver lesson materials to vision impaired students. The software needed for this study was mostly open source software. Thereby, the researcher had the opportunity of obtaining this software without bearing much of a financial cost. The normal way of giving lesson materials to students can be categorized as interactive lesson materials and normal power point slides, Word documents or interactive lesson materials by using Flash. The researcher used Word documents and PowerPoint presentations for this Learning Management System. Since

vision impaired students unable to read those lesson materials, researcher obtained advantage of the Screen Reading software, comparing availability, cost, user friendliness and functions of screen reading software, and considering expertise views researcher selected JAWS 10.0 software. Since JAWS 10.0 is open sources software, it is affordable for students. After installing JAWS 10.0, students could read these lesson materials.

3.11. LMS Using Moodle open source software

A Learning management system was designed and developed using Moodle open source software on apache platform.

Guidance was given to the lecturers, how to upload and how to maintain LMS for the other normal students of the Faculty.

Considering components, other factors, and relationship of each component of the initial Learning Management System for vision impaired students, the researcher developed the following diagram shows how lesson materials should deliver to vision impaired students (Figure 3-4). Under <http://192.254.32.8/lms/acc> website delivered lesson materials to vision impaired students.

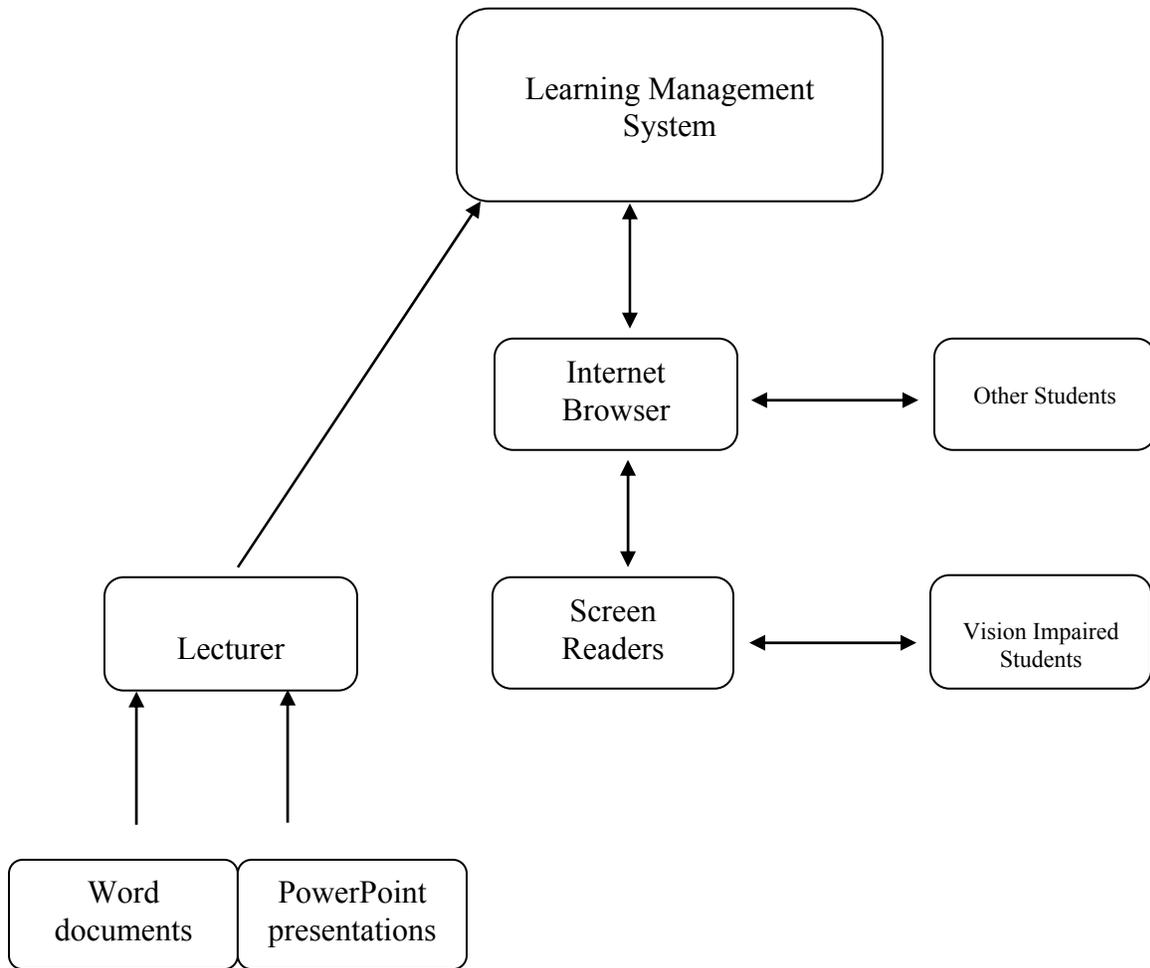


Figure 3-4 :Components of Initial LMS with Lesson Materials

3.12. Obtaining Feedback from Students and Identifying Issues

After introducing the new teaching learning system for vision impaired university students, this system was run for a few weeks as a test run. Using the interview method, feedback was obtained from the students using the LMS. After analyzing the students' feedback, main issues of this system was identified. Main issue was, using screen reading software, when they were reading documents. It was difficult to understand as well as to listen to synthetic speech over a long time span. And the other issue was, since they were following Arts degree, they had to work with Sinhala documents but according to this system it was not possible to read Sinhala documents.

3.9.1 Analyzing Issues in Proposed System

The issues faced by vision impaired students were identify by using the interview method (Figure 3-4). These issues can be analyzed as follows.

	Frequency	Percentage %
Difficult to understand synthetic speech	24	96
Difficult to concentrate on lessons due to synthetic speech	20	80
Unable to read Sinhala Documents	21	84
Most of lesson materials are in Sinhala medium	15	60
Unable to understand English	14	56
Other	6	24

Table 3-4: Identified issues in proposed system

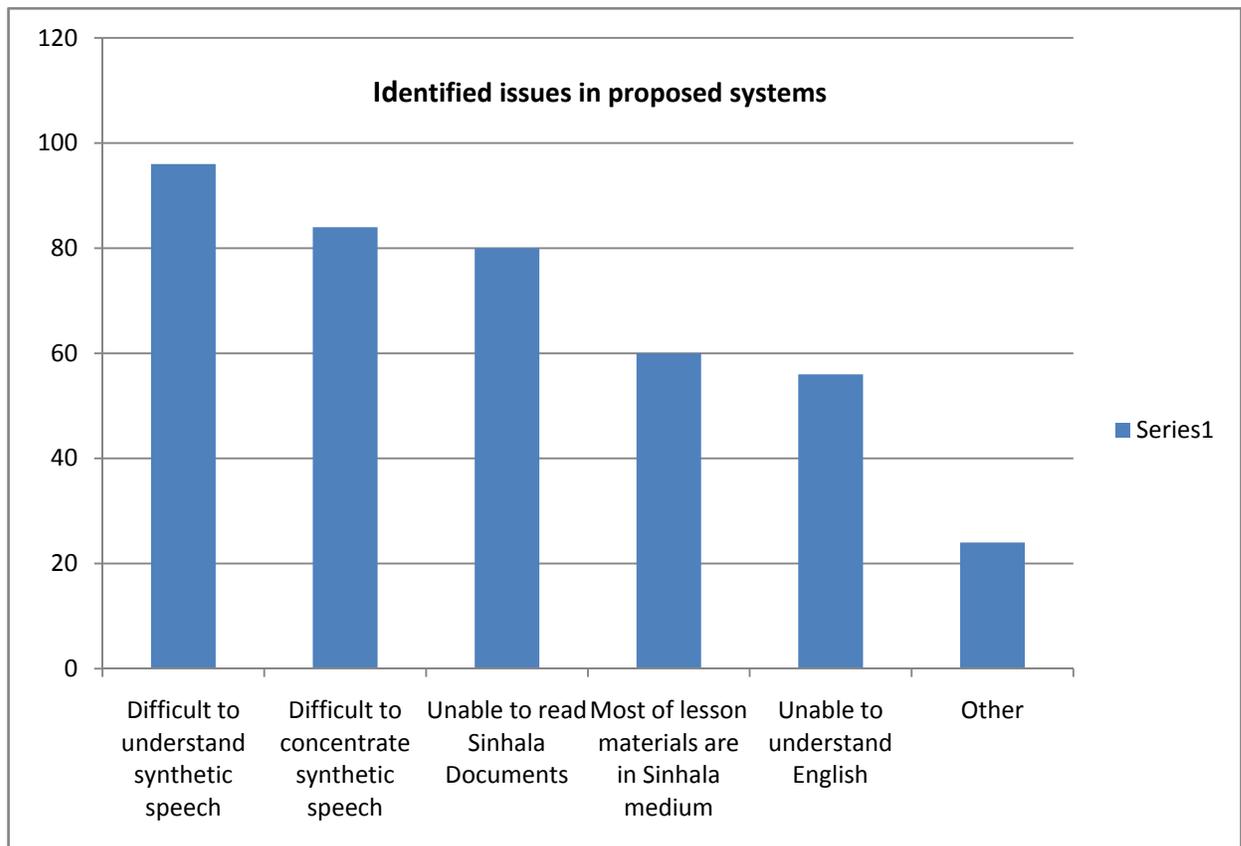


Figure 3-5: Identified issues in proposed system

According to above (Figure 3-5) illustration, most of vision impaired students are facing difficulty of working with Synthetic speech of screen Reading software. Other main issue was difficulty of working in the English medium. Since they are studying Arts subjects they have to work in Sinhala. To read Sinhala Text books and Sinhala documents they have to work in Sinhala medium.

At the interviews, it was suggested that it would be much better if they could have a human voice in the lesson material. Moreover, if they were could have Sinhala screen readers, which would be easy to understand.

3.13. Designing and Developing the New Environment

After identifying the limitations and issues of the initial Learning Management System which was set up and the needs of vision impaired students, and discussing with their lecturers and identifying problems that they face, when teaching vision impaired students, the researcher attempted to find a solution to this matter. The researcher also went through internet, various articles, and interviewed people related to DAISY studies and attempted to find answers to this problem.

The researcher faced difficulties in gathering detailed information on similar learning environments because such environments do not exist in the Sri Lankan context. Funding for such software especially screen reading, LMS developing, DTB developing software and so on is difficult too. Fortunately these software are available as open source software. The other fact is the unavailability of such computer laboratories for these students, provided with internet and required software.

To overcome problems of the Learning Management System introduced, the researcher went through the internet, various articles, and interviewed people who are experts related to DAISY studies and attempted to find answers to the problems of the initially Learning Management System setup.

3.14. Obtaining Relevant Knowledge

To obtain knowledge relevant to of DAISY software and the environment, the researcher first studied the existing learning environment and the DAISY software in order to obtain skills and knowledge required for the development of Sinhala Digital Talking Books and a Learning Management System.

Considering new components, new technologies, other factors, and relationship of each component of the recommending Learning Management System for vision impaired students, the researcher developed the following diagram shows how lesson materials should deliver to vision impaired students. This diagram can be shown as an overview of the new system (Figure 0-1).

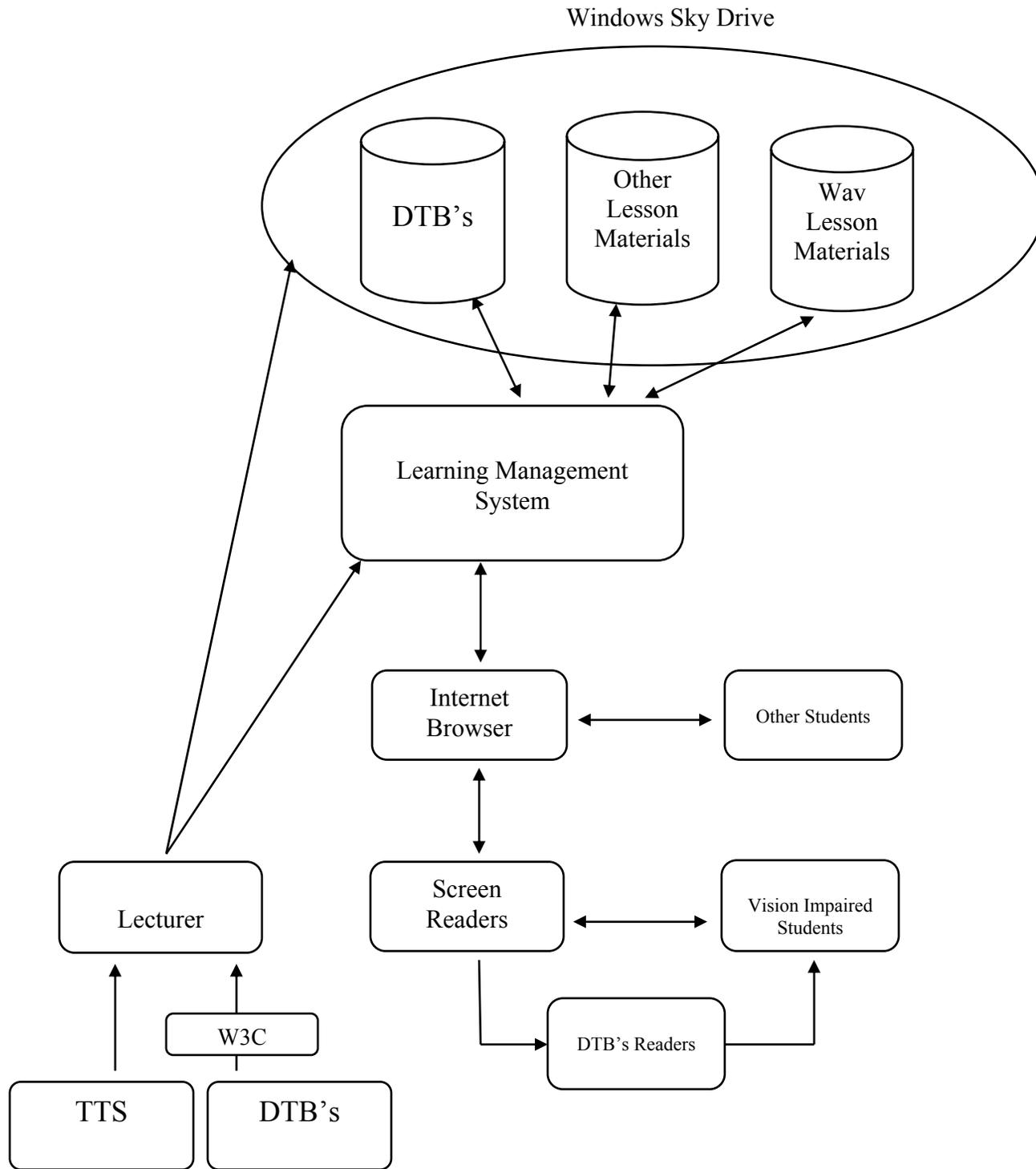


Figure 0-1: Overview of the system

3.15. Introduction of Sinhala Screen Reading Software to the LMS

Considering the above limitation, the necessity of a Sinhala Screen Reading Software was identified. Accordingly, “Thunder” the Sinhala Screen Reading Software was introduced to the LMS. Thunder is a free Screen Reader for noncommercial purposes. It supports Microsoft word, excel and some other windows applications as well. To use Sinhala Screen reading Software, documents should be typed using a Sinhala kit. The Sinhala kit is a Unicode based set of fonts which enable the user to create documents in Unicode. This software was developed by the language technology research laboratory (LTRL) of the University of Colombo, School of computing (UCSC). Using this software, vision impaired students can read Sinhala Word documents and Power Point presentations.

3.16. DAISY Sinhala Digital Talking Books to the LMS.

When analyzing problems of vision impaired student are facing in their learning environment, there are indicated in above section (3.6.3). To overcome these problems, the researcher suggested, DAISY Sinhala Digital Talking Books for the vision impaired students. Most of the above mentioned problems are expected to be solved by adding DAISY Sinhala Digital Talking Books to new system. Even though they are using traditional talking books for their studies, a traditional talking book is an analog representation of a print publication. A Digital Talking Book is a multimedia representation of a print publication.

A Digital Talking Book (DTB) is a collection of recorded electronic files to reading of a book, designed for use by the vision impaired community. Accordance with Digital Accessible Information System (DAISY) standard, When Digital Talking Books are creating, users able to obtained wide range of features such as rapid, flexible navigation, bookmarking and highlighting, keyword searching, spelling of words on demand, and user control over the presentation of selected items such as footnotes, page numbers, etc. Such features enable readers with visual and physical disabilities to access the information in Digital Talking Books flexibly and efficiently, and allow users with sight but with learning or reading disabilities to receive the information.

According to DAISY Consortium standards, the structure of the Digital Talking Book should designed by using the XML tags and is accessible to the reader by use of a browser or a playback device. The DAISY DTB utilizes the technology of the Internet with some specialized applications added to provide greatly improved access to the information. By using Sigtuna DAR 3 software, XHTML, the researcher created Sinhala Digital Talking Books. Sigtuna DAR 3 software has ability to create Sinhala Digital Talking Books in Sinhala medium.

3.17. Wav formatted lesson materials

Practically unable to develop all lesson materials are in Sinhala Digital Talking Books medium. In such occasions, the researcher's suggestion is to develop lesson materials using Text to speech convertors. According to this method we can convert lesson material text files to Wav format sound clips. To avoid problems which vision impaired student are facing in

their learning environment, the researcher accommodated this Text to Speech system to developing Learning Management System.

Text to speech refers to the conversion of written words to a voice output by means of speech synthesis, an artificial way of allowing access to verbal communication in an alternative form. Text to speech technology refers to software and hardware that provide speech output from text input. This technology can create words from stored phonemes individual speech elements and may also store whole words and phrases for better results. (Blenkhorn 1988) and (Evans 1988)

Sinhala Text-to-speech software has been developed by language technology research laboratory (LTRL) of University of Colombo School of computing (UCSC). The researcher obtained that software from UCSC and introduced it to the new system. The architecture of the Sinhala Text-to-speech converter is shown the (figure 3.7). (Source is University of Colombo School of computing (UCSC)).

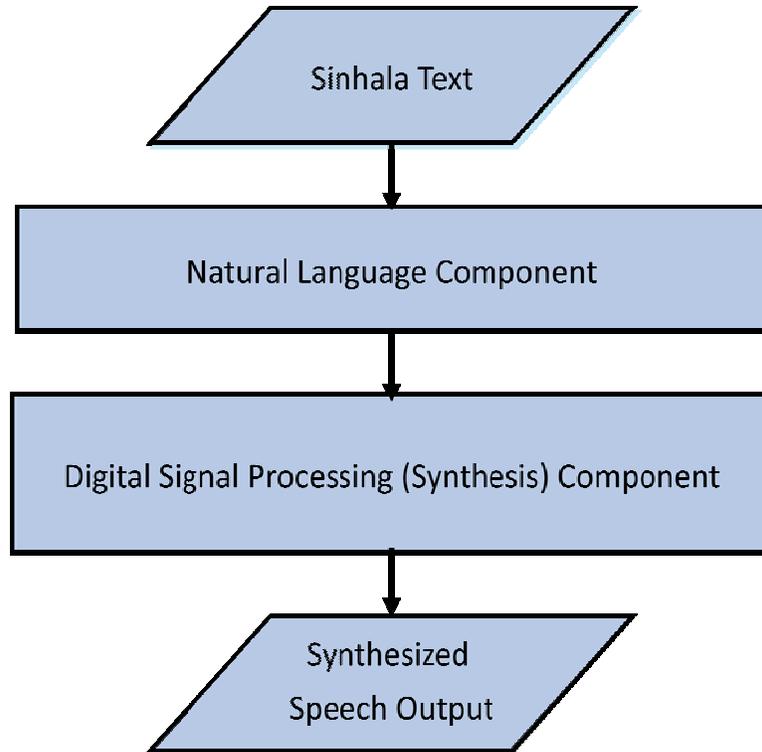


Figure 3-7: Architecture of Sinhala Text-to-speech

3.18. Uploaded Created Lesson Materials to the Windows Sky Drive

The University servers do not have enough memory capacity and the uploading capacity of lesson materials is limited as the maximum uploading capacity is 8MB. But the Sinhala Digital talking Book has an average of 30MB capacity. To overcome this problem, the researcher had to think of another way to upload lesson materials; and the researcher selected Windows Sky Drive to upload these lesson materials to the web. Microsoft Windows giving free online storage to their users via windows Sky Drive. After creating a sky drive account,

the lesson materials were uploaded to the web. After uploading Sinhala Digital Talking Books to the sky drive, its link was uploaded to the learning management system.

3.19. Introduce of the new System

Developed a Learning Management System, as a prototype to deliver learning aids for vision impaired university students with Sinhala Digital Talking Books and a Sinhala Text to Speech Converter, which can be to facilitate the teaching and learning problems of for vision impaired university students

A one day mini workshop was organized at the Accounting Resource Center, Department of Accounting to introduce these technologies to lecturers who are lecturing to vision impaired university students. Knowledge was provided on how to develop Sinhala Digital Talking Books, how to convert Sinhala Text to Speech, Using DAISY technology how to develop lesson materials and how to upload developed lesson materials to the Learning Management System.

The vision impaired students were provided Computer literacy and the DAISY software was introduced to them. DAISY Lanka Foundation conducted some lectures regarding Screen reading software, and how to play Digital Talking Books, etc.

3.20. Allocation of time slots to use computer center

The researcher made a request of the coordinator of the Accounting Resource Center to allocate time slots for vision impaired students to use the computer laboratory. The time given by them was Tuesday and Friday 9.00 am to 12.00 noon. They created separate logins with internet facility for them.

3.21. Installation of the necessary software in the computers of the Laboratory

By this study, Accounting Resource Centre (ARC) of the Department of Accounting of University of Sri Jayewardenepura was upgraded with the required technologies and facilities to assist the Vision Impaired University Students.

3.22. The Benefits of New Learning Techniques

The new system was delivered to the vision impaired students, and get feedback was attended from them. They were asked what are the benefits that they could gain if new learning techniques are introduced? They mentioned the benefits that they could gain. The summarized responses are as follows.

- Ability to conduct educational activities without difficulties
- Able to gather new knowledge
- Able to get good grades at the final exam
- Able to work like other students
- Ability to compete with other students
- Studies can be done even at home or in a distant area
- Increased job opportunities
- Easy access to additional knowledge
- Ability to gather more information
- Ability to overcome their educational problems
- Ability to understand the subject matters better
- Ability to read lesson materials and recommended text books
- Ability to shift Braille system to the digital system with computer literacy
- Improved efficiency

4. CHAPTER FOUR - DEVELOP A FRAMEWORK TO GUIDE THE DESIGNING OF A LEARNING MANAGEMENT SYSTEMS FOR VISION IMPAIRED STUDENTS

4.1. Introduction

This chapter explains the way in which the Learning Management System was designed and developed for Vision impaired students. It describe also how to develop a framework to guide in developing a prototype, and recommending software and framework that can be used as a guide in developing such advanced LMSs for vision impaired students.

4.2. Framework

The main objective of this study is to develop a framework to guide the designing of a Learning Management System for Vision impaired students. The knowledge obtained by reading research articles was used to develop main framework for the study. The whole process consists of three stages. Main framework was designed according to these three stages. The three stages are as follows. (Figure 4-1)

1. Objectives of a Learning Management System for vision impaired students
2. Qualitative Characteristics of the Learning Management System
3. Components of the Learning Management System for vision impaired students

The researcher developed this Framework based on two specific models. (DeLone, W.H. 2003) and (McLean, E.R. (2003), presented an IS Success Model and (Sevgi et al., 2009) Hexagonal e-learning assessment model (HELAM). These two models were combined where the main framework was developed.

(DeLone, W.H. 1992) and (McLean, E.R. (1992), presented an IS Success Model as a framework and presented what are the, categories, subcategories, characteristic, and features should be incorporated for a successful Learning Management System. After ten years (2002), DeLone, W.H. and McLean, E.R published a paper and discussed many of the important Learning Management System success research contributions. They proposed re developed their original 1992 IS Success Model. They identified a series of recommendations and components of Learning Management System, regarding current and future measurement of IS success. Their IS Success Model became very effective and it is used not only in the IS success model but also other related fields like e-learning assessment models.

Hexagonal e-learning assessment model (HELAM) is a conceptual e-learning success evaluation model for assessing learner satisfaction with both internet based Learning Management System and blended learning. HELAM has been developed for assessing the e-learning effectiveness according to six dimensions of e learning.

Though the researcher went through several Learning Management Systems success assessment models, this study is based on only these two models. Reason is these two models aim to combine system design, content design and service design. These are the most important factors for Learning Management System for vision impaired students.

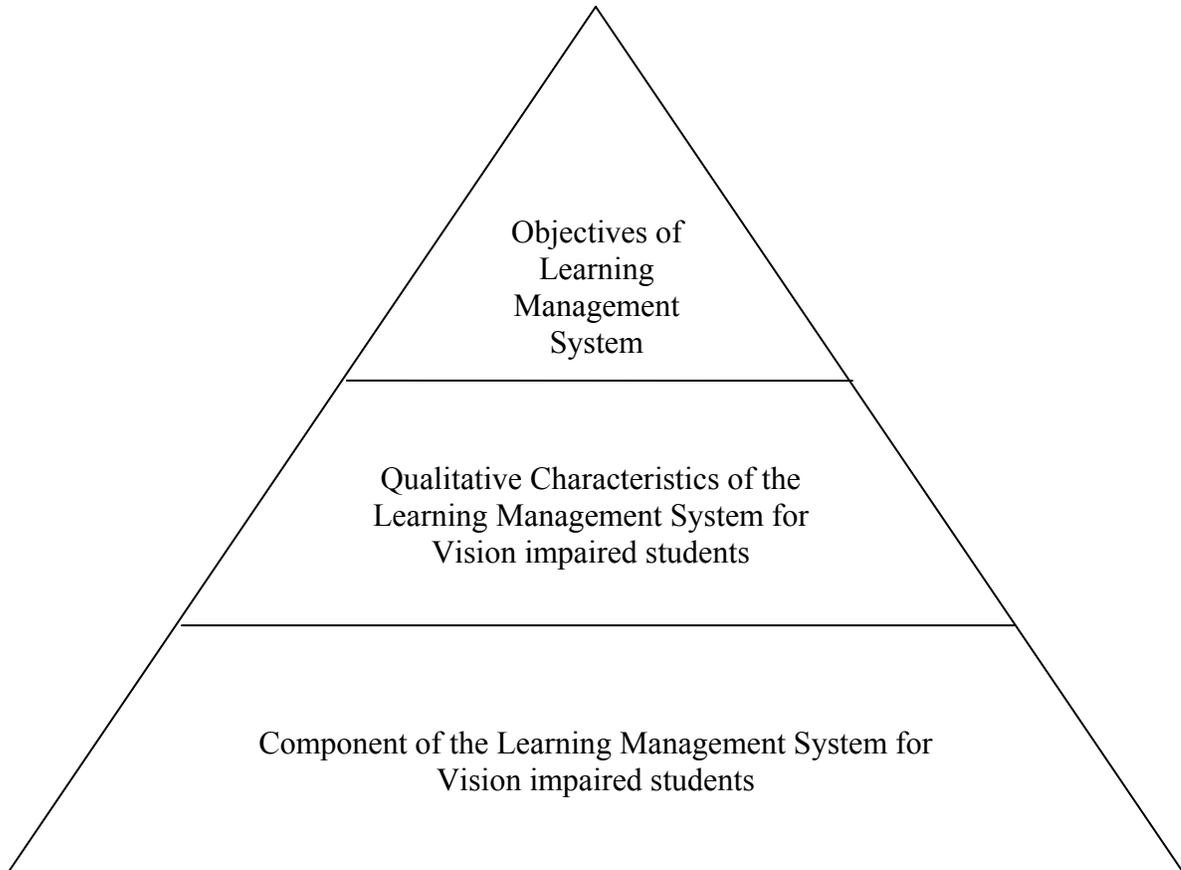


Figure 4-1: Main Framework

4.3. Objectives of the Learning Management System

Objectives of the Learning Management System is to introduce a Learning Management System with Sinhala Digital Talking Books and Sinhala Text to Speech Converter which could be developed to facilitate the teaching and learning problems of vision impaired university students.

4.4. Qualitative Characteristics of the Learning Management System

The qualitative characteristics required to achieve the objectives of the Learning Management System for vision impaired students will be discussed here. Before identifying the characteristics the researcher went through several research articles related to Learning Management Systems.

4.5. Categories of Learning Management Systems

By analyzing several categories of models of Learning Management Systems of various researchers, the researcher developed and obtained expertise knowledge regarding DAISY technology, and also obtained sound knowledge regarding categories of Learning Management Systems. And with the experience obtained by developing a prototype, the researcher identified qualitative characteristics of the Learning Management System for Vision impaired students. The researcher identified 32 characteristics which were grouped

into 3 categories. The overall success of Learning Management Systems initiatives depends on the attainment of success at each of these stages of Learning Management Systems development. This research study attempts, to underline the importance of each aspect of a Learning Management System which directly effects the overall success and learner's satisfaction. In this model, Learning Management Systems is divided into subcategories and these subcategories are evaluated individually, and the overall success of the Learning Management System could be defined as the cumulative sum of success levels of all these individual parts. The identified subcategories are as follows. (Figure 4-2)

1. System Design
2. Content Design
3. Service Design

4.6. System Design

The first sub category is System Design. System Design refers to the technical aspects of the system. Here the Learning Management System designers should consider how technical aspects are organized in order to develop the Learning Management System for Vision impaired students. The researcher identified 9 characteristics of the system design. To obtain maximum benefits from Learning Management System, it is best that designers follow these 9 characteristics. The 9 characteristics identified are as follows.

1. Study existing environment
2. Compatibility with other tools
3. User friendly
4. Accessibility
5. Stability
6. Security
7. Fast
8. Help option
9. Well organized

4.7. Content Design

According to the study the second sub category is content design. Content Design is a technology related learning management system where it is focuses on the development, management and publishing of the content that will typically be delivered via a Learning Management System. The following will be included; media files developed in other tools, assessment items, simulations, text, graphics or any other object that makes up the content within the course being created. Content Design manages the process of creating, editing, storing and delivering e-learning content. In this study thee researcher has identified 10 characteristics.

1. Curriculum management
2. Digital Talking Books
3. Wav lesson materials
4. Content quality
5. Lesson materials for other students
6. Updating
7. Assignments
8. Interactivity
9. Course flexibility
10. Exams

4.8. Service Design

The third sub category is service design. The aim of this sub category is to provide services to the Learning Management System users. After implementing the system, services should be provided to sustain the system. Characteristics of these services are as follows.

1. Environment
2. Availability of necessary software
3. Developing Digital Talking Books
4. Developing Wav lesson materials

5. Interaction with other students and lecturers
6. Ethical issues
7. Trends
8. Responsiveness
9. Availability
10. Students tracking
11. Enjoyable experience
12. Communication ability
13. Training and Development

All three sub categories and the 32 characteristics can be shown in one figure as follows. Qualitative characteristics of the Learning Management System for vision impaired have been divided into 3 categories and 32 characteristics. Relationship of 3 categories and 32 characteristics are clearly shown in (Figure 4-2: *Qualitative Characteristics of the LMS for Vision impaired*).

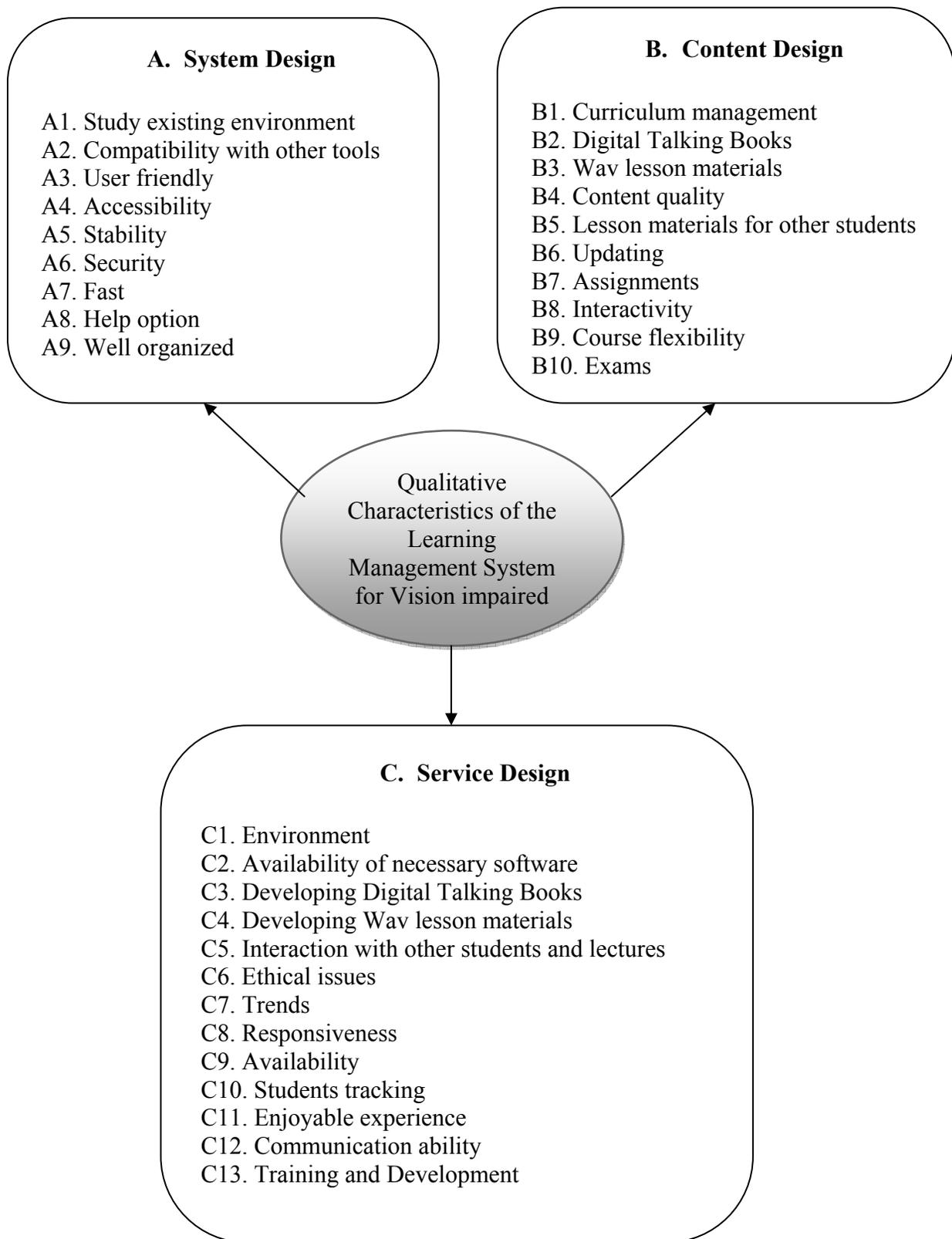


Figure 4-2: Qualitative Characteristics of the LMS for Vision impaired

4.9. Components of the Learning Management System

According to the main framework (Figure 4-1) the third stage is component of the Learning Management System for Vision impaired students. After conducting a survey and obtaining experts' views and knowledge and collecting information and obtaining experience in working with DAISY software and other software, the researcher developed components for the identified characteristics. Following tables (Table 4-2: *Content Design Component*), (Table 4-1: *System Design Component*), (Table 4-3: *Service Design Component*), illustrate components of each characteristic according to each sub-category. These sub-categories, characteristics and components of framework developed directly affect the overall success and learner's satisfaction. This framework and prototype will be helpful to those attempting to develop Learning Management Systems for vision impaired students. This can be used as a guide in developing such advanced LMSs for vision impaired students.

When developing the components, the researcher considered characteristic and sub-categories of the Hexagonal e-learning assessment model (HELAM). User satisfaction is the main aim of this model.

System Design Component

Characteristics	Component
Study existing environment	Questionnaire, Interviews, Discussion , Observation
Compatibility with other tools	Workability of different operating systems, W3C standards, Moodle is compatible for all operating systems.
User friendly	JAWS 5.00.812 screen reader,
Accessibility	ISO 8879, Standard Generalized Markup Language (SGML)
Stability	Proper maintenance
Security	Username and password, system Security
Fast	Broad band facility, Upload compressed files
Help option	Online User guide
Well organized	Well organized Course categories and other facilities

Table 4-1: System Design Component

Content Design Component

Characteristics	Component
Curriculum management	According to the Curriculum, Faculty prospectus
Digital Talking Books	Sigtuna DAR 3,AMIS, HTML, SGML, XML
Wav lesson materials	Text To speech convertor
Content quality	According to the Curriculum
Lesson materials for other students	Microsoft Word, PowerPoint , Flash etc.
Updating	Regularly update edited lesson materials
Assignments	Giving Assignments to the students
Interactivity	When creating Digital Talking Books
Course flexibility	flexibility
Exams	Midyear and year end examinations

Table 4-2: Content Design Component

Content Design Component

Characteristics	Component
Environment	Make workable environment (AMIS, JAWS 5.00.812 , Thunder)
Availability of necessary software	Provide necessary software
Developing Digital Talking Books	Develop more Digital Talking Books
Interaction with other students and lecturers	In the system, there should be a method to Interact with other students and lecturers
Ethical issues	Get copyrights from relevant text book authors and software
Trends	Innovations of the field
Responsiveness	Responsiveness to students request
Availability	Can be accessed from any where
Students tracking	There should be Student tracking system
Enjoyable experience	Working with System should be enjoyable
Communication ability	Ability to communicate with others
Training and Development	Give necessary training and development on the system

Table 4-3: Service Design Component

4.10. Study Existing Environment

Before introducing this type of learning system for vision impaired students, the existing environment should be studied. The questionnaire method, interview method, discussions, observations, etc, could be used to study the existing environment.

The students, who are going to be engaged with this system, need to have soft skills like ability to work with computers and knowledge about DAISY technology. After studying the existing environment, if there is a favorable environment The Learning Management System could be introduced to the vision impaired students. The following factors too should be considered; whether they really need this system, whether the relevant resources are available, and whether there is considerable population to provide these facilities with Learning Management System. If the above factors are favorable, this system could be implemented for the vision impaired students.

4.11. Compatibility with other Tools

There are operating system providers and operating systems, but compatibility of each operating system are different. Not only operating system application software and other software are also different. Hardware compatibility will differ with software and other hardware. When developing this type of system designers should consider these compatibilities.

When developing Sinhala the researcher recommending following DAISY standards. The DAISY Consortium set out to use existing standards wherever possible. There is a close relationship with the World Wide Web Consortium (W3C), the standards setting body for the Internet. To develop Audio and full text Digital Talking Books developers should follow DAISY standards. As a result, the DAISY standards are applications of XHTML, XML, and Synchronized Multimedia Integration Language (SMIL), which is what provides DAISY's multimedia support. Need to create specifications for the navigation center, and they have created an XML tag set to represent constructs found in most books

As an association DAISY Consortium has recommended Open, non proprietary standards that have a verified track record for accessibility. As well as the DAISY standards are completely open nonproprietary and have no royalty associated with the implementation. Financially this is favorable for developing countries like Sri Lanka.

According to this framework, the researcher has recommended some standards and software. When developing a Learning Management System according to the recommended standards Issues can be avoided. Overview of the System (Figure 0-1: *Overview of the system* is a guide to develop a successful Learning Management System with more advanced features for Vision Impaired University Students.

4.12. Selecting Learning Management System

There are so many Learning Management Systems in world wild; these systems can be divided into commercial and open sources. (e.g. WebCT, Blackboard, IBM LearningSpace, Moodle, Atutor, etc.) offering integrated services such as the creation and distribution of on line learning material, assignments submission, conducting examinations, the communication between lecturer and students, the management of the instruction process etc., thus providing the basic software platform for supporting web based learning in an easy to use, and providing flexible and quality education(Georgiakakis et al., 2001)

The researcher recommends the open source software, Moodle. Moodle could be installed in a computer using the Windows XP operating system and Vista. The installing steps are as follows:

4.12.1 Steps to follow when Developing LMS

- First download the standard Moodle install package
- Download the latest version of XAMPP from ApacheFriends.org. This is for the platform to installed Moodle package.
- Install XAMPP
- Start XAMPP, which will start Apache and MySQL
- Confirm that the webserver is operating with your browser
- Unzip Moodle into the htdocs folder
- Use your browser to navigate to Moodle
- Install Moodle, perhaps pausing to update some configuration files
- Create Admin user and Front Page settings.

After developing Learning Management System, content developers can upload relevant lesson materials to the students.

4.13. User Friendliness

A Learning Management System Should be user friendly. To ensure user friendliness to vision impaired students, the researcher considered main issues they are facing. The main issue was the inability of read the computer screen. Using Screen Readers in this type of system will be a solution to this issue.

Screen Reading Software attempts to identify the visual display and provides voice output or refreshable Braille. Screen Reading Software may be stand alone or may be in combined with other assistive technology such as screen magnifiers. Typically, a screen reader,

sometimes called a speech output system, works with a speech synthesizer. A speech synthesizer 'speaks' the text sent to it from the screen reading program installed in the computer. The speech synthesizer is usually a software program that read the texts.

According to (Morley, S. 1998) a screen reading program sends texts displayed on the screen to be spoken by a speech synthesizer. Common features of this system:

- The full screen
- A user defined area of the screen
- A line, word, individual letters or the phonetic equivalent of a letter
- Capital letters, punctuation, symbols
- System messages.

Screen reading software can benefit both persons with learning disabilities as well as those who are blind or severely visually impaired. Screen reading software is important, so that people who are blind or severely visually impaired can access a variety of technology like email, word processing documents, spread sheets, databases, and web pages.

4.14. Features to consider when selecting the Screen readers

On September 24, 2010 DAISY Consortium website, (features to be considered when selecting the Screen reader) (<http://www.daisy.org/>) published features should be considered when selecting the Screen reader. The features are as follows.

When selecting the Screen reader, users should consider about compatible with user's computer operating system. The Mac OS comes with Voice Over as part of the operating system, and there are few other products made for the Mac. Windows VISTA OS has accessibility features too. And most of the screen reading products runs on versions of the Windows OS.

If user needs to use the software while traveling or user is not working in his own computer, The "Dolphin Pen" is a USB device that user can plug into almost any computer running Windows and use the software to magnify and read speech. With this feature is useful for vision impaired students.

If user needs the software available in a language other than English, according to the existing environment students needed to Sinhala language screen reading software. Not all of screen readers are providing other languages than English. In this study the researcher incorporated Thunder" Sinhala Screen Reading Software for existing learning system.

Users' should consider hardware requirements of the software. Some require a CD-ROM or DVD drive, a certain amount of RAM or disk space, sound cards, graphic cards, and keyboards.

If user is a musician, there is specific software called 'CakeTalking'. This software provides a customized configuration for the JAWS for Windows screen reader that allows vision impaired musicians to use both basic and advanced features such as music editing and recording program

4.15. When need Sinhala Screen Reader

JAWS Screen reading software is important to read English Text. Since target group was working in Sinhala, a Sinhala Screen reading Software was necessary. Therefore "Thunder" Sinhala Screen Reading Software Installed to the LMS. Thunder is a free Screen Reader for noncommercial purposes. It supports Microsoft word, excel and some other windows applications as well. To use Sinhala Screen reading Software documents have to be typed using Sinhala kit. The Sinhala kit is a Unicode based set of fonts which enable the user to create documents in Unicode. This software is developed by the language technology research laboratory (LTRL) of the University of Colombo School of computing (UCSC). Using this software, students are able to read Sinhala Word documents and Power Point presentations.

4.16. Features to Consider when Developing Digital Talking Books

According to the (National Library Service for the Blind and Physically Handicapped (NLS) web site, 2010) Digital Talking Books are of three types. These types are imparting when creating Digital Talking Books. Depending on the need of the student one of the following types should be selected to develop Digital Talking Books.

Audio with Navigation Control Center (NCX): Digital Talking Books with structure. The **NCX** is the Navigation Control Center, a file containing all points in the book to which the user may navigate. To get this navigate developers need to follow the DAISY standards. The DAISY standards are applications of XHTML, XML, and Synchronized Multimedia Integration Language (SMIL), which is what provides DAISY's multimedia support. Need to create specifications for the navigation center, and they have created an XML tag set to represent constructs found in most books. If present, contains the structure of the book and may contain links to features such as narrated footnotes, etc. Some Digital Talking Books of this type may also contain additional textual components, for example, index or glossary, supporting keyword searching.

Audio and full text: Digital Talking Books with structure, complete text and audio. This type of DAISY Digital Talking Books is the most complete and provides the richest multimedia reading experience, and the greatest level of access. The researcher is recommending this type of DAISY Digital Talking Books for this learning system. The XML textual content file contains the structure and the full text of the book. The audio and the text are synchronized.

Text and no audio: Digital Talking Books without audio. The XML textual content file contains the structure and full text of the book. There are no audio files. This type of DAISY Digital Talking Books may, for example, be rendered with synthetic speech or with a refreshable Braille display. Considering limitations of synthetic speech, the researcher is recommending Audio and full text method for existing learning environment rather than Text and no audio method. According to the situation developers should be selected right type to develop Digital Talking Books for vision impaired students.

4.17. Choosing synthetic speech rather than human voice

Considering synthetic speech and human voice synthetic speech rather than human voice has summarized the factors, which should be considered when selecting Digital talking Books for vision impaired people. A summary of the factors to be considered, when choosing synthetic speech rather than human voice narrations are as follows. (DAISY Consortium website, Synthetic speech rather than human voice 2010)

- User acceptance of synthetic speech
- Frequency of publication (e.g., production of a daily newspaper would be impossible to sustain with human voice narration)
- How quickly the materials are needed
- Quality of speech synthesizing program
- Complexity of vocabulary or multiple languages in the source document
- Importance of completely accurate pronunciation (e.g., readers might rely on a glossary to learn how to pronounce new vocabulary)

When uploading lesson materials for vision impaired students via Learning Management System, lecturers and content developers need to consider above summarized factors, when choosing synthetic speech rather than human voice for lesson materials.

4.18. The Richest Reading Experience

DAISY Digital Talking Book with audio provides the richest reading experience with navigation facility. Rather than synthetic speech, most of vision impaired students like to read Digital Talking Book. A DAISY Digital Talking Book gives the end user the choice as of how the book is can be read. It will meet the needs of someone who wants to read a novel from end to end with a DAISY hardware player, without using any of the navigation features or other advanced functionality. At the same time, that book can be used by a university student reading the book with a DAISY software player going to specific pages to read the selections for the next tutorial, spelling out proper names for accuracy in essay writing, word searching throughout the book, bookmarking passages for later reference, etc. Digital Talking Books providing solutions for most of problems that vision impaired university students are facing. The researcher recommending to develop and upload Digital Talking Books to Learning Management System for improve quality of impaired student's education.

4.19. Sigtuna DAR 3

The recommended software for developing Sinhala Digital Talking Books is Sigtuna DAR 3. Sigtuna DAR 3 is designed to enable both fully and partially created materials to be produced and distributed across a range of media such as CD, Intranet and Internet.

The system is designed specifically for the inclusion of spoken audio as a key component of the resulting materials, and embodies technology that allows editing by audio phrase. As well as the production of new materials, Sigtuna DAR 3 allows the importing of existing audio materials. As above mentioned, there are three types of Digital Talking Books, from Sigtuna DAR 3 software; developers are able to create all types of Digital Talking Books.

The reason for the recommending Sigtuna DAR 3 software to create Digital Talking Books, was, Sigtuna DAR 3 supports production of materials into any audio codec that is properly and fully defined to the user's system as standard Windows audio codec. This allows the flexibility to archive into one format and to deliver materials in multiple formats suitable for the usage media, e.g. one format for CD and one for the Internet. This supportive feature very important when developing Sinhala Digital Talking Books

4.20. Following International Standards

To maintain the accessibility of Digital Talking Books among vision impaired university students, the researcher is recommends the following the international standards. The International Standards Organization (ISO) and the World Wide Web Consortium (W3C) already have developed International standards that can be used by the DAISY Consortium standardize for developing Digital Talking Books for vision impaired persons. These existing standards need to be applied for the specific purposes of Digital Talking Books. Standard Generalized Markup Language (SGML), ISO 8879 is the framework in which the DAISY Consortium intends to work. Hypertext Markup Language (HTML) and Extensible Markup Language (XML) are both applications of the SGML accepted standard. Likewise, the DAISY Consortium intends to apply these existing standards in the development of Digital Talking Books. In other words, the DAISY Consortium will use existing standards in the development of the new standard for Digital Talking Books.

4.21. Digital Talking Book Players

DAISY Digital Talking Book players can be divided into two main categories, hardware and software based players. Hardware players are independent stand alone machines that play DAISY Digital Talking Books that are on CD-ROM generally. They can be thought of as being like cassette tape players. Also like cassette players. Cost wise these hardware players are expensive, these players are not affordable for vision impaired university students. Navigation option is not in hardware players. There is also one sub category of hardware

player represented by the Book Port from the American Printing House for the vision impaired persons (APH). The Book Port is a small device that uses Compact Flash memory cards for storage. When transfer files or books from PC to the Book Port for later reading. These files can include text files, MP3 audio files, or DAISY books. Software based players can offer more features and options, including the display of full or partial text if available, and cost less money

There are so many of computer based software packages which can be read DAISY Digital Talking Books. AMIS, Ease Reader, gh PLAYER, Katie Player, The TAB Player, LP Player, TPB Reader and Victor Reader Soft.

If only one Digital Talking Book reading program can be used in the computer, the researcher recommends AMIS. While other programs have some good features and individual strengths, this one has a good combination of features, performance, and ease of use.

5. CHAPTER FIVE - CONCLUSION

5.1. Introduction

This chapter presents the conclusions of the researcher and ideas for future developments of this research area. With the improvements in technology, in the future there would definitely be innovations and changes in the development of Learning Management Systems for vision impaired students.

5.2. Conclusion and Recommendations

This study has been carried out, based on a conceptual framework (Figure 3-1: *Conceptual Framework*). According to the conceptual framework first stage is to assess the requirements and the existing learning facilities of vision impaired university students, for this, the researcher used the questionnaire method, observation and carried out interviews with students and lecturers. The questionnaire designed was given to the vision impaired university students, and the responses were analyzed. The questionnaire was based on three main elements, learning requirements, learning aids, and benefits of new learning techniques. From the responses, the researcher was able to identify learning requirements, learning aids and problems of the existing learning environment.

The main objective of this study is to develop a framework to guide the designing of Learning Management Systems for Vision impaired students. Knowledge obtained by reading research articles was use to develop the main framework of the study. Whole process consisted of three stages. Main framework was designed according to that categorization. (Figure 4-1: *Main Framework*). Objectives of the Learning Management System, Qualitative Characteristics of the Learning Management System for Vision impaired students and Component of the Learning Management System for Vision impaired students were identified as the three stages.

The researcher developed the above Framework combining, (DeLone, W.H. 2003) and (McLean, E.R. 2003) IS Success Model and (Sevgi et al., 2009) Hexagonal e-learning assessment model (HELAM). The researcher developed above framework (Figure 4-2: *Qualitative Characteristics of the LMS for Vision impaired*). Researcher identified 32 characteristics and grouped them into 3 categories. The overall success of Learning Management System initiatives depends on the attainment of success at each of these stages of developing a Learning Management System. Learning Management Systems was divided into subcategories and these subcategories are evaluated individually; and the overall Learning Management Systems success can be defined as the cumulative sum of success levels of all these individual parts. Identified stages are System Design (9 characteristics) Content Design (10 characteristics) and Service Design (13 characteristics). After identifying the characteristics, developed components which could achieve purpose of those characteristics were developed. These categories, sub categories characteristics and components of the framework developed directly affect the overall success and learner's satisfaction. This framework and prototype will be helpful for to those attempting to

developer Learning Management System for vision impaired students. This can be used as a guide in developing such advanced LMSs for vision impaired students.

5.3. The Prototype

The researcher designed Overview of the system (Figure 0-1: *Overview of the system* Based on this overview prototype was developed to show how a Learning Management System with Sinhala Digital Talking Books and Sinhala Text to Speech Converter could be developed to facilitate the teaching and learning problems of vision impaired university students.

The prototype of this study was designed to operate on any Internet ready personal computer using Microsoft Windows 95/98, XP, Vista, as a single application program after installation. The hard disk capacity required is 20 GB or above. The user can download lesson materials and use it repeatedly. Users residing in remote areas could also access this Learning Management System and download lesson materials. This LMS was designed as an internet surfing tool for visually impaired students as well as for normal students.

Lesson materials were delivered under <http://192.254.32.8/lms/acc> website to vision impaired students.

5.4. Technologies applied

Since Moodle is Open sources software, the researcher selected LMS is Moodle. Moodle is used in a large number of Educational Institutes. To develop a Learning Management System for vision impaired students, the following technologies were employed.

- Moodle
- Sigtuna DAR 3
- Apache and MySQL
- HTML 4.0 supports
- AMIS, (Adaptive Multimedia Information System)
- JAWS for Windows, version 5.00.812
- “Thunder” Sinhala Screen Reading Software

Moodle software was the core technology applied in developing the Learning Management System. Apache and MySQL were used as a platform for Moodle. By using Sigtuna DAR 3, Sinhala Digital Talking Books were created. The International Standards Organization (ISO) and the World Wide Web Consortium (W3C) standards supported to create Audio and full text: DTB with structure, complete text and audio. To play Digital Talking Books the researcher used AMIS (Adaptive Multimedia Information System) software as player. JAWS for Windows, version 5.00.812 and “Thunder” Sinhala Screen Reading Software was used for screen reading purposes.

5.5. Advantages of New System

This research study discussed, How a Learning Management System with Sinhala Digital Talking Books and a Sinhala Text to Speech Converter can be developed to facilitate the teaching and learning problems of vision impaired university students and developed a Framework that can be used as a guide in developing such advanced Learning Management System for vision impaired university students. This Learning Management System, Talking Books and a Sinhala Text to Speech Converter can be intended provides opportunities to increase the quality of education and availability of information to vision impaired university students. Vision impaired students have the same needs as everybody else: access to all types of information. Because of this issue vision impaired students are facing several problems. There is a gap between vision impaired students and normal students, to fulfil the gap, information should not be limited to the language of origin or the language group in which vision impaired students' lives. With this new system, more accessible and convenient Learning Management System to facilitate the teaching-learning process of vision impaired university students in order to enhance equality of learning opportunities and quality of their education.

The vision impaired community is becoming increasingly multi ethnic and multi cultural. The right to receive education is a fundamental human right. Every individual, irrespective of race, gender, nationality, ethnic or social origin, religion or political preference, age or disability, is entitled to receive education in this world. As culture, education and information become increasingly global in nature, libraries for the Vision impaired students have been cooperating internationally to develop the next generation of Digital Talking Books and then

share the books, which are so desperately needed by the people they serve. There were several problems that they were faced, when they are studying and these problems directly affect their education as well as their future but with this teaching learning system they can avoid their problems.

5.6. Future Developments

According to the conceptual framework mentioned, even though this study presented a framework that can be used as a guide in developing a Learning Management system for vision impaired students, when new technologies crop up in related fields, any other researchers can develop a learning system with new technologies.

Nowadays mobile devices are available as an interaction tool. As a future development can be investigating how mobile devices can be used, as an interaction tool within the learning environment of vision impaired university students, assessing the existing environment. This becomes more relevant with mobile devices becoming more common in the Sri Lankan society and with the connectivity speed being increasing with a parallel reduction in usage cost. It can be envisaged that DAISY software will be developed based on mobile technology.

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7. Annexure

7.1. Annexure 1 – Questionnaire of the Study

Study of Computer Based Learning Aids for Vision Impaired University Students

Questionnaire:

1. What are the main learning requirements do you have?

- a) Reading of text books and other learning materials
- b) Referencing Reading
- c) Taking down notes
- d) Writing assignments
- e) Making Orel Presentations
- f)
- g)

2. What are the presently use learning aids?

- a) Reading and writing Braille system
- b) Use of computer Packages
- c) Use of audio techniques
- d) Use of Digital Talking Books
- e) Use of a Learning Management System
- f)
- g)
- h)

3. What are the problems that you face in the learning?

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4. How do these problems effect your education?

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5. What are your suggestions overcome these problems?

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6. Do Your lectures know about these problems

a) Yes

b) No

7. If question (6) answer is **“Yes”** what are the solution introduced?

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8. If question (6) answer is **“No”** please indicate the reasons for lack of awareness

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9. What are your suggestions to overcome these problems?

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10. What are the benefits that you could gain if new learning techniques are introduced?

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7.2. Annexure 2 – Organizational Structure of the Arts Faculty

