

Blekinge Institute of Technology Licentiate Dissertation Series

No 2008:04

ISSN 1650-2140

ISBN 978-91-7295-135-8

**Development of e-Learning Content and
Delivery for Self Learning Environment:
Case of Selected Rural Secondary Schools in Tanzania**

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School of Technoculture, Humanities and Planning
Division of Technoscience Studies
Graphic Design and Typesetting: Bildbolaget i Kyrkhult
Publisher: Blekinge Institute of Technology
Printed by Printfabriken, Karlskrona, Sweden 2008
ISBN 978-91-7295-135-8

Abstract

The use of Information and Communications Technology (ICT) in developing countries like Tanzania is considered to be a necessity in order to overcome the challenges that are hindering the country from developing in all sectors and also from reducing the digital divide. As ICT is becoming more and more integrated in societies world wide, its effects are clearly seen i.e. on peoples' lives, on countries' economy, opens doors to new opportunities, change how people learn etc. Applying ICT to empower education is one of the national strategies in eradicating poverty in Tanzania.

This licentiate research is about the use of ICT tools in the secondary schools arena particularly in the development of e-Learning content and delivery for self learning environment. The main aim is trying to reduce the long time existing problems of lack of learning and teaching resources and inadequacy of qualified teachers in rural secondary schools in Tanzania. The research is focused on two secondary schools as pilot schools at Kibaha district Pwani region.

The licentiate research involves multidisciplinary principles in the development of the e-Learning resources. The knowledge of instructional design, learning objects, theories in pedagogy and software engineering principles has been acquired in the course of this study. The licentiate research is also based on the participatory action research methodology throughout the conduction of the research.

The licentiate thesis is developed based on the data obtained from the two surveys conducted in a number of secondary schools in Tanzania, data from the readily available reports, literature review and from the participatory activities with the stakeholders. The main stakeholders are students, teachers, head teachers, and Ministry of Education and Vocational Training (MoEVT) officials.

This is an applied type of research designed to solve a practical problem, the outcome of this study is a trial package of e-Learning material for secondary schools at the pilot site. The end product of the whole e-Learning research is the e-Learning Management System (e-LMS) and the proposed name for the system is TanSSe-L (Tanzania Secondary School e-Learning) system. The e-Learning contents will be delivered using a blended mode approach. Three delivery options are considered, first, of using the e-LMS (TanSSe-L) or local server for online delivery, second of using Compact Disc Read Only Memory (CD-ROM) for offline delivery and third of using face to face (F2F) for classroom delivery. This licentiate research is part of the on going e-Learning research work which will lead to a doctoral thesis.

Acknowledgements

I am very much grateful to my supervisors, Prof. Lena Trojer of Blekinge Tekniska Högskola (BTH) Sweden, Dr. M. M. Kissaka of the Faculty of Computer and Systems Engineering (ECSE), University of Dar es Salaam (UDSM) Tanzania and Prof. E. P. Bhalalusesa of the Faculty of Education (FoED), UDSM Tanzania for their constructive suggestions, guidance and valuable time devoted throughout this research work. Prof. Lena thanks for being very responsible during my stays in Sweden.

I would like to thank the Swedish International Development Agency with its department for Research Cooperation (Sida/SAREC) for sponsoring this study and the UDSM for granting me the opportunity to study.

I appreciate special efforts of Mr. Mattias Schertell (BTH) for his assistance in acquiring requisite knowledge in the crucial areas of the research and Dr. Bagile (ECSE, UDSM) for constructive consultations.

My thanks are extended to Dr. Joyce Ndalichako of the National Examinations Council of Tanzania (NECTA) for valuable discussions during early stages of the licentiate and for facilitating data collection at NECTA and also to Mr. Mikole (NECTA) for simplifying data collection exercise at NECTA.

I acknowledge contributions from all stakeholders who participated in this research. The Ministry of Education and Vocational Training officials - Mr. Pillemon, Mrs. Njau, Mr. Kibga, Mr. Kavishe, and Mr. Mwenda. Teachers from Kibaha secondary school - Mr. Kayenga, Mr. Mgina, Mr. Urrio, Ms. Mbawala, and Mr. Kadelya. Teachers from Wali-Ul-Asr girls' seminary - Mr. Jabir, Mr. Lubuva and Mr. Uwesu, and all head teachers, teachers and students in the surveyed schools. Thanks very much for your inputs and cooperation during participatory activities.

It is my pleasure to thank the following individuals who supported me in different ways in the course of conducting this study; Mr. Peter Giegar, Dr. Pirjo, Dr. Peter Ekdahl, Mr. Silvio Ocasic and Ms. Madeleine Persson of BTH, Prof. Nzali, Dr. Mvungi, Prof. Geoffrey, Prof. Victor, Prof. Mwinyiwiwa, and Dr. Haule of UDSM. Let me also take this opportunity to thank all ECSE staff members for their support in time of need and all who in one way or the other have contributed to this licentiate research.

My sincere thanks are extended to Ms. Ellen A. Kalinga, for academic contributions, licentiate thesis proof reading and companionship.

I am highly indebted to my husband Dr. N. K. Lujara and the whole family for their moral support, understanding and patience during the whole period of the licentiate research, especially during the months I spent away from home.

Above all, I thank God for blessings which made this licentiate research successfully completed. Otherwise, I would have not reached this far.

Dedication

*This work is dedicated to
My late Dad Mr. Kwegyir McDonald Munthali and
My late Grand Parents Mr. Waddy Juttu Munthali & Mrs. Ellah Gondwe Munthali*

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List of Abbreviations and Acronyms

ACSEE	Advanced Certificate of Secondary Education Examination
ADDIE	Analysis Design Develop Implement Evaluation
ADEM	Agency for Development Education Management
ADL	Advanced Distributed Learning
AICC	Aviation Industry Computer-Based Training Committee
AIDS	Acquired Immune Deficiency Syndrome
A-Level	Advanced Level
API	Application Programming Interface
AVU	African Virtual University
BEST	Basic Education Statistics in Tanzania
BOL	Benson Online
BTH	Blekinge Tekniska Högskola (Blekinge Institute of Technology)
CAI	Computer Aided Instruction
CAM	Content Aggregation Model
CD-ROM	Compact Disc Read Only Memory
CoET	College of Engineering and Technology
CSEE	Certificate of Secondary Education Examination
CSS	Cascading Style Sheet
DBMS	Database Management System
DiLES	Distance Learning and Education Services
DVD	Digital Versatile Disk
ECSE	Electrical and Computer Systems Engineering
EGM	Economics Geography and Mathematics
e-LMS	e-Learning Management System
EMIS	Education Management System Improvement
ESDP	Education Sector Development Programme
F2F	Face to Face
FoED	Faculty of Education
GNU	Gnu's Not Unix
GoT	Government of Tanzania
GPL	General Public License
HIV	Human Immunodeficiency Virus
HTML	Hyper Text Markup Language
IAE	Institute of Adult Education
ICT	Information and Communications Technology
ICT4E	Information and Communications Technology for Education
ID	Instructional Design
IEEE	Institute of Electrical and Electronics Engineers
IICD	International Institute for Communication and Development
IMS	Instructional Management System
IO	Information Object
IQ	Intelligence Quotient
ISD	Instructional Systems Design
ISP	Internet Service Provider
ITU	International Telecommunication Union
JS	Java Script
Kbps	Kilobits Per Second
LAMP	Linux Apache MySQL PHP

LAN	Local Area Network
LCMS	Learning Content Management System
LMS	Learning Management System
LO	Learning Object
LOM	Learning Object Metadata
LTSC	Learning Technology Standards Committee
Mbps	Megabits Per Second
MDGs	Millennium Development Goals
MKUKUTA	Mkakati wa Kukuza Uchumi na Kupunguza Umasikini Tanzania
MoCT	Ministry of Communications and Transport
MoEC	Ministry of Education and Culture (old name)
MoEVT	Ministry of Education and Vocational Training
MSTHE	Ministry of Science, Technology and Higher Education
NECTA	National Examinations Council of Tanzania
NER	Net Enrolment Ratio
NIXP	National Interchange Exchange Point
NSGRP	National Strategy for Growth and Reduction of Poverty
O-Level	Ordinary Level
OS	Operating System
OSS	Open Source Software
PAR	Participatory Action Research
PCB	Physics Chemistry and Biology
PCM	Physics Chemistry and Mathematics
PCs	Personal Computers
PEDP	Primary Education Development Plan
PHP	PHP: Hypertext Preprocessor
PIF	Package Interchange File
PoP	Point of Presence
PSLE	Primary School Leaving Examination
PSTN	Public Switched Telephone Network
RAS	Regional Administrative Secretary
REO	Regional Education Officer
RLO	Reusable Learning Object
RTE	Run Time Environment
SCO	Sharable Content Object
SCORM	Sharable Content Object Reference Model
SEDP	Secondary Education Development Plan
Sida	Swedish International Development Agency
SAREC	Swedish Agency for Research Cooperation
SRMIS	Students' Registration Management Information System
TANESCO	Tanzania Electric Supply Company
TanSSe-L	Tanzania Secondary Schools e-Learning
TCRA	Tanzania Communications Regulatory Authority
TEA	Tanzania Education Authority
TEIL	Technology Enhanced Independent Learning
TIE	Tanzania Institute of Education
TLSB	Tanzania Library Services Board
TSD	Teachers Service Department
TTCL	Tanzania Telecommunications Company Limited
TV	Television

TZS	Tanzanian Shilling
UDSM	University of Dar es Salaam
URL	Uniform Resource Locator
URT	United Republic of Tanzania
USD	United States Dollar
VAT	Value Added Tax
VETA	Vocational Education and Training Authority
W3C	World Wide Web Consortium
WAMP	Windows Apache MySQL PHP
WLL	Wireless Local Loop
WWW	World Wide Web
XHTML	eXtensible Hyper Text Markup Language
XML	eXtensible Markup Language
XSLT	eXtended Stylesheet Language Transformation
ZANTEL	Zanzibar Telecom Limited

Overview

This licentiate project is part of an ongoing e-Learning research project for rural secondary schools in Tanzania, particularly on the development of pedagogically sound e-Learning resources for self-learning environment.

The Rural Concept: The term rural in the developed world means sparsely populated. Within the context of this study, rural schools can be defined as all disadvantaged schools in terms of resources, i.e. schools with limited, qualified teachers, reference and teaching books, laboratory equipment, non-functional libraries and ICT facilities. In this case, these schools may not necessarily be in real geographical rural areas but may even be in urban areas.

The research is in line with the national strategies of having a learned society, the Tanzania Development Vision 2025 and the National ICT policy. The Government of Tanzania (GoT) recognizes the central role of education in achieving the overall development goal of improving the quality of lives of Tanzanians and its multifaceted role in economic growth and poverty reduction. The Government launched the Secondary Education Development Plan (SEDP) in 2004, with the focus to increase access, equity and quality in education, conduct management reforms, capacity building and address cross-cutting issues (MoEC, 2004).

The delivery of education is guided by Tanzania Development Vision 2025 which spells out the need of having a well educated and learning society, a nation which produces the quantity and quality of educated people sufficiently equipped with the requisite knowledge in order to respond to development challenges and effectively compete regionally and internationally (Tanzania Development Vision 2025, 2006). Therefore the National ICT policy is a reflection of national goals, objectives and aspirations as expressed in Vision 2025, setting out digital opportunities that Tanzania can exploit towards meeting the Vision 2025 (MoCT, 2003). The MoEVT in the draft of ICT Policy for Education envisages the use of ICT for improved access, quality and management of education. Its mission is to “integrate ICT in education to enhance efficiency while stimulating and improving teaching and life-long learning” (Philemon et al., 2006).

The education pipeline in Tanzania is in the state of crisis, schools are deeply inequitable and of extremely poor quality. Education opportunity is highly stratified, decent schooling is increasingly the preserve of a small elite. With regard to computers in schools, their presence is minimal. Major computer access is confined mostly to the private/elite schools, thus intensify the inequities (Esselaar, et al., 2001).

The research involves two higher learning institutions for academic support, the University of Dar es Salaam (Tanzania) and the Blekinge Tekniska Högskola (Sweden), where at both institutions I am registered as a PhD candidate. I am working with the College of Engineering and Technology (CoET) UDSM and is the site where my research empirical work is taking place. The Division of Technoscience Studies at BTH, offers relevant courses needed for the research through the licentiate program. BTH is together with UDSM responsible for the PhD program including the licentiate degree. This is a sandwich program where I spend eight months at UDSM and four months at BTH yearly for the whole research period.

This licentiate thesis is structured in three parts as follows;

Part I – Licentiate Chapters

Chapter one is about the background information which covers the education system in Tanzania, statement of the problem, importance of secondary education, ICT developments in Tanzania and strategies to support secondary education using ICT. The chapter also covers research objectives, research questions and significance of the research. The Tanzania Secondary Schools e-Learning system is also introduced. The pilot site and limitation of the research are also explained.

Chapter two discusses about the concepts that have been reviewed in the literature required for this licentiate thesis. These include e-Learning, Instructional design, learning objects, metadata, e-Learning standards, content packaging and content repository, pedagogy in e-Learning, open source software and web technologies, overview of multimedia contents and e-Learning content delivery approaches.

Chapter three deals with research methodology used in the research, it also accompanies the literature review of the participatory action methodology.

Chapter four discusses two surveys conducted for secondary schools and on-going participatory activities as part of action participatory methodology.

Chapter five explains the e-Learning content analysis and design for the new environment. The chapter gives information regarding the needs analysis, determination of learning objects and subject structure design for the new environment.

Chapter six gives the summary and conclusion for the licentiate thesis and future plans towards PhD work.

Part II – Publications

The thesis includes two scientific papers published in conferences and journals. A brief summary of the papers is given and the two papers are also attached.

Part III – Appendix A

The appendix gives a practical example of participatory action research methodology. The design of a Students' Registration Management Information System for the two schools in the Kibaha pilot site is given in brief.

Part I – Licentiate Chapters

1. BACKGROUND INFORMATION

1.1 INTRODUCTION

1.1.1 The Education System in Tanzania

Tanzania follows a 7-4-2-3 system of education. Primary school education takes 7 years (Standard 1 – 7), followed by 4 years (Form I – IV) of ordinary level (O-level) secondary school education, then 2 years (Form V – VI) of advanced level (A-level) secondary school education and 3 years of undergraduate university degree program, though some university programs take more than 3 years.

The Tanzanian primary and secondary education system is managed by the Ministry of Education and Vocational Training (MoEVT). The MoEVT also has several independent semi-autonomy agencies under it responsible for some core functions such as the National Examinations Council of Tanzania, the Tanzania Education Authority (TEA), the Tanzania Institute of Education (TIE), the Tanzania Library Services Board (TLSB), the Institute of Adult Education (IAE), the Teachers Service Department (TSD), the Agency for Development Education Management (ADEM), and Vocational Education and Training Authority (VETA) (Philemon, 2007). The higher education is managed by the Ministry of Science, Technology and Higher Education (MSTHE).

Under this system of education, students sit for three levels of nationally set examinations in the course of study from primary up to the point of joining undergraduate studies. The three sets of National Examinations which are conducted throughout Tanzania and governed by NECTA are;

- Primary School Leaving Examination (PSLE) the National standard 7 Examinations, used as a criterion for selection of standard 7 candidates to join the Government O-level secondary schools
- Certificate of Secondary Education Examination (CSEE) the O-level National Examinations, used as a criterion for selecting candidates to join the Government A-level secondary schools and other colleges like teachers' colleges, technical colleges, social welfare colleges, business education colleges etc, and
- Advanced Certificate of Secondary Education Examination (ACSEE) the A-Level National Examinations used as one of the criterion for the selection of the candidates to join higher learning institutions

1.1.2 Educational Pyramid and Selected Education Statistics

In 2006, there were 1,316,727 new enrolments in standard 1 in the country, 697,639 students in standard 7 enrolments, 664,263 students sat for the PSLE and 448,448 enrolments in Form I. The primary net enrolment ratio (NER) for 2006 was 96.1% with a primary school pupil population of 7,063,362 while the NER for secondary

schools O-level was only 13.1% and NER for secondary schools A-level was 1.0% (MoEVT BEST, 2007). Table 1.1 shows the number of students' enrolled in different levels of education, transition from primary education to secondary education, transition from Form IV to Form V and at the point of ACSEE results. The data is given for four years consecutively (2003 – 2006).

Table 1.1: Number of Students and ACSEE Performance for the Period 2003 – 2006

Year		2003	2004	2005	2006
Number of students	Standard 7 Leavers	490,018	499,241	493,946	664,263
	Joined Form I	147,490	180,239	243,359	448,448
	Sat for CSEE	62,359	63,487	85,292	85,865
	Passed CSEE	54,876	58,091	76,166	76,505
	Joined Form V	17,200	18,893	27,780	33,088
	Sat for ACSEE	12,003	13,975	16,884	21,126
ACSEE Performance	Division I	16.5%	26.6%	20.1%	18.1%
	Division II	30.8%	32.2%	28.9%	31.7%
	Division III	40.9%	32.4%	39.1%	36.8%
	Division IV	9.1%	6.8%	8.8%	9.7%
	Failed	2.5%	1.9%	3.1%	3.7%

Source: (MoEVT BEST, 2007)

Data from Table 1.1 show that students decrease in numbers as they progress from lower levels of education to higher levels. With this trend, very few students reach higher levels of learning, there are many reasons for this trend, some of which are discussed in this licentiate. A clearer picture of this situation is seen in Figure 1.1 where a closer look is made in the year 2006.

Figure 1.1 shows students' transitions in different levels of education for the year 2006. Out of 664,263 students who completed standard 7, 448,448 (65.7%) students were selected to join Form I.

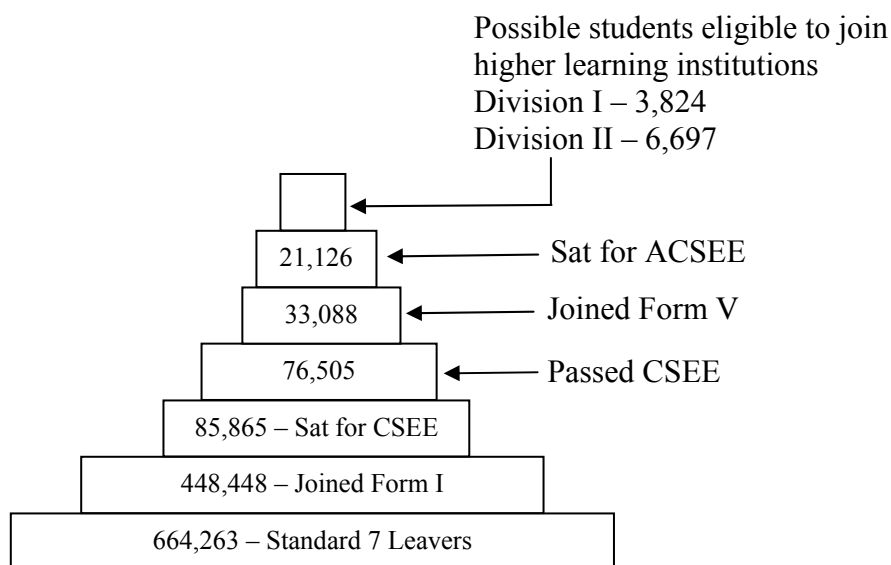


Figure 1.1: Students' Transitions in Different Levels of Education in 2006

85,865 students sat for CSEE and 76,505 students passed the exams but the number selected to join Form V was only 33,088 (38.5%). Students who sat for ACSEE were 21,126, the ACSEE results revealed that 3,824 (18.1%) students got Division I, 6,697 (31.7%) students got Division II, 7,774 (36.8%) students got Division III, 2,049 (9.7%) students got Division IV and 782 (3.7%) students failed. Division I is highly ranked in the performance and Division IV is the lowest rank in performance, while Fail is a failure. In this case, students who are eligible to continue for higher education are those who mostly fall in Division I and Division II.

The total number of primary schools in Tanzania has increased from 14,700 in 2006 to 15,624 in 2007 an increase of 6.29%. In 2007, the number of secondary schools has increased from 2,289 in 2006 to 3,485 an increase of 52.23%. Out of 3,485 secondary schools, 91 are government schools, 2,715 community schools and 679 non-government schools. The number of teachers in secondary schools has risen from 23,252 in 2006 to 29,858 in 2007, where 22,076 teachers are in Government secondary schools and 7,782 teachers in non-government secondary schools. There are 55 teacher training colleges in the country where 32 are Government colleges and 23 are non-government colleges (MoEVT BEST, 2006; MoEVT BEST, 2007).

1.2 STATEMENT OF THE PROBLEM

1.2.1 General Challenges of Education Sector in Tanzania

There are a number of challenges facing the education sector, these are: low enrolments, inadequate and obsolete physical facilities and infrastructure at all levels; inadequate qualified teaching staff at all levels; inadequate teaching and learning materials and equipment at all levels; curriculum not demand driven; inadequate capacity in governance, management, monitoring and evaluation; inadequate capacity of the existing education system to address cross cutting issues; inadequate linkages and synergies within the education sector and the overall inadequate funding of education programmes (MoEC, 2006).

The capacity of secondary education in Tanzania is still very low. The number of students leaving standard 7 is more than availability of spaces in the secondary schools. Table 1.2 shows number of secondary schools and primary schools for the period 1997 – 2007 and their percentage increase.

Table 1.2: Number of Secondary and Primary Schools in Tanzania for the period 1997 - 2007

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	10927	11130	11290	11654	11873	12286	12815	13689	14257	14700	15624
% Increase		1.86	1.44	3.22	1.88	3.8	4.31	6.82	4.15	3.11	6.29
2	721	781	826	927	937	1024	1083	1291	1745	2289	3485
% Increase		8.32	5.76	12.23	1.08	9.28	5.76	19.21	35.17	31.17	52.25

Key: 1 = Number of Primary Schools, 2 = Number of Secondary Schools

Source: MoEVT BEST, 2006

From the data in Table 1.2, it is obviously seen that there are many primary schools as compared to the number of secondary schools in Tanzania; this automatically limits the number of candidates enrolled in secondary schools from primary schools.

Increased number of primary schools goes with increased enrolment in primary schools which calls for urgent attention for secondary school education.

In the period from 1997 to 2007 (Table 1.2), the percentage increase on average in primary schools is 3.69% and that of the secondary schools is 18.02%. In 2007, the secondary school to primary school ratio is approximate to 1:4.5 this results in a big number of students not likely to be absorbed with the available secondary schools.

Figure 1.2 shows the enrolment of Form I students from standard 7 leavers. It can be seen that the rate of increase of students completing standard 7 does not cope with the rate of increase of students who are enrolled in Form I, i.e. there are many primary education leavers than Form I enrolment. It can also be shown that the number of students selected to join Form I has increased from 14.6% (56,414) in 1995 to 67.5% (448,448) in 2006.

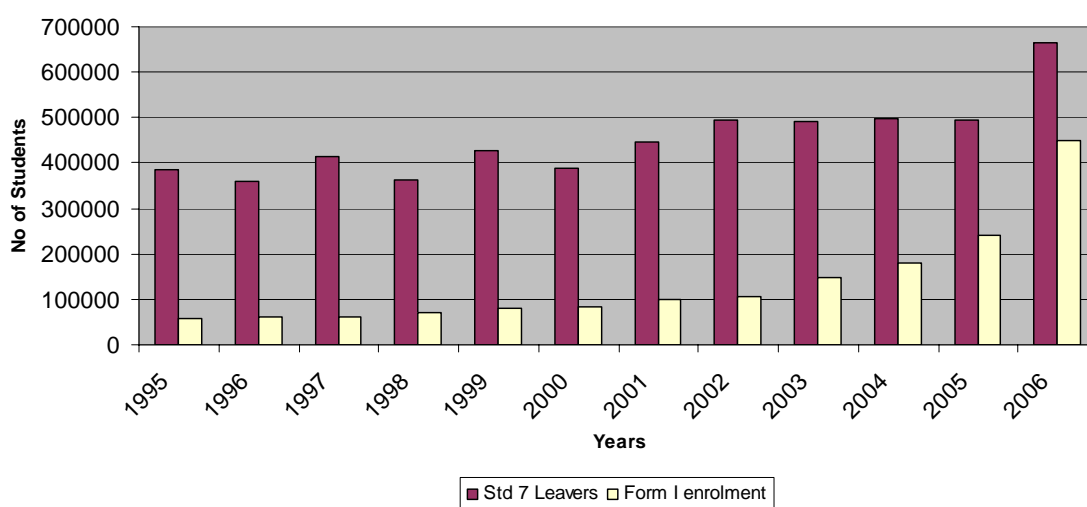


Figure 1.2: Enrolled Form I Students from Standard 7 Leavers (MoEVT BEST, 2006)

From Table 1.2, there is a remarkable percentage increase for secondary schools for the last three years 2005 – 2007, this increase is also seen in Form I enrolments for the years 2005 and 2006 in Figure 1.2. With this sharp increase of secondary schools, the need for qualified teachers naturally increases. However, due to the low capacity of teachers’ training colleges in the country, it has not been possible to produce the required number of qualified teachers. Table 1.3, shows the number of teachers grouped by qualification, for the data obtained in the years 2002, 2003, 2005, 2006 and 2007.

Table 1.3: Number of Teachers Grouped by Qualification

Year/Level	Graduates	Diploma	Grade A	Grade B/C	Total
2002	3,012	11,244	189	1,392	15,837
2003	3,168	11,029	682	1,619	16,399
2005	3,644	12,993	213	1,897	18,747
2006	4,084	15,858	294	3,016	23,252
2007	4,891	19,259	268	5,440	29,858

Source: (MoEVT BEST, 2006; MoEVT BEST, 2007)

Data from Table 1.3 indicates that while teachers' colleges capacities are expanding, recruitment of new teachers has not yet come close to approaching levels needed to keep pace with student enrolment expansion. In 2006, teacher to students ratio was 1:29 (MoEVT BEST, 2006) and in 2007 statistical data shows that the average teacher to students ratio has reached 1:34 (MoEVT BEST, 2007).

Table 1.4 shows the teacher to students ratio for secondary schools in Tanzania for the period from 1997 – 2007.

Table 1.4: Teacher to Students Ratio for Secondary Schools in Tanzania

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total	1:20	1:19	1:19	1:20	1:20	1:20	1:21	1:23	1:22	1:29	1:34
Gvt	1:18	1:20	1:19	1:19	1:21	1:20	1:20	1:23	1:26	1:31	1:38
NonGvt	1:21	1:19	1:19	1:20	1:20	1:20	1:22	1:23	1:16	1:25	1:25

Key: Gvt = Government Schools, NonGvt = Non Government Schools

Source: (MoEVT BEST, 2006; MoEVT BEST, 2007)

In the financial year 2006/07, the budgetary allocation for the education sector stood at TZS 958 Billion (US Dollar (USD) 740million) with 64.5% going into the Primary Education, 12.5% to Secondary Education, 1.1% to Teachers' Training Education and 21.9% to Tertiary Education (MoEVT BEST, 2006). The trend shows that there is always insufficient budgetary allocation for the secondary schools education i.e. 2000/01 (9.8%), 2001/02 (7.5%), 2002/03 (7.5%), 2003/04 (6.7%), 2004/05 (18.2%), 2005/06 (15.6%) (MoEVT BEST, 2006). Insufficient allocations for the Ministry to run and manage secondary schools result into many problems that are commonly faced by a number of secondary schools in Tanzania.

By 2007, very few schools have computers, computer laboratories, Internet access and other multi-media facilities. These facilities are found more in private schools than in public schools. At universities and other institutions of higher learning, few computers are available for use by students and academic staff. However, they are not enough to meet the demand.

1.2.2 Problems Facing Secondary Schools in Tanzania

The majority of rural and semi-rural secondary schools in Tanzania lack access to learning resources and necessary information. Owing to this situation, students are denied the chance to actively participate in the learning process and this seriously degrades the quality of provided education (Senzige et al., 2004).

The other major problem faced by the rural secondary schools in Tanzania is shortage of teachers. Due to the real situation in rural areas; poor living and working conditions, low morale amongst teaching staff and competition from private industry, qualified teachers tend to concentrate in the urban areas than in the rural areas, schools in wealthier areas tend to attract better qualified teachers (Wedgwood, 2005). Pupil teacher ratio stand at 22:1 but this ratio hides rural-urban disparities and shortages in subjects such as science and mathematics (World Bank, 2004).

The overall outcome of the above mentioned problems is poor students' performance in the National Examinations at CSEE level. Table 1.5 shows students performance at CSEE level for the period 1996 – 2006.

From Table 1.5, over the period from 1996 – 2006, percentage of students pass have changed from 3.5% to 4.5% for Division I, from 4.6% to 6.9% for Division II, from 15.3% to 24.3% for Division III and from 51.5% to 53.2% for Division IV. The performance for which candidates have more chances of joining the A-level is considered to be from Division I and Division II. In some cases, students with pass in Division III may be considered if have passed with proper subject combination i.e. Physics, Chemistry and Mathematics (PCM), Physics, Chemistry and Biology (PCB), Economics, Geography and Mathematics (EGM) etc.

Table 1.5: CSEE Performance in Percentage for the Period 1996 – 2006

Year	Division (No. of students in Percentage)					Total No. of Students Examined
	I	II	III	IV	Failed	
1996	3.5	4.6	15.3	51.5	25.1	40,479
1997	5.8	6.6	17.6	49.7	20.4	41,867
1998	5.5	5.5	18.0	46.8	24.3	42,172
1999	4.3	6.2	18.4	51.1	20.0	44,172
2000	4.1	5.7	16.0	52.6	21.6	47,389
2001	4.5	5.7	18.2	49.1	22.6	50,820
2002	6.4	8.2	21.6	50.1	13.7	49,512
2003	7.2	7.3	23.6	50.0	12.0	62,359
2004	4.8	8.4	24.6	53.7	8.5	63,487
2005	5.2	6.5	21.9	55.7	10.7	85,292
2006	4.5	6.9	24.3	53.2	10.9	85,865

Source: MoEVT BEST, 2007

From Table 1.5, it can also be seen that the average pass in percentage for the period 1996 – 2006 is; 5.07% in Division I, 6.51% in Division II and 19.71% in Division III, while that of division IV is 51.2%. The average percentage in the same period for possible candidates to join A-Level (Division I – Division III) is 31.29% which is almost one-third ($1/3^{\text{rd}}$) of the total number of students who sat for the National Examinations in that period. Over 50% of students fall in Division IV who have no chances to pursue higher studies.

1.3 THE IMPORTANCE OF SECONDARY EDUCATION

Tanzania has put education at the centre of its National Strategy for Growth and Reduction of Poverty (NSGRP), in Swahili also known as “Mkakati wa Kukuza Uchumi na Kupunguza Umasikini Tanzania” (MKUKUTA) (2005-2010) with the aim of ensuring equitable access to quality primary and secondary education for boys and girls, universal literacy among women and men; and the expansion of higher, technical and vocational education (URT Website, 2005).

Secondary education in Tanzania occupies a strategic place in the education and employment systems. It influences the primary education system, providing the

motives for many of the students at that level to remain in school, and it feeds the tertiary and higher education sector with its graduates. Most workers in the formal and informal sectors of the economy are likely to remain secondary school leavers for a long time to come and the expansion of the modern sector depends, to a great extent, on the supply of suitably educated and trainable secondary schools students. It is crucial that secondary education be developed in a systematic way if the diverse challenges and expectations of Tanzanians in an expanding free market economy are to be effectively addressed (MoEC, 2002).

Education is central to development and a key to attaining the Millennium Development Goals (MDGs). It is one of the most powerful instruments for reducing poverty and inequality and lays a foundation for sustained economic growth. The importance of secondary education includes (MoEC, 2004);

- (a) Modern economies needs educated and trainable labour force with secondary education as the minimum qualification
- (b) Secondary education is essential for the improvement of the quality and retention in primary education
- (c) Secondary education is a necessary condition for economic competitiveness in the context of globalization and liberalization
- (d) Secondary education is one of the major components of the poverty reduction in Tanzania
- (e) Secondary education has social benefits such as improvement of health standards, mitigation of fertility rates, containment of the spread of Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS) and greater social participation in democratization and development process
- (f) Expansion of secondary education especially at advanced level in order to enlarge the supply of students for expansion of tertiary and higher education
- (g) Chances of achieving gender balance in tertiary and higher education depend on the girls graduates of secondary education.

Thus secondary education occupies a strategic place for future growth and economic development of the country.

1.4 ICT DEVELOPMENTS IN TANZANIA

Developments in ICT have opened new doors in every profession and segment of the society worldwide. The advent of the electronic mail, personal computers (PCs), the Internet and its application to education have produced amazing results. The health of the economy of any country, poor or rich, developed or developing, depends substantially on the level and quality of the education it provides to its workforce. Education reform is occurring throughout the world and one of the tenets of the reform is the introduction and integration of ICT in the education system (Jhurree, 2005).

Information technology has entered the world of learning. From the use of computing technologies in the classroom to the creation and delivery of entire online courses,

new technologies are changing the ways in which we think about and practice education. With the development of the Internet it is possible to deliver educational materials in electronic form to anyone, anywhere, and at anytime. With developments in educational technology comes the promise that educational resources in electronic formats can change the ways in which we teach and learn (ADL, 2003)

The extension of infrastructure for the use of the Internet in developing countries, Tanzania being one of them has generally been much slower than in economically developed parts of the world. This is mostly due to low demand and thereby low profitability of ICT businesses (Wong, 2002). At the regional level, Africa is in a particularly bad condition. According to the (UN ICT Task Force, 2002), the digital divide is at its most extreme in Africa, where the use of ICT is still at a very early stage of development compared to other regions of the world. Sub-Saharan Africa remains at the bottom of the list of developing regions in Internet usage around the world (ITU Website, 2006).

In developing countries, in particular, we see clear tendencies of increased concentration of information flows to urban and central areas (Wong, 2002; Mwesige, 2004). In economically disadvantaged countries, rural and peripheral districts within these nations tend to fall further behind in human resource development as well as in economic progress and political participation and thus widening the intra-country or national digital divide.

1.4.1 National ICT Policy

Tanzania embarked on the development of ICT only few years ago. Initiatives to develop ICT came from individual, public and private entities. Although, these initiatives recorded commendable achievements, the lack of an overall policy and poor harmonization have led to random adoption to different systems standards as well as wasteful duplication (Moulali, 2006).

Recognizing the development potential of ICT and the need to address the issue of coordination and harmonization, in 2001, the government appointed the Ministry of Communications and Transport (MoCT) as the National ICT coordinator and a focal point of all ICT related issues. The main tasks of the MoCT were to formulate and prepare the National ICT policy document that will guide the provision of ICT services in Tanzania. The ministry was also required to create a conducive environment that encourages growth of public-private partnership in ICT development. The National ICT policy was launched in 2003.

The dangers posed by the digital divide, and the risk of being excluded further from the knowledge economy and social development, have propelled the Government of Tanzania to put in place a policy framework through which coordinating mechanisms and harmonized strategies might be nurtured. Under the National ICT policy context, among focus areas drawn from the aspirations of Tanzania's Vision 2025 is the education sector. There are new opportunities in applying ICT to enhance education, including curriculum development, teaching methodologies, simulation laboratories, life-long learning and distance education (MoCT, 2003).

1.4.2 Current Status of ICT Infrastructure (Services)

ICTs impacts cut across all sectors (productive and services ones) of the entire economy. ICTs services, improve information exchange among people, fight poverty and thus enhance economic growth, factors which are in line with the goals and objectives of the National Development Vision 2025. The main objective for effective and efficient ICTs services is to build up a strong and sound national socio-economic performance through the use of modern facilities and infrastructures for the provision of efficient info communications services to all key users and to the general public. The primary goals for ICTs services include that of promoting access to all the people through data and voice communications means such as telephones, Internet, e-mails, e-commerce, e-education, e-medicine, etc. Such services will significantly play an important role in the poverty reduction since the same activate and enhance socio-economic activities in many sectors such as education, health, agriculture, tourism, mining etc. (MoCT, 2002).

The main telecommunication services provider in Tanzania is Tanzania Telecommunications Company Ltd (TTCL) which has Point of Presence (PoP) in almost all districts. In most areas, the connectivity is done using leased lines and Wireless Local Loop (WLL). The available bandwidths are: 64kbps, 128kbps, 512kbps and 2Mbps. TTCL reaches most parts of the country but within the city vicinity of each district head quarters. Table 1.6 shows costs for a basic bandwidth of 64Kbps.

Table 1.6: Internet Connection Access Costs (64Kbps) in Tanzania

Internet Connection for basic bandwidth 64Kbps	Installation/Initial Charges (USD)	Monthly Charges (USD)
Dedicated Bandwidth ¹ VAT Inclusive)	100	900
Private Leased Line (VAT Exclusive)	600	150 (0-5km) -Digital 232 (6-50km) - Digital 349 (51-100km) - Digital 130 (0 – 5km) - Analog
Virtual Private Network (VPN) (VAT Exclusive)	100	300

Source: ²(TTCL Website, 2006)

Following is the current (2007) statistics on telecommunication services as given by the Tanzania Communication Regulatory Authority (TCRA) (TCRA Website, 2006);

➤ Fixed Line Services:

There are two operators licensed to provide basic telecommunication services, i.e. TTCL and Zanzibar Telecomm Limited (ZANTEL). Both operators have national and international licenses. The total number of subscribers for the fixed line is about 236, 493.

¹ VAT = Value Added Tax

² <http://www.ttcl.co.tz>

➤ **Mobile Cellular Services**

The market structure is dominated by five (5) mobile operators namely Vodacom (T) Limited (3,870,843 customers), Celtel (T) Ltd (2,205,548 customers), Tigo (1,191,678 customers), Zantel (684,214 customers) and TTCL mobile which is still new to mobile communication. About 17 out of 100 of population average Tanzanians own voice telephone line. There is also a new mobile telephone company Benson Online (BOL) started its services in 2007. So far it operates in Dar es Salaam only with very few subscribers.

➤ **Data Communication Services**

There are eleven (11) Public Data Communications Network operators with the right to install their own international gateways for routing the international traffic. The provision of Data communication services is fully competitive.

➤ **Internet Service Provider (ISP)**

The Internet Service provision is under full competition mode of licensing. There are 37 Internet service providers operating mainly in Dar es Salaam and few in major cities and towns countrywide. To improve service provision, the National Internet Exchange Point (NIXP) has been installed.

➤ **Broadcasting Services**

There are 47 radio stations and 29 television stations in operation in the country. In the same period 32 cable television operators have been licensed and are in operation.

The above statistics put a reflection on the deployment of ICT services in Tanzania. However, in comparison to the situation 7 years ago there has been an impressive growth. The number of fixed line has increased by over 35% as compared to 173,591 (in 2000). On the other hand, the mobile services have grown from 126,646 subscribers (in 2000) to over 8 million subscribers. Internet which started to be used commercially in 1996 has an aggregate international bandwidth of over 35 Mbps (TCRA Website, 2006).

1.5 STRATEGIES TO SUPPORT SECONDARY SCHOOL EDUCATION USING ICT

The use of ICT in Tanzanian schools is not entirely new. In the late 1960s and early 1970s primary and secondary schools were provided with radios to enable students to listen to educational programmes designed by the then Ministry of Education in collaboration with and broadcasted by Radio Tanzania, the state radio station (Senzige et al., 2004). Although due to some economic hardships it did not last for long.

The Bagamoyo roundtable of 2002 could be considered as the beginning of the ICT integration in secondary schools in Tanzania. The workshop was called by the then ministry of education and culture (MoEC) now-a-days MoEVT with support from the International Institute for Communication (IICD). The roundtable identified areas of ICT interventions and eleven (11) projects proposal were generated. These projects helped to raise awareness of the benefits and potential gains in adopting ICT in the

education sector which in turn elevated ICT to a priority area in education planning (Hare, 2007).

1.5.1 Secondary Education Development Plan

For Tanzania to be a learned society, to achieve higher levels of economic growth and productivity it has to adequately invest in education. In view of this, the Government of Tanzania put concerted efforts to revitalize the education system by establishing the Education Sector Development Program (ESDP). Under this umbrella, two plans at different times are in progress i.e. Primary Education Development Plan (PEDP) 2002-2006 and Secondary Education Development Plan (SEDP) 2004-2009 (MoEC, 2004).

SEDP has been established to address all weaknesses encountered in the secondary school education system in Tanzania and increase the proportion of Tanzania youths completing secondary school education with acceptable learning outcomes of high quality competences, required aptitudes and right attitudes in all subjects. Particular attention will be paid to competences in sciences, mathematics and languages, especially those of instruction and learning which are also medium of dialogue, intellectual and commercial transaction. The plan has five areas of concentration; improvement of access, equity improvement, quality improvement, management reforms and devolution of authority, and education management system improvement (MoEC, 2004).

1.5.2 ICT Policy for Basic Education

In August 2007, the MoEVT formulated an ICT policy to guide the integration of ICT in basic education. The policy covers pre-primary, primary, secondary and teachers' education as well as non-formal and adult education. Due to many challenges Tanzania has to overcome in order to provide quality education for all, ICT should be given high priority with the major goal of building a highly skilled and educated workforce. For this reason, there is need to provide schools with the required ICT know-how and resources. The integration of ICT in education will empower learners, teachers, educators, managers and leaders to use ICT judiciously and effectively for expanding learning opportunities and ensuring educational quality and relevance. The strategic integration of ICT is expected to improve access, equity, quality and relevance of basic education. ICT will be used to increase a number and quality of teachers through improved pre-service and in-service training and better provision of teaching and learning materials. The use of ICT will improve the efficiency and effectiveness of the management and administration of education at all levels (MoEVT, 2007).

Among objectives of ICT policy for Basic Education include; promote the harmonization of activities approaches and standards in the educational uses of ICT, ensure that there exists equitable access to ICT resources by students, teachers and administrators in all regions and types of educational institutions and offices, facilitate the use of ICT as a tool from assessment and evaluation of education as well as administration and management, facilitate the use of ICT resources in schools and colleges in the neighbouring community, facilitate the development and use of ICT as a pedagogical tool for teaching and learning and for the professional development of

teachers, administrators and managers and promote development of local content for basic education and other stakeholders (MoEVT, 2007).

In line with the ICT integration in secondary school education, MoEVT prepared secondary school computer studies syllabus for Form I – IV. However, only a few students have taken these courses so far. The lack of a programme for training teachers on computers and other multi-media utilization has been identified as a major reason for slow take up of computer studies in primary and secondary schools. In this respect, private schools are far better than public schools. Generally, the use of ICT enhances effective delivery of education, although, this benefit is only evident in some schools and colleges in urban areas (MoCT, 2003).

In general there is a shortage of well-qualified ICT professionals in Tanzania. There are also no well-established ICT professional profiles, and a standardized process of evaluation or certification of the different courses offered by various training centres is lacking. Access to online and distance learning for ICT is also still limited. Furthermore, opportunities for training are mostly limited to few urban centres.

1.5.3 ICT4E Programmes

As recognized in the National ICT Policy that ICT offers new opportunities to improve education at all levels. MoEVT is promoting the introduction of ICT in basic education in teaching and learning as well as administration and management. Under ICT for Education (ICT4E) programmes, MoEVT is supported and assisted by the Swedish International Development Agency (Sida) to work on the following country-wide interventions (Philemon et al., 2006), which are:

(i) ICT Implementation in Teachers' Training Colleges

All teachers' training colleges in Tanzania will be equipped with computers and Internet connectivity, allowing teachers to acquire computer skills and use these in their future work in schools.

The main aim of this project is to improve the quality of pre-service teacher education by using ICT. Initiated in 2005, the project is now in the process of equipping all government teachers' training colleges with computer laboratories, Internet access and training of ICT tutors.

(ii) ICT for Secondary School Education in Tanzania: The e-School Programme

The 'e-Schools programme is under formulation, a programme aimed at equipping a number of Tanzanian secondary schools with ICT equipment including access to the Internet. The e-School Programme proposal is currently under review by the MoEVT.

(iii) The Education Management Information System project

The main aim of Education Management Information System (EMIS) is to collect, process, utilize and disseminate education data as well as related information to educational stakeholders on a timely basis. To date, the Ministry has provided computers and printers to all region and district education offices, and carried out computer training for staff in these offices (MoEVT, 2007)

The Ministry has received a proposal for ICT in secondary education, prepared by an e-School forum composed of key stakeholders. The proposed programme includes ICT infrastructure and technical resources, integrated EMIS, curriculum and e-content, sensitisation and human resources. A phased approach is suggested, starting with 400 schools (within 2 years), followed by 2,000 schools (within 5 years), and nationwide coverage by 2015 (MoEVT, 2007).

Introducing ICT in schools will enhance the teaching and learning processes by encouraging self motivated and interactive learning and helps to remove the isolation by allowing even the most remote schools to participate in the global village.

1.5.4 IICD Projects

In the case of secondary schools in Tanzania, there are few e-Learning activities supported by non-government organizations. One of them is the International Institute for Communication and Development in collaboration with the Royal Dutch Embassy. The IICD has developed the website with Universal Resource Locator (URL) <http://www.diles.or.tz/index.htm> which provides notes and exercises for secondary schools subjects. IICD also supports a number of smaller scale ICT pilot projects, ranging from making teachers notes and syllabi available online (IICD News, 2004). Other websites which give information about education in general in Tanzania are Tanzania Education and Information Services Trust with url <http://www.tanedu.org>, and other urls <http://www.wanafunzi.or.tz>, and <http://www.idea.or.tz>.

1.5.5 ICT for e-Learning Research Project

The Department of Research Cooperation within Sida (Sida/SAREC) in supporting rural development in Sub-Saharan Africa has initiated and is funding the ICT for e-Learning research under the Extended Support ICT project. This is a collaborative project between the UDSM, CoET in Tanzania and BTH in Sweden. The project has also a component on Regional Collaboration with the universities from three countries; UDSM in Tanzania, Makerere University in Uganda and Eduardo Mondlane University in Mozambique.

ICT for e-Learning research at the UDSM has three main parts carried out by three research students. These include:

- The development of learning management platform
- The network connectivity and configuration and
- The development of e-Learning content

This licentiate thesis is mainly concerned with the development of e-Learning content by employing ICT as a tool for developing and delivering learning materials for self learning environment for rural secondary schools in Tanzania. The learning materials will be centrally produced and accessed as needed by teachers and students from the targeted schools. It is intended to use open source software (OSS) in the whole process of content development. The open source license allows users to freely run the program for any purpose, to study and modify the program, and to freely redistribute copies of the original or modified program (Weber, 2004).

1.6 MAIN AND SPECIFIC OBJECTIVES

Main Objective

To develop and deliver e-Learning contents for self-learning environment using Open Source Software tools.

Specific objectives

- (i) To develop a sharable content repository for secondary schools in Tanzania.
- (ii) To determine pedagogical and technological factors in the design of e-Learning content for self learning environment.

1.7 RESEARCH QUESTIONS

- (i) What can be done to improve the availability and accessibility of learning contents for secondary schools?
- (ii) What factors need to be considered for delivery of e-Learning content for self learning environment?

1.8 SIGNIFICANCE OF THE RESEARCH

Academically, this research will

- increase learning resources availability and accessibility
- enhance the quality of teaching
- raise performance standards at CSEE level
- empower rural secondary schools by providing teaching and learning support using ICT based contents

Socially, the research will; promote awareness of the ICT potentials in education to teachers, students and the society, encourage schools and the communities to engage more in ICT based activities.

1.9 TanSSe-L SYSTEM

The end product of the e-Learning research is the prototype of the e-Learning system to be developed for secondary schools in Tanzania. The proposed name for this e-Learning system is TanSSe-L system which stands for Tanzania Secondary Schools e-Learning (TanSSe-L) System. The system will be used for storing, retrieval and management of e-Learning contents and users.

This study is concerned with the development of e-Learning content and the content repository as part of the final product. The purpose of the TanSSe-L system is to

support the existing F2F teaching and learning approach used in the secondary schools. Students will still be attending classes as usual but will have time with the system to enhance what has been taught in the class. The system is expected to increase access to learning and teaching materials to different secondary schools. As for the scope of the research the prototype will be implemented at two secondary schools in the pilot area.

1.10 PILOT SITE AND RESEARCH SCOPE

The research is conducted in Kibaha district, Pwani region in Tanzania. The pilot area covers two secondary schools i.e. Kibaha Secondary School and Wali-UI-Asr girls' seminary.

A prototype will be developed and tested within the Local Area Network (LAN) to be configured at UDSM and the two secondary schools in the pilot area. The e-Learning content will be stored in a server that will be located at the UDSM and can be delivered via a blended (hybrid) delivery environment on e-Learning Management System (e-LMS) for web-based delivery or CD-ROM drive for off line delivery in a non-networked environment and also F2F in classroom environment. The study is up to the prototype implementation. Only formative evaluation is considered in this study, summative evaluation is not in the scope of this research but can be considered later in the recommendation for future research work.

2. CONCEPTS REVIEWED

2.1 e-LEARNING

e-Learning is another way of teaching and learning. It comprises of instructions delivered through electronic media including the Internet, Intranets, extranets, satellite broadcasts, audio/video tapes, interactive television (TV) and CD-ROMs (Govindaswamy, 2002). It facilitates access to knowledge that is relevant and useful. e-Learning involves the delivery of education and training to anyone, anytime and anywhere. The development and delivery of e-Learning materials in recent times by several organizations and institutes is under-pinned by a desire to solve authentic, learning, teaching and performance problems. The success of e-Learning depends on how learning takes place, that is, the underlying pedagogy and the real value of e-Learning lies in the ability to deploy its attributes to train the right people to gain the right knowledge and skills at the right time.

Education and training is poised to become one of the largest sectors in the world economy. e-Learning is being recognised as having the power to transform the performance, knowledge and skills landscape (Gunasekaran et al. 2002). e-Learning is viewed variously as having the potential to: improve the quality of learning, improve access to education and training, reduce the cost of education and improve the cost-effectiveness of education (Alexander, 2001).

2.1.1 e-Learning Definition

There is no clear and explicit definition of the concept of e-Learning. Definitions in the research literature are partially exclusive and sometimes contradictory, and there are few common terms used consistently (Anohina, 2005; Cohen et al., 2006; Nichols, 2003). It is difficult to distinguish the term “e-Learning” from terms such as “virtual learning”, “network learning”, “online learning”, “multimedia-based learning”, “Web-based learning”, “Internet-enabled learning”, and similar terms. From other e-Learning literatures, there is a general consensus that e-Learning in some way involves the use of ICTs to enhance and/or support learning activities (Kanuka, 2006) or can be defined as the use of Internet and digital technologies to create experiences that educate fellow human beings (Horton, 2001).

An attempt to define e-Learning, from a technological point of view, is to look at the relationships between e-Learning and some closely related concepts: Internet-based learning, Web-based learning, online learning, and computer-based learning (Hadjerrouit, 2007).

The concept of Internet-based learning is broader than Web-based learning. Hence, the Web is only one of the Internet services that use Hypertext Markup Language (HTML), browsers, and URL. Internet offers many other services, not only Web, but also e-mail, file transfer facilities, etc. Learning could be based on the web, but also as correspondence via e-mail. Online learning could be organized through any network. Thus, Internet-based learning is only a subset of online learning. Learning may take place via any electronic medium. It is not automatically connected to a network e.g.

learning that includes computer-based learning that is not network-based. As a result, e-Learning includes both network-based (online learning, Internet-based learning, and web-based learning) and non-network-based learning or computer-based learning as shown in Figure 2.1.

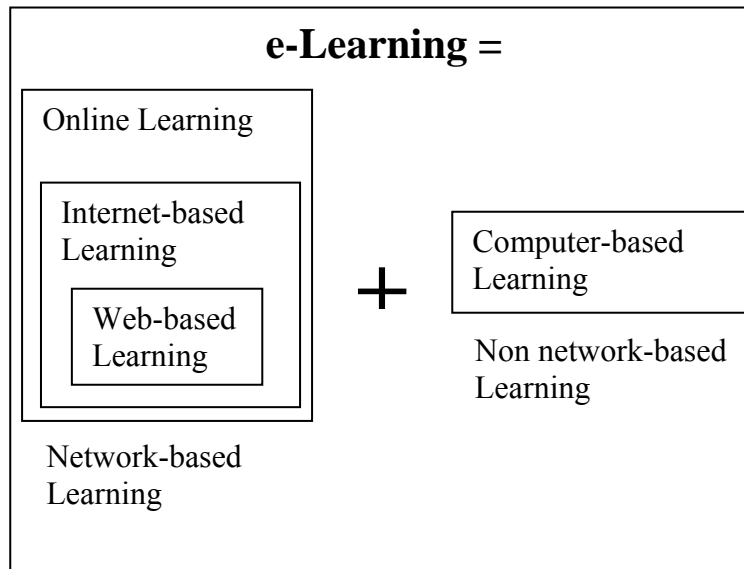


Figure 2.1: e-Learning Dimensions from a Technological Point of View (Hadjerrout, 2007)

e-Learning may also be defined as the acquisition and use of knowledge distributed and facilitated primarily by electronic means. This form of learning depends on networks and computers but may involve CD-ROMs, software, other media, and telecommunications. e-Learning can take the form of courses as well as modules and smaller learning objects. e-Learning may incorporate synchronous or asynchronous access and may be distributed geographically with varied limits of time (Wentling et al. 2000).

2.1.2 Purpose of e-Learning Resources

In many cases the creation of e-Learning resources must have a purpose (Kabita, 2003). There are many purposes of e-Learning resources some of them include the following.

(i) A flexi-time approach

An e-Learning resource offers a flexi-time, flexi-location approach by changing the learning environment. It enables learning to take place in a variety of different places, both physical and virtual.

(ii) A mixed-mode, blended approach

Most of people learn well when computer-mediated lessons are combined with virtual classes, study groups, team exercises, off-line and on-line assignments. With e-Learning, a mixture of both F2F and computer-mediated learning can be achieved.

(iii) A student-centred approach

An e-Learning package not only provides a combination of Internet, digital technology and learning, but also facilitates student-centred learning. It is believed that in this approach, students are active participants and construct their own knowledge by interacting with the information available (Harmon et al., 1996).

(iv) ICT empowerment

e-Learning generally promotes greater proficiency in information technology skills (Stephenson, 2001). ICT can empower learner by offering choice and potentially more engaging and effective means of learning. ICT can accommodate a whole range of different learning styles and preferences.

(v) Global opportunities

Exposure to the global learning community is increased. This is an important factor in the case of learners from disadvantaged rural communities where they do not have functional libraries or latest information that learners need (Duderstadt, 1999). The Internet may provide this kind of information and more resources that may never be seen in a traditional classroom.

2.2 PEDAGOGICAL OVERVIEW

Pedagogy is the method by which educational content is exposed to learners. It includes teaching methods related to the presentation of experiences, engagement of learners, reinforcement, motivation, organization of teaching tasks, feedback, and evaluation. When technology is applied together with pedagogical concepts, it can create an effective student-centred environment and enhance learning outcomes (Govindaswamy, 2002).

Most of the pedagogical principles such as discussion, demonstration, collaborative learning, etc, that apply to the traditional classroom delivery method also apply to e-Learning. However, these principles need to be extended to accommodate and provide for the rapid changes in technology. Pedagogically designed learning contents increase the interactivity and hence improve retention (Govindaswamy, 2002).

2.2.1 Basic Pedagogical Approaches

Pedagogical approaches vary in terms of the educational context, purpose and user group. For example considering the education context such as primary, secondary, vocational training and university education, pedagogical approaches are different with each demonstrating a particular emphasis (Herrington et al., 2002).

Pedagogical approaches within educational sectors vary in purpose, from those produced to guide and inform development, to those that evaluate the nature of existing resources. Furthermore, the guidelines differ in terms of the user group to which they are directed. Pedagogical considerations for learning instruction are also influenced by the learning theories (Golas, 2000).

A number of authors have presented models to guide tertiary academics and instructional designers in online developments based on current pedagogical thinking (Reeves et al., 1997). Pedagogies are connected with students' learning outcomes and have been widely accepted in the learning community; hence for a good pedagogical design theory of learning must be adopted (Mayes, 2004).

2.2.2 Learning and Teaching Approaches

There are diverse theories and approaches to instructions. In a traditional transmissive view of learning reflecting teacher-centred approach where the agency lies with the instructor, teacher constructs the learning environment and specifies what the students should do and how they should do it (Diaz et al., 2000). The learning process is relatively passive and reactive, while the instructional agent is relatively active and causal. Teacher-centred learning involves methods, activities, and techniques where the teacher conveys information to students and decides what to teach, how to organize the subject material, and the means of communicating the material to students. Learning is judged by how well students can report back what the teacher has told them. The teacher-centred approach commonly takes the form of the note-taking/lecture ("listen and learn") model and makes use of direct instructional guidance; providing information that fully explains the concepts and procedures that students are required to learn. In many literatures, it is argued that novice learners should be provided with direct instructional guidance on the concepts and procedures required by a particular discipline and should not be left to discover those procedures by themselves (Kirschner, 2006).

At the other end of spectrum where the agency for learning lies with the learner, learning is viewed as an active, constructive process. Learners are seen as creating new knowledge for themselves, extracting information from the environment as they see fit, and meshing it with existing knowledge. This is known as student-centred learning, it recognizes that learning agency lies with the learner. Learners decide for themselves what content to bring forward and the tutor role is more of a facilitator than instructor. The knowledge is seen as more subjective, dynamic and expanding rather than objective and static (Olgren, 1998). The student-centred approach has many different names and forms, the best known of which are discovery learning, problem-based learning, inquiry learning, experiential learning and constructivist learning (Kirschner, 2006).

Constructivism demands participation at all levels and moves responsibility and empowerment down the hierarchy, thereby flattening it. Constructivist learning is a process which is cumulative, goal-oriented, self-regulated and dependent on prior knowledge/experience through active construction of understanding (Mayes, 2004). It requires enquiry-oriented pedagogies which include problem based learning, anchored instruction, cognitive apprenticeships, reciprocal teaching, goal-based scenarios, and project-based learning (Horton, 2001). Constructivism may have variations such as active learning, discovery learning and knowledge building learning. Regardless of the variety, constructivism promotes a student's free exploration within a given framework or structure (Mayer, 2004).

Instructional teaching may be used where the need is to establish a common task, give a quick overview, introductory courses or give personal inspiration and motivation.

When a deeper understanding, making sense of things is needed, a constructivist approach may be useful. When learners together create a joint product and understanding, they develop higher order skills (Watkins et al., 2002).

2.2.3 Pedagogical Principles for e-Learning Environment

The e-Learning pedagogy focuses on the exploitation of information technologies to adapt to the varying learning scenarios and diverse student needs. Successful learning pedagogy requires teachers to understand how students learn and must have the capacity and autonomy to design, implement and assess educational activities that meet the needs of individual and all students (Chao et al., 2006).

Systems based on pedagogy do exist, but they give attention to only one or a few delivery methods. And as far as the pedagogy is concerned, there is no method that is superior to all others or that serves all learning needs equally well. This is valid for e-Learning as well. Instructional methods can be grouped into the following categories; presentation, demonstration, discussion, drill-and-practice, tutorial, cooperative learning, gaming, simulation, discovery, and problem solving (Heinich et al., 2002).

Subsequent developments in computer technology, whereby interactivity and functionality could more readily be provided within rich multimedia environments, have produced software at least inspired by more constructivist notions (Herrington et al., 2000). Since Internet and World Wide Web (WWW) has increased in education delivery. Technology-based approaches to learning provide many opportunities for constructivist learning; it provides and supports a resource-based, student-centred learning environment thus enabling learning to be related to context and practice.

2.3 INSTRUCTIONAL DESIGN

Instructional design (ID) also known as instructional system design (ISD) is the art and science of creating an instructional environment and materials that will bring the learner from the state of not being able to accomplish certain tasks to the state of being able to accomplish those tasks (Thompson, 2001).

The approach to instructional design is effective because it forces attention to what is going to be learned (learning objectives) and what must already be known prior to the learning transactions. Once the learning objectives have been identified, they are progressively sequenced from lower order to higher order learning. These elements are essential if learning is to be effective under all conditions. Therefore, when instruction is designed based on a system instructional design model, the end result is an effective instruction regardless of who is teaching (Morrison et al., 2003).

Instructional systems design combines knowledge of educational theory and practice with appropriate technologies to enable learning. It involves choosing appropriate technologies and designing interactions that promote effective and efficient knowledge transfer (Eklund et al., 2003). The effectiveness of any instructional material depends also upon an appropriate planning, hence the instruction has to be planned if it is to be effective and designed in some systematic way (Dick et al., 2005).

2.3.1 Instructional Design Models

Models for instructional design provide procedural frameworks for the systematic production of instruction. They incorporate fundamental elements of the instructional design process including analysis of the intended audience or determining goals and objectives. ADDIE model is a generic model which used a systematic approach to the instructional design process and serves as the foundation for most ISD models in use today. ADDIE approaches in designing instruction is similar to that of software engineering approach. ADDIE is acronym of five phases in the model namely; Analyze, Design, Develop, Implement and Evaluate. These phases are ongoing and iterative activities that continue throughout the life of a training program (Dick et al., 2005).

ISD provides a road map to guide designers and instructors through analysis, design, development, implementation, and evaluation to the goal. The ISD road map provides a route to many different destinations depending on the turns one chooses to take. At its most basic level, instructional design focuses on three fundamental concerns: identifying the goals; selecting the strategy; and, evaluating success (Moore et al., 2002).

Most models subscribe to one or more learning theories which shape the models. Instructional design models have the ambition to provide a link between learning theories and the practice of building instructional systems (Gros, 1997). The development of contents for e-Learning can well benefit from the ISD approach. However, there is need to revisit the traditional ISD in order to incorporate the Learning Object (LO) paradigm.

2.3.2 Instructional Strategies

Instructional strategies are what instructors or instructional systems do to facilitate student learning (Dabbagh, 2005). Instructional strategies can also be described as the plans and techniques that the instructor uses to engage the learner and facilitate learning (Jonassen et al., 1991). Instructional strategies operationalize pedagogical models i.e. putting them into practice hence are derived from pedagogical models which in turn are derived from learning theory. Some of the examples of instructional strategies are promoting or supporting authentic learning activities, facilitating problem-solving, promoting collaboration and social negotiation, and providing scaffolding (Dabbagh, 2005). Instructional materials that have been effectively designed with sound instructional strategy will facilitate desired learning outcomes for the students, enabling them to acquire higher order skills (Teo et al., 2006).

2.4 LEARNING OBJECTS

Learning objects (LOs) is a term that originated from the object-oriented paradigm of computer science, it has been proven to be valuable in the areas of knowledge management and e-Learning and they build a bridge between these two converging fields (Ras et al., 2005). The idea behind object-orientation is that components

(objects) can be reused in multiple contexts (Wiley, 2000). The concept of learning object refers to a generally small-sized, reusable instructional component, normally designed for distribution over the Internet and use in different learning management systems (LMS) to be accessed by many users.

2.4.1 Definition and Characteristics of Learning Objects

While there are numerous definitions of LOs, almost all describe the function of a learning object as facilitating learning. Learning objects can be best defined according to the Institute of Electrical and Electronics Engineers (IEEE) Learning Technology Standards Committee (LTSC) which states that learning objects are any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning (IEEE LTSC, 2000).

Learning objects describe any chunk of de-contextualized learning information, digital or non-digital, such as, an image, text, video, educational game or sound files. The aim of those entities is to provide a tremendous set of learning knowledge that once developed can be exchanged among organisations, and be used to build individual lessons and courses (McGreal et al. 2001). Learning objects are often used as components to assemble larger learning modules or complete courses, depending on different educational needs. Learning objects allow instructional designers to build small (relative size of an entire course) instructional components that can be reused a number of times in different learning contexts with the aim to increase the flexibility of training, and make updating courses much easier to manage (Muzio et al., 2002).

By definition, a learning object should have potential for reuse (IEEE LTSC, 2000). The definition contains the important characteristics of a LO that are referred to in the literature. Reusability is a core characteristic of a LO as evidenced by the fact that nearly all definitions of a LO refer to it. The other characteristics of a LO which actually are intended to enhance the reuse potential of a LO include;

- Flexibility: easy of updates
- Accessibility: easy to locate and use (metadata mechanism)
- Durability: retain utility over a long period of time
- Interoperability: can be used on a variety of platforms or course management systems
- Sharability: content from several different sources may be accessed by multiple users (simultaneously) with different e-Learning systems
- Activity-sized based: large enough to be used as an activity within a lesson or module, or large enough to be a lesson by itself

Learning objects go by several names in the learning field i.e. educational objects, knowledge objects, training objects, Reusable Learning Object (RLO), Sharable Content Object (SCO). Sharable Content Object coined by Sharable Content Object Reference Model (SCORM) from the concept of learning object given by Instructional Management System (IMS) (IEEE LTSC, 2000) is the most commonly accepted term with regard to learning and reuse elements.

2.4.2 Learning Object Granularity

Learning objects can be in the form of documents, pictures, simulations, movies, sounds, etc. Structuring these in a meaningful way implies that the materials are related and are arranged in a logical order, but without a clear and measurable educational objective, the collection remains just a collection (Smith, 2004). Digital learning objects open up possibilities that traditional materials may not offer. Within a single learning object, information can be presented in several different ways, allowing students to explore a topic from various perspectives, engaging interactive elements, give learners a chance to practice what they are studying. In object design, learning content is prepared as modular small “chunks”, or learning objects, that can be used alone or dynamically assembled to provide “just enough” and “just in time” learning (Wieseler, 2000).

When creating learning objects two issues are of important consideration; the granularity and combination (Wiley, 2000). Granularity refers to the size of a learning object while combination refers to the manner in which objects are assembled into larger structures to facilitate instructions. When teachers first gain access to instructional materials they often break the materials down into their constituent parts, finally reassembling these parts in ways that support their individual instructional goals (Reigeluth et al., 1999).

In the concept of learning objects, granularity refers to the smallest item that is found inside a course or other deliverable created from learning objects. It should ideally include; content, assessment and practice items. LO can be specified at any level; a course, a module or even a sub-topic. It helps instructors to precisely describe what students are to gain from instruction, making them measurable guides to accurately assess student accomplishment (Wiley, 2000).

2.5 e-LEARNING STANDARDS

To facilitate the widespread adoption of the learning objects approach, the LTSC of the IEEE was formed in 1996 to develop and promote instructional technology standards (IEEE LTSC, 2003).

Desired features of learning content i.e. interoperable, reusable, discovered and properly attributed characterize e-Learning and hence can not be achieved without standardization. The most useful standards are Sharable Content Object Reference Model and Instructional Management System which work with standard bodies such as; Aviation Industry Computer-Based Training Committee (AICC), and IEEE to integrate their specifications into a cohesive, usable, holistic model, and define key interrelationships between the standards (Jones, 2002).

The IEEE Learning Object Metadata (LOM) draft standard for Learning Object Metadata (IEEE LTSC, 2000) specifies a variety of bibliographic and technical properties of LOs, as well as different relationships between LOs, and makes exchange, reuse, and search of LOs based on these metadata possible.

It is a well known fact that explosion of technologies were due to the wide spread adoption of common standards. Standards impose certain order providing more uniform and precise access and manipulation to e-Learning resources and data (Babu, 2001). All contents that conform to an e-Learning standard will run equally well on all LMSs that conform to the same standard. Today's e-Learning market favours SCORM standards (Kanendran et al., 2005).

2.5.1 The SCORM Standards

The Sharable Content Object Reference Model standard allows compliant e-Learning content to be deployed on any LMS and assembled with other SCORM-compliant e-Learning content to create a course that brings together best-of-breed learning components. SCORM focuses on interface points between instructional content and LMS environments, and is silent about the specific features and capabilities provided within a particular LMS. SCORM adapts the object properties for all SCORM-based e-Learning environments which include interoperability, durability, reusability, accessibility, adaptability and affordability. SCORM's operational principles offer the following abilities (ADL, 2006);

- The ability of a web-based LMS to launch content that is authored using tools from different vendors and to exchange data with that content.
- The ability of web-based LMS products from different vendors to launch the same content and exchange data with that content during execution.
- The ability of multiple web-based LMS products/environments to access a common repository of executable content and to launch such content.

SCORM brings together components developed by the IEEE LTSC and the IMS Global Learning Consortium to describe how to define, package, and manage Sharable Content Objects (ADL, 2006).

SCORM contains two specifications: the Content Aggregation Model (CAM) and the Run-Time Environment (RTE). CAM specifies how individual learning content is described and how a sharable and interoperable course is composed from the content. The RTE specifies an Application Programming Interface (API) and data model for course packages to interface with the LMS (ADL, 2006).

2.5.2 The SCORM Content Aggregation Model

The SCORM CAM has three types of information which are the content model, metadata and content packaging (ADL, 2006).

(i) SCORM Content Model

The model describes the SCORM components used to build a learning experience from reusable learning resources. SCORM content model is made up of three types of content: assets, SCO and Content Aggregations.

- **Assets:-** These are learning contents in their most basic forms, composed of electronic representations of media, text, images, sound, web pages, assessment objects etc which can be delivered to a web client.

- **Sharable Content Object:-** A collection of one or more assets. A SCO represents the lowest level of granularity of learning resources. One or more SCOs can be aggregated to form a higher-level unit of instruction that fulfills higher level of learning objectives. One of the SCOs should implement the prescribed methods to interface with LMS. SCO can be launched and tracked by LMS. The SCORM does not impose any particular constraints on the exact size of a SCO.
- **Content Aggregation:-** Is a map (content structure) that can be used to aggregate learning resources into a cohesive unit of instruction e.g. subject, chapter, topic etc. The content structure defines the taxonomic representation of the learning resources. It is like a table of contents to organize the sequence and navigation of content in a course.

(ii) Metadata

SCO are described, searched and discovered by using metadata which follow some standards i.e. LOM standard (IEEE LTSC, 2000). The purpose of this standard is to facilitate search, evaluation, acquisition, and use of learning objects. The purpose is also to facilitate the sharing and exchange of learning objects. The LOM standard was also developed to enable the use and re-use of technology-supported learning resources such as computer-based training and distance learning. SCORM allows metadata to be included in every object and in every content package.

Metadata is a formal and structured way of describing the LO so it can be found when searched for or otherwise make it easier to retrieve, use or manage an information resource. It is also a mechanism used for the management of LO and digital rights information (Ravasio et al., 2003). In the context of digital LOs, metadata refers to information about the learning object: what the content is about, who the authors and developers are, who the target audiences are, who owns the object, and how it may be used, etc (Smith, 2004).

Metadata is often defined as “data about data”. A metadata record generally only exists or has meaning in relation to a referenced document or objects and consists of a set of attributes or elements necessary to describe that resource (Hillmann, 2000). The term metadata is used differently in different communities. In the library environment, metadata is commonly used for any formal scheme of resource description, applying to any type of object, digital or non-digital. Traditional library cataloguing is a form of metadata.

The LOM defines the minimal set of attributes to manage, locate, and evaluate learning objects. The attributes are grouped into eight categories (IEEE LTSC, 2000) which are:

- (a) General: Provides information that describes the learning object as a whole such as title, a brief textual description, and keywords.
- (b) Life Cycle: Describes the development and current state of the resource (learning object).
- (c) Meta-MetaData: Describes the metadata itself (rather than the learning object), e.g., who entered or validated this meta-data instance and what language it is written in.

- (d) Technical: Provides information on technical requirements and the characteristics of the learning object. i.e. media type, size, software requirements, etc. for those learning objects to which these attributes apply.
- (e) Educational: Is intended to provide basic information about the pedagogical characteristics of the resource.
- (f) Rights: Describes the conditions under which one may acquire and use the learning object.
- (g) Relation: Is intended to describe the learning object in relation to other learning objects.
- (h) Annotation: Allows for the accumulation of comments by persons who have used or are otherwise evaluating the learning object.
- (i) Classification: Describes this learning object in relation to a particular classification system. It provides a means of extending the LOM to meet specialized needs.

(iii) Content Packaging

A content package bundles content objects (assets and SCOs) or aggregations of content objects together with a content organization. A SCORM content package may represent a course, lesson, module or may simply be a collection of related objects. The manifest, an essential part of all SCORM Content Packages is similar in many ways to a “packing slip”. It lists the contents of the package and may include an optional description of the content structure. The content packaging component is a standard format for packaging the final SCO for electronic transfer. SCORM uses a standard file format, Package Interchange File (PIF), to package the SCO, at the root of this package must reside an eXtensible Markup Language (XML) file, which describes the contents of the package and how to access and structure its contents in the target system (ADL, 2006).

Content needs to be packaged due to the following reasons; firstly, many e-Learning contents are now being created in the form of learning objects, which need to be assembled in order to form a coherent e-Learning course. Secondly, e-Learning contents need to be stored in digital repositories so that they can be made accessible to as many students and across many dispersed areas. Thirdly, there is a need to address the reusability of the course materials (Chew, 2001).

2.5.3 The SCORM Run-Time Environment

The purpose of the SCORM Run-Time Environment (RTE) is to provide for interoperability between SCO and LMSs. For this to be possible, there must be a common way to launch content, a common way for content to communicate with an LMS, and predefined data elements that are exchanged between an LMS and content during its execution. The three components of the SCORM are defined as Launch, API and Data Model (ADL, 2006).

- (i) Launch – Defines the conventions by which LMS and SCORM conforming content will be delivered and displayed to the learner.
- (ii) The API – Provides a set of functions to enable communication between the LMS and the SCOs it launches. These functions complete the launch process

- by establishing a “handshake” between the SCO and the LMS that launched it, and breaking that handshake when the SCO is no longer needed.
- (iii) The Data Model – Provides the vocabulary agreed to pass information, or to “get” and “set” data from and to an LMS when calling API functions.

2.6 CONTENT REPOSITORIES

e-Learning relies on digital-based learning curricula and contents which have been converted from paper forms. In addition, the contents need to be restructured to allow for ease of navigation, self-learning, access and self-test. There is need to develop a generic model for course content transformation into digitized form (Zahran, 2003).

A repository is a collection of learning objects (or metadata describing learning objects) that is managed by technology; it allows users to find, retrieve, publish or submit them via a network. e-Learning repository allows small building blocks (e-Learning objects) to be tagged for storage and subsequent retrieval, facilitating flexible re-use of small elements of learning, thereby allowing the sharing of objects across a wide variety of subjects and authors. In addition to housing LOs, repositories can store ‘locations’ for objects that are held elsewhere i.e. Virtual Objects or URLs (The JORUM Team, 2005).

2.7 MULTIMEDIA LEARNING RESOURCES

The rapid development of computer and Internet technologies has made e-Learning become an important learning method. One of the key characteristics of e-Learning is its capability to integrate different media, such as text, picture, audio, animation and video to create a multimedia instructional material, promoting the reading interests and willingness of the learner (Gillani et al., 1997; Vichuda et al., 2001).

Researches proved that humans have several forms of intelligence instead of a single static Intelligence Quotient (IQ) and individual learning styles are largely dependent on this diversity. A learner’s dominant sensory system, i.e. visual, auditory or kinaesthetic, also plays a major role in determining their natural learning style. If the teaching style employed closely matches learner’s preferred style, learning becomes more natural and easier hence consequently reduces learning time and improve results (Collin, 1987). Multimedia technologies can be used to forge stimulating, interactive learning environments and are essential in the creation of e-Learning systems which support multiple learning styles as they present a wide range of graphical, textual and aural sources. Studies focused on the effectiveness of this type of education have proven that multimedia learning resources can enhance motivation, attention, comprehension and recall.

The inclusion of multimedia in the design of learning objects concerns the means used to make the content as illustrative as possible. The use of multimedia elements such as images and different animated formats is important here. Images are very useful when it comes to explaining difficult issues. Some difficulty concepts in the laboratory

experiments for instance, can be understood much more easily when explained using an appropriate multimedia object.

2.8 e-LEARNING CONTENT DELIVERY APPROACHES

Various approaches can be used to make learning objects available over the web. The simplest approach is to generate web pages containing these resources and make the web pages available through a web site for the course. The other approach is to use a full-fledged course management system such as a Learning Content Management System (LCMS). Other approaches may include CD-ROM, print based material, presentational slides etc. e-Learning materials can be delivered using different modes; asynchronous or self study learning, synchronous leaning and blended learning (Singh, 2003).

The recent advances in the distance education have potential to fill the gaps between time and location constraints. Distance learning is now truly able to help bridging the digital divide and realize the purpose of the flexible education and lifelong learning. According to the time component, the distance learning could be divided into asynchronous and synchronous learning (Chen et al., 2004). So, is the form of e-Learning system, can either operate in asynchronous or synchronous mode.

2.8.1 Asynchronous Mode

Asynchronous or self study learning; consists of content that is available online at any time that the student wants to access it (Singh, 2003). Is where communication, collaboration and learning can occur in different time and different place, and users can select when they wish to communicate. Based on the developed techniques of networking, asynchronous learning is split up into on-line and off-line status (Fang et al., 2006).

➤ Off-line Learning

Computer-Aided Instruction (CAI) is a typical method of off-line learning (Huang et al., 1998). In general, the content of CAI — text, graphs, pictures, audio and video are stored in a CD-ROM. Recent product a Digital Versatile Disk (DVD) - ROM is capable to store seven times more capacities than a CD-ROM. Therefore, these two kinds of disks are basic storage for off-line learning. In general, interactive response on off-line state is faster than on-line state. Once the contents have been stored, editing is not allowable. Hence, it is suitable to construct the core courses that are well developed fundamental curriculum.

➤ On-line Learning

The content of on-line learning is built by the hypermedia technique, which is stored in the network computer server. Students can study or review the contents from the web site at anytime. There are two types of data sources, the static type based on text, graphs and pictures combined as the auxiliary parts of the resources to provide the leaner a complete concept. The second is dynamic involve motion pictures, associated texts, matched sounds etc. The static resources require less bandwidth than the dynamic content; however, it lacks sense of reality that enables the learners get a

whole picture of the subject. On the other hand, the latter type enables the learners' to feel the sense of reality. Students would pay more attention on the subjects due to the colourful and diversified environment; hence the outcome is better than the former one. But, huge amount of data and slow transmission speed of the net are its weaknesses. Contents are allowed to renew at anytime, therefore, it always remains up-to-date (Fang et al., 2006).

2.8.2 Synchronous Mode

Synchronous learning; is generally occurring in real-time with highly interactive and structurally dynamically characteristics, is led by the instructor (Singh, 2003). Allows people to interact with each other at the same time in different places, synchronous e-Learning imitates a classroom, which means classes take place in real-time and connect instructors and students via streaming audio or video or through a conference room. Synchronous learning requires the presence of both parties at the same time for the learning to take place. Therefore, it is also referred to as live or real-time interaction (Harriman, 2005). Discussion between students and instructor is ongoing in real time via the system equipment. Instructor and students may not meet each other face-to-face. Moreover, the common source of content is distributed to learners at the same time in different places, that avoiding repetition work of the lecture. The environment is named Videoconference Classroom. Although it has several advantages, steady and wide bandwidth network configuration is absolutely needed (Fang et al., 2006). The most important advantages of synchronous learning are immediate feedbacks and more motivation and obligation to be present and participate (Harriman, 2005).

2.8.3 Blended Learning

Blended learning also called hybrid learning, is the mixing and integration of different learning delivery approaches including classroom and e-Learning to create a single learning programme. This mode meets the needs of larger numbers of students and teachers, and seems to be a key component of the more successful uses of ICT (Smith, 2001).

To complement traditional methods of delivery, e-Learning is often being used in a blended manner (Valiathan, 2002). The term blended learning is used to describe a solution that combines several different delivery methods. These can be a mix of various event-based activities such as face to face classrooms, self-paced learning (asynchronous), and synchronous. A mixture of face-to-face and e-Learning is known as hybrid or blended e-Learning (Buzetto-More et al., 2006). With blended learning, technology-delivered learning and the classroom come together to generate the best possible offering (Larry et al., 2002).

Past patterns suggest that the likely future will be neither solely depend on online learning nor solely depend on instructor-led classroom learning. It appears that the hybrid or blended models most frequently emerge as the most effective learning strategies (Lating, 2006). Determining the right blend of technology-delivered and classroom-based learning is almost like perfecting a recipe. The real situation for secondary schools in Tanzania is that there is nothing *e-* in the education system, there

is need to look for better ways of delivering the instruction in order to solve the problems faced.

2.9 OPEN SOURCE SOFTWARE

Open source refers to software's source code that is freely available to anyone who wishes to extend, modify, and improve the code. Some examples of open source projects are Linux (<http://www.linux.org>), Apache (<http://www.apache.org>), Mozilla (<http://www.mozilla.org>), and OpenOffice (<http://www.openoffice.org>) (Koohang et.al, 2005).

The most popular open source license is called the General Public License (GPL). The GPL stipulates not only that the source license needs to be available, but also the program can be modified and re-distributed, as long as that re-distributed program is also governed by the GPL (Murrain, 2007). The GNU project (<http://www.gnu.org>) defines free software as “a matter of the users' freedom to run, copy, distribute, study, change and improve the software”.

2.9.1 Proprietary Software

On the other hand, software that is not Open Source is also referred to with different terms, such as commercial software or proprietary software. Proprietary indicates closed source, the source code strictly belongs to the vendor and it is not given to the public. The code of the software cannot be modified, copied or changed from its original construction. It costs money to acquire and maintain it in terms of license fees (Koohang et al., 2005). Most proprietary licenses explicitly limit the number of allowed users (Murrain, 2007).

2.9.2 Open Source Software in Education

Open Source Software can play an important role in education, especially in developing countries. The open source model encompasses a set of principles and values that ensure the integrity of OSS. The use of OSS in education is more encouraged due to many reasons as compared to proprietary software (Tong, 2004);

- **Lower costs** – OSS can lower the barriers to the access of ICTs by reducing the cost of software, there is no license fee, can be freely distributed, and have negligible upgrading costs
- **More reliable** – bugs are rapidly removed with the help of large number of developers, availability of source code allows vulnerabilities to be identified and resolved by third parties
- **The open philosophy** – OSS is consistent with academic freedom and open dissemination of knowledge and information common in academia
- **Encourage innovations** – as academic environment will encourage students and staff to experiment with and participate in the development of OSS that may eventually lead to innovative solutions
- **Alternative to illegal copies** – with OSS one can make unlimited copies of software and re-distribute without any harm

- **Localization** – there are possibilities for non-English speaking countries to localize the OSS, with proprietary software localization is constrained by commercial interests
- **Learning from source code** – Due to code availability, it can be examined and modified (customization) to meet user needs

In the past several years in developed countries, higher education institutions have initiated the creation of enterprise open source applications such as course management systems and electronic portfolios. These e-Learning applications initiatives are initial steps taken by the higher education sector to move away from proprietary software towards open source. With open source, the system becomes open, flexible and transparent and reduces the vendor lock-in. There will be ultimate access/control, ownership, and freedom. The open system encourages increased exchange of ideas that advances innovation, (Koochang et al., 2005). The open software environment is slowly coming up to developing countries although the pace is very slow due to the effects of digital divide.

2.9.3 MySQL Open Source Database Management System

MySQL is a server-based database. It differs from the database management system such as Microsoft Access which is primarily designed as stand-alone desktop databases for a single user. In contrast, server-based databases are designed to be used on servers instead of on desktops, and they are meant to be shared by many users. Technically, multiple users can share in stand-alone desktop databases, but as the number of users increase and the number of requests for information increases performance suffers greatly. That is why a server-based database is a common choice where many people need to share data (Murray, 2002).

Primarily; cost, stability, and security are the reasons to choose an Open Source server-based database management package, MySQL is freely available, fairly easy to set up, and more secure. MySQL database system runs well on UNIX-based operating systems (OS) such as Linux as well as Windows. In general however, UNIX is a better OS for multi-user database applications because of its stability and scalability.

2.10 WEB BASED TECHNOLOGIES

Web based technologies are integrated software packages that offer all the appropriate characteristics and functionalities for building integrated e-Learning applications (Mazure, 1996). The adoption of web based technologies in learning communities has increased efficiency and quality of learning systems. There are possibilities of creating context based authoring tools to meet user demands, increase communication and interactivity. Learning contents can also be created and distributed to learners by creating web pages or make use of learning management platforms to deliver content to the learner.

At present, there is available a wide variety of learning content authoring tools and a lot of them conform to one or more learning technology specifications. The vast majority of these tools can import various content types (text, figures, charts, presentation, multimedia files, etc.) and produce web-compliant content (HTML, eXtensible Hypertext Markup Language (XHTML), XML, JavaScript (JS), etc.) that

can be used by an e-Learning environment. They allow content to be broken down into discrete objects, though the level of granularity they can achieve may vary (Banks et al., 2003).

Web-based integrated learning systems will revolutionise e-Learning by enabling personalised, interactive, just-in-time, current and user-centric learning tools. These systems will allow all facets of a course, including lessons, practice, self-assessment, collaboration activities, etc. to be tracked in order to make the necessary adjustments for improving the course quality and the learners to be able to monitor their progress (Avouris et al., 2003)

2.10.1 Markup Languages

A markup language is a set of annotations to text that describe how it is to be structured, laid out or formatted. Examples of markup languages in use today are HTML, XHTML and XML (Wikipedia, 2006). Markup language is a language that is basically used to create web pages (or hypertexts) which has pre-defined sets of tags to format the content of the web pages. Tags are words imbedded between the <triangle-brackets>. The tags directs the browser what to render/display on the page. Different tags will perform different functions. The tags themselves do not appear when viewing the page through a browser but their effects do.

Every web page is written using some standard. W3C (World Wide Web Consortium) is a body which creates different standards to be used in web. HTML or XHTML is one such standard that W3C recommends for creating web pages and is the de-facto industry standard these days for creating web pages. The document written in markup languages can be saved using 'html', or 'htm' or 'xhtml' formats so that it can be viewed by any browser like Internet Explorer, Mozilla Firefox, Netscape Navigator etc.

2.10.2 Cascading Style Sheets

Markup languages just display the contents and cannot format the content. Cascading Style Sheets (CSS) is used to control look and feel of the markup (X/HTML) document in an organized and efficient manner. A style sheet is simply a list of style rules that tell a browser how to present a web page. It should be used to control the visual effects, or style used, such as font and colour formatting and the visual layout of different parts of the page content.

CSS has been designed to be readable by humans: most of the terms used are self-explanatory whole words, for instance "background-color". The style sheets are called "cascading" because a rule declared for one element can cascade down through other elements without having to be declared again.

CSS can be written using a simple editor like Microsoft notepad, and save a file with .css extension. CSS can be applied to web pages in many ways. However, the most powerful way to employ CSS rules is from an external cascading style sheet. Advantages of using external style sheets include: web pages size reduction, same styles can be used in different web pages without having to code them again and again, and updating the master style sheets will simultaneously update styles on every page of the website

2.10.3 Scripting Languages

Scripting languages are programs that are responsible for improving the design of a web page. Use of scripts on the website allows addition of many new “interactive” features like feedback forms, guest books, message boards, counters etc hence gives a more professional image. By using the scripting languages communication between the client and the server and between the server and the database can be established. There are scripting languages for client side and server side.

Java Script, a client-side scripting language usually imbedded directly to the web pages. It is the most popular scripting language on the Internet and works in all browsers. Java script can be imbedded in the X/HTML document or used externally when you want to run the same script on several pages without having to write the same script on every page. If using externally the script must be saved with a .js file extension, and can be pointed to when required in the X/HTML document (Wikipedia, 2007b).

PHP Hypertext Preprocessor (PHP) is a server-side scripting language for creating dynamic and interactive websites. PHP is an OSS and supports many databases like MySQL, Oracle, PostgreSQL etc. PHP file may contain text, X/HTML and scripts, and saved with a .php file extension (Wikipedia, 2007b).

2.10.4 The W/LAMP Environment

The W/LAMP environment is a stack of software usually free and OSS used to run dynamic websites or servers, Apache web server, MySQL Database, and PHP scripting language. Windows Apache MySQL PHP (WAMP) is based on windows operating system and Linux Apache MySQL PHP (LAMP) is based on Linux operating system. The combination of these technologies is used primarily to define a web server infrastructure, define a programming paradigm of developing software and establish a software distribution package (Wikipedia, 2007a).

3. RESEARCH METHODOLOGY

This research incorporates two methodologies; the instructional design (ID) methodology and the participatory action research (PAR) methodology.

ID leans on software engineering approaches and makes sure that the e-Learning content is designed systematically and not in a haphazard manner. Instructional design aims at a learner-centred rather than the traditional teacher-centred approach to instruction, so that effective learning can take place. This means that every component of the instruction is governed by the learning outcomes, which have been determined after a thorough analysis of the learners' needs (McGriff, 2000).

The PAR methodology ensures that the participation of users is taken into consideration throughout the instructional system design process. PAR is more of a holistic approach to problem-solving, rather than a single method for collecting and analyzing data, it allows for several different research tools to be used as the project is conducted. These various methods, which are generally common to the qualitative research paradigm, include; document collection and analysis, participant observation recordings, questionnaire surveys, case studies, focus group discussions, structured and unstructured interviews (Ferrance, 2000).

3.1 PARTICIPATORY ACTION RESEARCH METHODOLOGY

PAR methodology aims at contributing to both the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. Thus, there is a dual commitment in PAR to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client, and thus it stresses the importance of co-learning as a primary aspect of the research process (O'Brien, 1998).

PAR is people-centred in the sense that the process of critical inquiry is informed by and responds to the experiences and needs of oppressed people (Brown, 1985). PAR is about power, and power is crucial to the construction of reality, language, meanings and rituals of truth (Foucault, 1994). PAR promotes empowerment through the development of common knowledge and critical awareness which are suppressed by the dominant knowledge system.

In PAR, the process is seen as a spiral activity going through repeated cycles and changing each time. It is therefore seen as a continual and integral process of linking research and practice. It is an approach or methodology which enables researchers and their participants to learn from each other through a cycle of planning, action, observation and reflection (Steeple, 2004). PAR challenges practices that separate the researcher from the researched and promotes the building of a partnership between researchers and the people under study (Freire, 2000). Both researchers and participants are actors in the investigative process, influencing the flow, interpreting the content, and sharing options for action forge. PAR also attempts to be an interactive process, rather than a one-off exercise extracting information from people.

This approach involves the active collaboration of the research participants as shapers of the research process. This requires that the research process be operated as an exploration with participants to enable gain of better understanding of user needs and context (Salmon, 2002). There is a need to understand users' needs, concerns and preoccupations as well as aspects of their practice and contexts in order to align, in effective ways, the development of e-Learning content and delivery to support their learning activity.

Several attributes separate action research from other types of research. Primary is its focus on turning the people involved into researchers too, people learn best, and more willingly apply what they have learned, when they do it themselves. It also has a social dimension - the research takes place in real-world situations, and aims to solve real problems. Finally, the initiating researcher, unlike in other disciplines, makes no attempt to remain objective, but openly acknowledges their bias to the other participants (O'Brien, 1998).

PAR is used in real situations, rather than in contrived, experimental studies, since its primary focus is on solving real problems. It can, however, be used by social scientists for preliminary or pilot research, especially when the situation is too ambiguous to frame a precise research question. Mostly, though, in accordance with its principles, it is chosen when circumstances require flexibility, the involvement of the people in the research, or change must take place quickly or holistically (O'Brien, 1998).

PAR can be used as a methodology for developing learning objects, involving successive cycles of reflection and feedback between researching and developing learning objects. This approach is important for collecting and analyzing data using qualitative methods. PAR is of paramount importance for educational research (Cochrane, 2005).

Within all the definitions of participatory action research, there are basically five themes of consideration which are: empowerment of participants, collaboration through participation, acquisition of knowledge, social change and co-learning (O'Brien, 1998). In the educational theme, PAR is a collaborative activity among colleagues searching for solutions to everyday, real problems experienced in schools, or looking for ways to improve instruction and increase student achievement (Ferrance, 2000).

3.1.1 Rationale for Using Participatory Action Research Methodology

Participatory methodologies have emphasis on actively engaging user groups in processes involving enquiry, intervention and implementation related to their needs. The rationale for including users is based on the acknowledgement that users themselves have much first-hand information, knowledge and experience, they bring valuable insights into decision-making processes, and participation encourages a sense of ownership related to the final outcome (Stringer, 1999).

PAR methodology adds value to the research

- Improves research by enriching understanding of the lived realities of users, and arriving at solutions which make sense and relevance to those affected
- Values collaboration with non-researcher participants. While the action researcher brings to the research process theoretical knowledge, experience and

skills of conducting a research, the participant collaborators bring practical and tacit knowledge and experience about situations that are being studied

- It is a way of designing a functional system that meets users requirements
- It empowers users ownership of the system and skills from the very early stages of design
- Builds trust between users and researchers in solving together a problem which is existing
- It is domain-based it tries to involve all affected parties and stakeholders
- It is contextual - as it entails reconstituting the structural relations among actors in a social environment

3.2 INSTRUCTIONAL DESIGN METHODOLOGY

The systematic design of instruction is a way to ensure the quality of the instruction (Dick. et al., 2005). Instructional System Design (ISD) is a defined process used to determine where there is a training need, develop targeted learning to meet that need, and evaluate whether that need has been met (Cot, 2004). It guides in the design of learning materials in a systematic manner; it identifies the outcome of the instruction and establishes how instructional effectiveness will be evaluated.

High quality instructions with good support services are among the key factors in order to develop efficient and effective learning systems to meet the needs of many users. ISD is the backbone of a course conversion process, it is a process to ensure learning does not occur in a haphazard manner, but is developed using a process with specific measurable outcomes. This approach provides a step-by-step system for the evaluation of students' analysis, the design and development of training materials, and the evaluation of the effectiveness of the training intervention (Cot, 2004).

The choice of an ID model to follow to build effective instruction is frequently difficult since there are many different models based on a variety of contexts which might not be relevant to our context, hence going for the generic ISD model. Examples of other models which are derivatives of the ADDIE are;

- Dick and Carey Design Model – It uses systems approach for designing instruction. The design model describes phases of an iterative process. It is learner centred model but has the limitation that behavior is not considered
- Knirk and Gustafson Design Model – Is a three stage process which includes problem determination, design and development. The model appears simple in its design but inclusive of details and focus on evaluation and development seem to be very late in the process
- Rapid Prototyping Design Model – Is a four level process which includes needs analysis, constructing a prototype, utilizing the prototype to perform research and installing the final system. This model relies on expert instructional designers

For best development of e-Learning contents, the research uses the instructional system design ADDIE model. ADDIE is the process of developing e-Learning content systematically (Dick et al., 2005). With the generic model it is easier to design

according to our needs and also there are possibilities of designing a hybrid model system to integrate the benefits of teacher-centred approaches and student-centred approaches. Furthermore, with the ADDIE model the development will cover all the stages as required. In this research, the ADDIE model is integrated with the PAR methodology in order to include the participation of users in all phases. PAR methodology is very crucial in developing systems which are new to the environment and have to be functional in accordance to the user's needs.

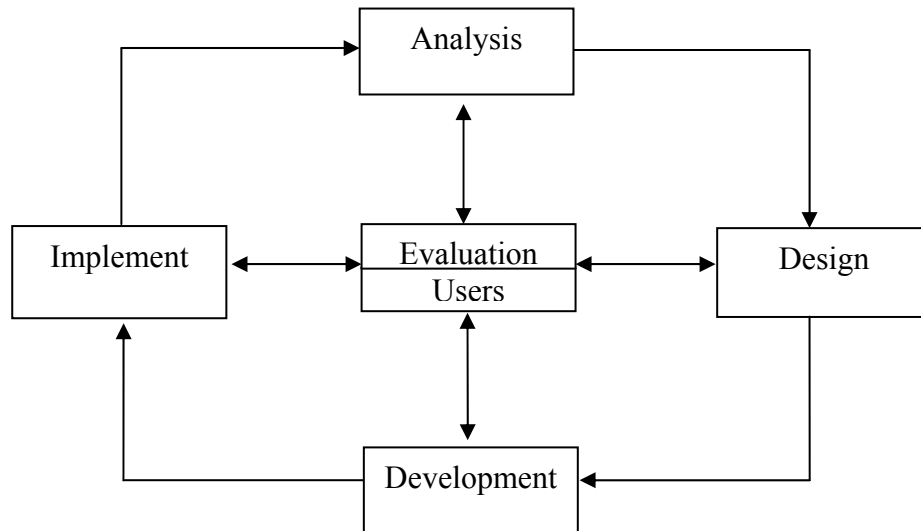


Figure 3.1: ADDIE Flow Chart Incorporates Users' Participation

Figure 3.1, shows the ADDIE flow chart which incorporates users in all phases. As for the scope of this research, the design, development and implementation phases are based on the prototype to be designed for the pilot site and the subject under consideration is mathematics. Formative evaluation is conducted at each phase to judge for the movement from one phase to another and for the effectiveness of whole process. The model allows for user participation in all phases and continuous evaluations of all phases until all the needs are satisfied. It also allows for any modification thereafter whenever is required to do so.

The analysis phase is the basic and necessary step in order to ensure production of quality learning materials. It comprises of many analyses, but for the scope of this research, needs analysis was conducted which comprised of four analyses which are users, content, context and technology.

The design phase defines the instructional strategies for courses and gives description of the content like a blueprint. It shows how the content should be organized (learning object approach), presented and delivered to learners, it includes also types of activities and exercises. Some of the issues to be considered when devising an instructional strategy are: material grouping and sequencing, instructional methods and tactics (pedagogy) to be used to present materials, learner's assessments methods, etc.

A successful development phase draws upon information collected in the analysis phase and the decisions made in the instructional design phase. Using these information, prototype can be created and course material developed. Development phase will result

into consistency subject materials with sound instructional design principles, technological and pedagogical strategies.

The implementation phase in this case will involve testing a developed prototype in the pilot site. The test must check for content pedagogical design, accessibility and delivery issues, also test on the functions of the content repository.

Two types of evaluation are considered in this model, i.e. formative evaluation normally done at each phase and summative evaluation done at the end of all phases. Formative evaluation is preferred for better quality of the product. Although for the scope of this research only formative evaluation will be covered.

3.3 DATA COLLECTION AND ANALYSIS

The collection of data is an important step in deciding what action needs to be taken. Multiple sources of data are used to better understand the scope of the problem, using at least three sources (triangulation) of data for the basis of actions (Ferrance, 2000). The data is collected through primary sources of data collection such as interviews, questionnaires, observations, surveys, focus group discussion and also through secondary sources of data i.e. readily available reports and literatures.

Until the time of writing this licentiate (2007/08), two comprehensive surveys have already been conducted in different secondary schools in Tanzania. The e-readiness survey, conducted in 2004, where several secondary schools were visited in the rural and semi-rural areas of Tanzania. Another survey was conducted in 2006/7 which clearly gave the justification of the problems which are common in most of the secondary schools in Tanzania as explained in the statement of the problem.

The data collected was analyzed using stratified sampling technique where defined strata i.e. students, teachers, and system administrators were identified and analyzed to represent the whole scenario. At this point, the analysis involved the first phase of the ADDIE methodology i.e. the analysis phase. The needs analysis was conducted and for this context; users, content, context and technology analyses were done. The purpose of the needs analysis was to determine the objective of the instruction, to determine course instructional goals, to define the learning environment in which the learner will learn, to discover information and knowledge to be taught, and to know the behaviours of learners. Statistical analysis for readily available data from NECTA used the excel software package.

More data will be collected during the on-going participatory activities with the stakeholders.

3.4 e-LEARNING CONTENT DESIGN AND DEVELOPMENT

The analysis of materials collected from teachers and relevant books leads in the realization of the current content structure. The aim is to come out with the proper size of learning objects to be used in the e-Learning content design for the new environment.

The learning content will be broken down into smaller chunks in a sequential manner. Subject structuring will follow the top-down approach, i.e. starting from the top level of a subject going down to assets (down level) which are the smallest learning materials. Multimedia technologies and e-Learning pedagogical principles will be integrated to create a self learning and interactive environment.

3.4.1 Learning Object Design Approach

Learning objects are potentially reusable components from which study courses may be constructed. In the current practice, a learning object can be a single idea or it might be a cluster of several concepts to deliver a more substantial chunk of learning (Polsani, 2003). From the learning point of view, a learning object can be composed of information objects (IOs), an overview, summary and assessment (CISCO Systems, 2000). The number of IOs depends on the time allocated for one period and the granularity of the IO. Figure 3.2 shows the composition of a learning object, it comprised of several IOs, overview, summary and assessment objects.

(i) Overview Object

Overview object offers general information about the subject i.e. subject code, level, aims, pre-requisites, co-requisites, learning outcomes, indicative content (information object), assessment strategy and credits.

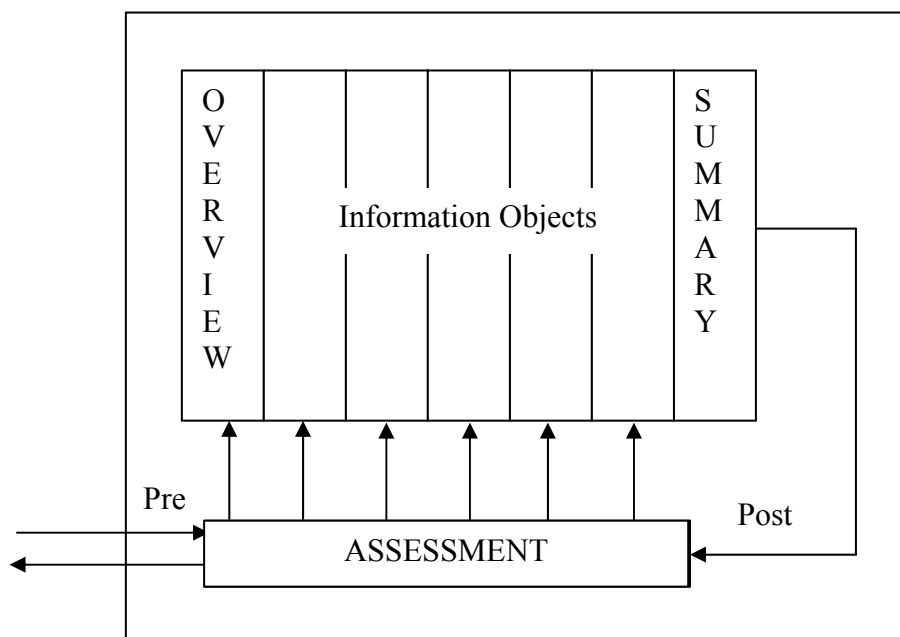


Figure 3.2: Composition of a Learning Object

(ii) The summary Object

The summary object concludes the subject. The summary object reviews the subject, this will assist in self-assessment and self-reflection on understanding the topics and applying the knowledge skills for solving the problems.

(iii) Information Object

This contains the core content. The pedagogical and technical considerations determine the quality of the information object hence directly affecting learning. It also represents a topic in the subject learning object. The attributes of the information object have respective content objects (i.e. Introduction, concept/principle and examples), practice element (learning activities) and assessment item. Figure 3.3 gives an example of components of the information object. Each information object is built upon a single objective and is classified as either being a concept, fact, process, principle or procedure (CISCO Systems, 2000).

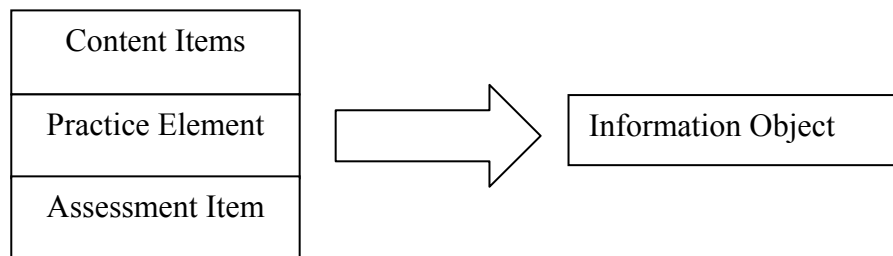


Figure 3.3: Composition of Information Object

3.4.2 Pedagogical Considerations for e-Learning Resources

Pedagogy promotes students centred learning environment and produce learning material with high degree of interactivity. Sound learning materials can only be achieved if pedagogical considerations are incorporated into learning materials.

Pedagogical considerations should be able to help designers to engage in the process of constructing e-Learning material and associated activities in a way that will enact sound principles of pedagogy. A lot of research about learning processes provide evidence for this stance that learning doesn't come from a provision of knowledge solely, but that it is the activities of the learners into the learning environment like solving problems, interacting with real devices, interacting with their social and work situation which are accountable for the learning (Koper, 2001).

In this case study, analysis of data showed that secondary schools in Tanzania have limited resources such as learning and teaching materials, qualified teachers, non functional libraries (Lujara et al., 2007a) and laboratories. The pedagogy to be adopted in the design of e-Learning resources is proposed to be an integration of teacher-centred and student-centred approaches taking into consideration that the e-Learning contents will be used to support the F2F teaching and that it is to be designed for the first time in the pilot site for secondary school students. Instructional approach can be used in the classrooms and whenever a new knowledge has to be introduced to students and

constructivist (learner-centred) approach can be used to strengthen whatever has been taught already by the teacher and in problem solving.

Students in addition to learning and understanding existing knowledge should themselves also produce new knowledge in order to be a part of the knowledge society. In order to respond to these demands, new forms of teaching and learning are required that build upon the possible interconnected nature of goals, tasks, resources, roles, pacing and social structure. This interconnectedness can be very effectively supported by the use of ICTs.

Pedagogy for e-Learning environment must capture most of the learning activities done in a traditional mode. In the process of content analysis, some of the pedagogical considerations for e-Learning content may include;

- Make clear learning objectives for each topic
- Provision of extra references to topics apart from the recommended materials
- Inclusion of more drill and practices
- Provision of frequently self assessment exercises and right type of feedback for student's self assessment
- Material presentation in the order of difficulty which directs progress in the learning process
- Focus on goal oriented learning and activity based learning
- Enforce collaboration among students-students, students-teachers by providing group works/assignments some of which may lead to dialogue that is to be conducted outside the e-Learning environment

The aim is to make content more engaging and self learning, so that students can independently and easily follow the learning content.

3.4.3 Multimedia Content Considerations

Multimedia is the use of text, graphics, animation, pictures, videos and sound to present information (Bagui, 1998). Multimedia involves the simultaneous use of multiple media formats (Hede et al., 2002). In e-Learning environment, multimedia files are digitized and saved in different formats based on established and emerging standards, for delivery via a computer and/or a network.

Multimedia learning combining animation with narration generally improves performance on retention tests better than when information is presented as either text or narration alone. More importantly, meaningful learning is demonstrated when the learner can apply what is presented in new situations, and students perform better on problem-solving transfer tests when they learn with words and pictures (Mayer, 2001).

The analysis of content should clearly indicate parts of the learning materials which need multimedia design. Generally, parts which may need multimedia design consideration include; tough concepts, introducing new concepts, some illustrations,

graphics etc. OSS and web-based technologies can be used in the production of the multimedia contents. CD-ROMs and DVDs are appropriate for multimedia files.

Multimedia resources can best be designed following the learning object approach and act as optional learning objects and interconnected to the base learning object via specific links. A learning object may be thus simple, consisting of one independent object, or it may be compound. A compound object consists of two or more independent learning objects that are linked to create the compound. Compound objects support alternative views of the same learning issue, e.g. as a text based explanation or as a multimedia animation. They thus provide a basis for pedagogical richness that fully exploits the opportunities offered by the technology. It provides a basis for repurposing through the addition or deletion of objects to amplify or shape the pedagogical richness of the compound object (Boyle, 2003).

In some cases graphics may need to be put into motion i.e. animation. Animations are time consuming to develop, so they should be used only when they add significant interest level to the material or engages the learner. An example of animated graphics would be an animated character that provides suggestions for obtaining help and guides the learner through the subject content. Due to limited Internet bandwidth and inadequacy of high capacity computers, care should be taken not to design too richly multimedia contents to avoid slowness or clogging the system during content delivery.

3.4.4 Content Packaging and Metadata

The content must be packaged in order to be stored and delivered without any difficulties. Content packaging may correspond to the reuse of existing learning resources in courseware authoring and the delivery stages where resources are repurposed and assembled, from different sources such as digital repositories (Low, 2002).

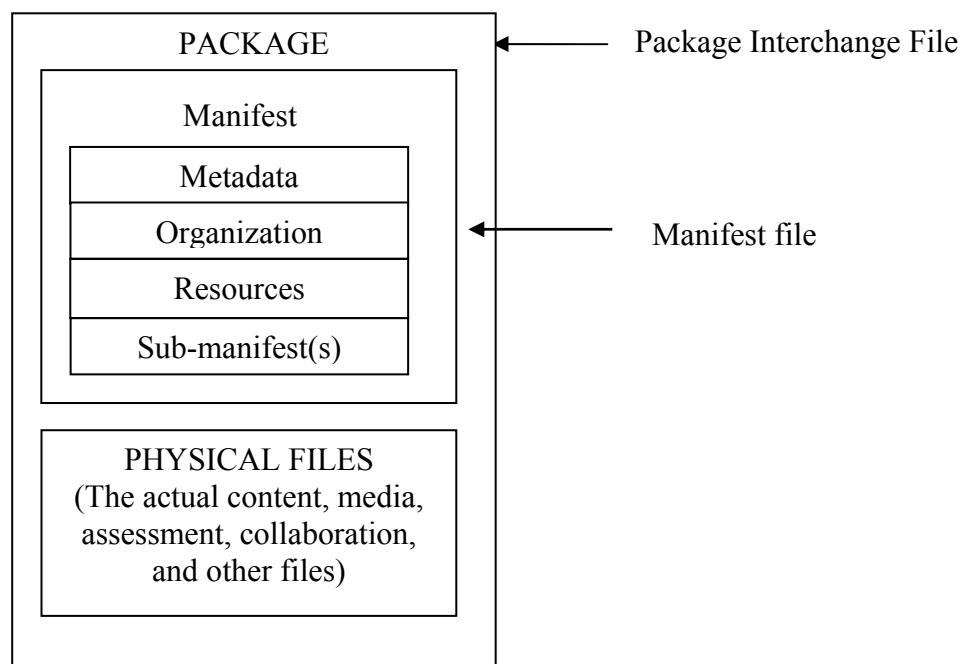


Figure 3.4: IMS Content Packaging Conceptual Model

(IMS Global Learning Consortium, 2004)

The reuse of educational resources can be accomplished through the practice of separation of content from presentation. Instead of producing materials that are bound to specific presentations and proprietary formats, such practice asserts that educational content can be packaged in open and granular learning objects (Koper, 2001), using standards and specifications such as the IEEE LOM and IMS specifications. Figure 3.4 shows the IMS Content Packaging Conceptual Model.

The content packaging defines the structure and the intended behaviour of a collection of learning resources and also provides a standardized way to update digital learning resources by using Learning Content Object. A content package is a zip file or hierarchical list of files. Content packaging is based on SCORM standards. A content package represents a unit of replaceable content and may be part of the course that can be delivered independently as an entire course or a collection of courses. Package contains two major components (BECTA, 2005);

(i) The manifest file (imsmanifest.xml)

This is a description in XML of the resources comprising meaningful instruction. It is a special document describing the content organization and resources of the package. It is automatically generated based on the context specific meta-data about learning object in the course. It is placed at the root of the Package Interchange File.

(ii) The physical files

These are assets referenced in the manifest file. They are actual files referenced in the resource components. They may be local files that are actually contained within the content package or they can be external files referenced by URLs.

The `imsmanifest.xml` file describes the package itself through the metadata, organization and resources units (IMS Global Learning Consortium, 2004)

- (a) **Metadata:** - Provides a common nomenclature enabling learning resources to be described in a common way. Learning resources described with metadata can be systematically searched for and retrieved.
- (b) **Organization:** - Describes how the contents of the learning object are to be presented to the learner. Each manifest must contain an organization. Essentially, organization is organizing the learning object contents into tree structured that complies with the pedagogical approach considered.
- (c) **Resources:** - Contain all references to all the actual resources and media elements that make up the learning object. May also include metadata describing the resources and any references to files held externally.
- (d) **Submanifest(s):** - Describes any logically nested units of instruction (which can be treated as stand-alone units).

3.5 CONTENT REPOSITORY DEVELOPMENT

The contents to be created will be stored in a repository for proper management. Design and development of content repository will involve use of OSS. The plan is to use LAMP environment. A database structure is first determined depending on the subject structure obtained in the instructional system design. Different user interfaces for

subject authoring and retrieval will be developed with the help of markup languages, scripting languages and style sheets which include; XHTML and XML technologies, PHP, JS, and CSS.

The content repository design is an iterative process, starting from the table structures to the development of the database. End users are involved as early as possible to meet the end user's needs, the earlier the users are involved the quicker it can be understood what is useful and what decisions are good ones while making the user feel they are part of the design process.

3.6 INSTRUCTIONAL USER INTERFACE DESIGN

Different user interfaces will be designed depending on the user role in the management and usage of the system. The main roles defined in the system are student, teacher, content administrator, guest, MoEVT official, system administrator and school administrator. For instructional purposes content administrator's interface will be designed to deal with content creation and upload to the system and any modification if required. The design of the user interface will involve use of web technologies and OSS packages.

3.7 OPEN SOURCE SOFTWARE PLATFORMS CUSTOMIZATION

To ease the development process, the use of existing content management systems with modifications is suggested to help generate a timely solution. Most content management systems could support the basic functions needed, but there is a need of detailed customization to meet users' needs and context. The customization techniques give chance of making use of code reuse approach in the development process to attain various system functionalities. Hence development of content repository involves a thorough understanding of the existing open source platforms. With the wide array of choices in the open source space, it is hard to choose the right solution for ones needs. Two open source platforms have been identified to work with i.e. Moodle and Claroline.

The selection for the two open source platforms has implications for other tools that are in need to use. Both Moodle and Claroline make use of PHP, HTML, and CSS for the development of pages and MySQL for the database and apache web server. Further more Moodle platform is based on a learner-oriented pedagogy, and uses SCORM e-Learning standards and Claroline is simple in design which can render to have better user friendly interfaces.

3.8 UNIT INTEGRATION AND PROTOTYPE TESTING

Completed units of the developed learning content will in the beginning be tested independently. The unit test focuses on testing functionality and usability within the subject itself, local navigation will also be tested. When unit testing is completed for all units i.e. learning objects, topics, chapters, exercises can be assembled to create a

complete e-Learning subject. External links to any added information will be tested before commissioning the prototype.

3.9 CONTENT DELIVERY MECHANISMS

e-Learning content to be designed will be used to support the existing F2F, chalk and board form of teaching and learning and not to replace the existing delivery methodology. The learning content will be delivered using a blended or hybrid approach which involves more than one form of delivery, i.e. the e-LMS where users will access the contents for online delivery. Other delivery mechanisms are off-line using CD-ROMs, Digital Video Discs Read Only Memory (DVD-ROMs) or Flash memories. For larger multimedia files, DVD-ROMs and Flash Discs can provide a better option than CD-ROMs.

4. PRELIMINARY SURVEYS AND ANALYSIS

4.1 INTRODUCTION

The feasibility of doing this research is based on the preliminary data collected from the two surveys, the literature review, reports from MoEVT, NECTA and also from the on-going participatory activities with the relevant stakeholders. Some of the methods used in the process of data collection include:

- Questionnaires (Students, Librarian, Teachers, Head Teachers)
- Consultation with persons in the key positions - Head Teachers, MoEVT Officials, Regional Administrative Secretary (RAS) and Regional Education Officer (REO)
- Review of relevant literature
- Interviews (Students, Teachers and Head Teachers)
- Direct observation (Students, Teachers, Notes, library and laboratory conditions)
- Focus group discussions (Students, Teachers and MoEVT officials)
- Using readily available information – reports, studies (NECTA statistical performance reports, Basic Educational Statistics in Tanzania - BEST)

4.2 THE e-READINESS SURVEY IN SECONDARY SCHOOLS– SURVEY I

The main aim of the research is to use ICT tools in the process of reducing some of the problems in the secondary schools. The use of ICT tools needs some minimum requirements of ICT environment which include availability of computers, power and ICT personnel. The e-readiness survey was conducted in 2004 with the main purpose of determining the status of ICT and ICT awareness in secondary schools in Tanzania.

A total of 40 secondary schools were surveyed in 12 districts. Questionnaires were used to collect the data from the schools. The following is a summary of the data collected. The situation varies to some extent from one school to another.

4.2.1 Telecommunication Services to Secondary Schools

Landline telephones are available in most schools, business places and government offices but they are used mainly for voice communication. Most of the secondary schools visited in the townships have landline connections operated by TTCL who is a Public Switched Telephone Network (PSTN) operator. The main mobile telephone companies that provide services in the most of the townships for quite a long time are Celtel, Vodacom, Tigo and Celtel (refer section 1.4.2).

4.2.2 School Details

School details covered information include, school contacts, physical facilities, staff profile, school profile, school financial status, students enrolment and performance, ICT status and means of communication, record keeping and publication.

➤ **School Contact Information**

The data obtained from basic school contact information covered the school location, accessibility, communication information (telephone, fax, and postal address), the name and position of the contacted person was also given. Schools can also be contacted via postal addresses and/or telephone numbers. Many schools are reached by road with exception of very few schools which are not easily accessible due to bad road conditions.

➤ **Physical Facilities**

This gave the information regarding school physical structures (offices, classrooms, labs, libraries, dormitories for boarding schools etc.), school ICT facilities (number of computers, audio/visual teaching aids). Data regarding availability of electrical power was also obtained, if is via Tanzania Electric Supply Company (TANESCO), solar system, or generator. Also information regarding Water Services was obtained i.e. water from Water Supply Company, Well-water, or other alternative means.

Generally most schools had enough classrooms, not enough laboratories for science subjects, not stocked libraries or no libraries at all. Many schools had computer labs though some of them had no computers or had one or two computers only, at least there was a room kept aside for keeping computers. The statistics showed that 26 schools had at least one computer lab, 12 schools had no computer labs and 2 schools did not state if they had any. The availability of electric power through TANESCO is almost there in all schools in the districts. Out of 40 schools surveyed 31 schools had power via TANESCO, 3 schools had power through generators, 3 schools had no electricity and 3 schools did not mention.

➤ **Staff Profile**

The staff profile gave information regarding status of staff, qualification, employment status (fulltime/part-time), computer literacy, gender balance, staff performance evaluation scheme, professional/academic development program, and salary scheme.

➤ **School Profile**

This covered information regarding school ownership, school registration number, donor projects if any, school's subject combinations PCM, PCB, EGM etc, school level (O-Level/A-Level) and type of school (Co-education, Girls', Boys', day/boarding).

➤ **School Financial Status**

School finances depend much on the type of the school i.e. Government owned, or non-government. For Government schools they solely depend on the Government for their sustainability. The school fees for day government schools was TZS 40,000/ (≈USD 40), and for boarding government schools was TZS 70,000/= (≈USD 70). The school fee for private day school was TZS 150,000/= (≈USD 150) and for boarding private schools was TZS 300,000/= (≈USD 300). All rates quoted in 2004 and were for the O-Level secondary schools. Non-government schools, depend on the school fees and any other income generation projects to maintain the school.

➤ **Students Enrolment and Performance**

The aim was to get the school enrolment and the National Form IV Examination results (CSEE) for consecutive four (4) years (2001 – 2004). Only available data was collected,

not all schools provided the information for the whole period requested, some schools provided results for three (3) consecutive years i.e. from 2001 – 2003. In some schools the enrolment information showed enrolment by gender for both at O-level and A-level and in some schools just the total number was given. The data collected for performance showed number of students passed for each division i.e. (I, II, III, IV and 0).

The general performance of all schools in the National Examinations at CSEE level is poor with an exception of very few schools which had performed well. Table 4.1 shows a sample of schools performance in CSEE for the period from 2001 to 2003, the number of students is given under each division. From the table 4.1, with an exception of Kibaha Secondary school, most of the students fall in Division III, IV and 0. Division III is not a bad performance and can promote a student to Form V or other colleges but it depends on individual subject passes, if can make a combination for selection like PCM, PCB, EGM etc. Division IV is poor performance and division 0 is a fail it is not easy to proceed with further studies if one gets such a poor performance. Some of the schools in the sample given are government schools (Kibaha, Kilwa and Bagamoyo), and some are non-government schools (St. Matthews, Forest Hill, and Dindimo).

Table 4.1: Sampled CSEE Performance for the Period 2001 - 2003

Name of Secondary School	YEAR														
	2001					2002					2003				
	DIVISION					DIVISION					DIVISION				
	I	II	III	IV	0	I	II	III	IV	0	I	II	III	IV	0
St. Matthews	Data Not available					6	13	41	110	4	12	33	93	27	0
Kilwa	1	1	3	30	17	1	2	3	27	13	0	2	11	29	12
Kibaha	45	17	17	14	0	64	16	18	06	0	35	7	13	6	0
Bagamoyo	10	16	42	70	21	8	14	47	73	15	13	16	53	81	14
Forest Hill	3	16	48	97	15	9	21	59	111	1	14	17	67	103	4
Dindimo	0	0	1	6	12	0	0	0	10	1	0	1	1	13	12

Source: Survey I Reports

- St. Matthews is a private, boarding co-education secondary school
- Kilwa is a Government, day, co-education secondary school
- Kibaha is a Government, boys', boarding secondary school
- Bagamoyo is a Government, day and boarding, co-education secondary school
- Forest Hill is a private, day, co-education secondary school
- Dindimo is a non-Government – Owned by a religious organization, day and boarding, co-education secondary school

➤ ICT Status

The ICT status gave information on the availability of computer labs, number of available computers, running software packages, computer usage (teaching, administrative work, etc.), computer networking, Internet connection availability and status of staff computer knowledge (computer literacy).

The number of Personal Computers (PCs) in schools varies remarkably. The range varies from a minimum of not possessing even a single computer to 72 pieces. Majority of schools had less than 4 pieces, and very few secondary schools had a considerable

amount just to sight a few schools like; Kigurunyembe 72 Pentium pieces, Machame Girls' 35, Nia Njema 32 pieces and Kaole 30 pieces.

As far as the computer literacy is concerned, 20 schools had ICT personnel in the range of 1 to 5, 7 schools in the range of 6 to 10, 3 schools had none, and 10 schools did not provide the requested data.

➤ **Means of Communication, Record Keeping and Publication**

On the average 90% of the schools indicated that the internal communication is paper based. For schools without telephone, the communication is 100% paper based. For schools which possess computers, computer communication is in the range of 0% - 10% while paper communication ranges between 90% - 100% mainly for administrative, record keeping and publication. For schools which do not have computers, communication is on the average close to 100% paper based.

4.2.3 Surrounding Community

Most of the schools are surrounded by at least one of the followings; teachers' college, other secondary schools, primary schools, bank, TANESCO offices, post office, university (a case in Iringa and Morogoro districts), a dispensary, hospital, church, mosque, government departments (a case in Morogoro) etc. It was noted that, many of the urban and semi rural schools are surrounded by a live community.

4.2.4 The Kibaha Pilot Site

The e-readiness survey conducted in rural and semi rural secondary schools in Tanzania revealed that there are many schools which have taken initiatives to engage in ICT activities by starting computer laboratories. However, the utilization of these ICT facilities in e-Learning is still very low due to the reasons including; lack of connectivity, lack of computers and insufficient number of ICT personnel. In many schools, computers are mainly used for administrative purposes and in some few schools for computer literacy training.

A pilot site was established from the data collected in the e-readiness survey. Among all the schools surveyed, two schools Kibaha secondary and Wali-UI-Asr girls' seminary in Kibaha district, Pwani region were selected to form the pilot site. Several reasons were considered in selecting the pilot site which included;

- The capacity of the two schools chosen in terms of ICT infrastructure
- The active neighbouring community (Kibaha education center, Tumbi Hospital, Government offices – regional headquarters, nearby secondary and primary schools)
- Easy accessibility to the district and schools from UDSM or the city centre, by tarmac road about 30 - 40 minutes from UDSM, Kibaha is 40km from DSM
- The availability of the electrical power by TANESCO which in this case seem to be stable and reliable
- Performance of the two schools in CSEE; Kibaha Secondary has better performance as compared to Wali-UI-Asr girls' seminary

Summary of the specific information obtained from the two schools under e-readiness survey is as presented in table 4.2.

Table 4.2: Pilot Schools Comparative Information

Variable	Wali-UI-Asr Girls' Seminary	Kibaha Secondary School
Basic Infrastructure		
Number of Computers	20pcs	4pcs
Computer Lab	Available	Available
Local Area Network	Available in the administration	None
Power	TANESCO	TANESCO
Connectivity	Leased line from Maili Moja	Leased line from maili moja Possibility of Fiber connectivity
ICT Personnel	4 persons available 1-Degree level 1-Diploma level 2-Certificate level	9 persons available
Accessibility	Excellent by tarmac road 30-40 Minutes from UDSM	Excellent by tarmac road 30-40 Minutes form UDSM
Science Subjects	O-Level - (Mathematics, Physics, Chemistry, Biology) A-Level - (Chemistry, Biology)	O-Level - (Mathematics, Physics, Chemistry, Biology) A-Level - (Mathematics, Physics, Chemistry, Biology)
Boys/Girls/Coed	Girls	Boys
Surrounding Community	Kibaha secondary school (3km) Tumbi secondary school (3km) Kiluvya secondary school(10km) Pwani secondary school (5km) Kibaha Education Centre Regional Headquarters	Wali-UI-Asr girls' seminary (3km) Tumbi secondary school (3km) Kiluvya secondary school(10km) Pwani secondary school (5km) Kibaha Education Centre Regional Headquarters
2006 Form IV (CSEE) Performance	Div – I = 0 Div – II = 2 Div – III = 7 Div – IV = 77 Fail = 11	Div I = 37 Div – II = 10 Div – III = 19 Div – IV = 22 Fail = 2

Source: Summary of Survey I Report

4.3 JUSTIFICATION OF PROBLEMS FACING SECONDARY SCHOOLS – SURVEY II

One of the fundamental requirements of all education institutions is adequate provision of appropriate instructional and learning materials for use by teachers and students. The other fundamental requirement is adequacy of qualified teachers in all subject areas. Many parents in Tanzania fall in the category of low to medium income people with a salary of an average of TZS 80,000/= (\approx USD 80) per month in urban areas. Purchasing of books and other learning materials becomes very difficult and support for their children to sustain schooling sometimes is a problem. Items like school uniforms, stationeries and school fees are among them.

In Tanzania, Government schools depend on the Government budget for sustaining the smooth running of schools, supply of books and learning resources, supply of qualified teachers and their welfare. MoEVT is also responsible for administering the deployment of qualified teachers for Government secondary schools.

The establishment of school libraries has always been the traditional and preferred solution to providing access to supplementary reading material. Libraries not only have the capacity to acquire, organize and make general reading materials available for the use of teachers and students, but can also organize collections of multiple copies of textbooks for loan, when purchase is not possible. But all this depend on the Government (library establishment and maintenance), which is facing lack of enough funds to run the schools; resulting in a situation where the majority of schools do not have libraries at all. Where there is one, it is often a collection of few shelves of outdated and worn out materials, inadequately staffed and thus marginal to the teaching and learning process. The prospects of providing every school with a library is very good but not with the economic situations of developing countries like Tanzania. In reality the solution cannot be reached in the near future.

According to literature reviews and studies done for secondary schools in Tanzania, the secondary schools in Tanzania are faced with many problems but the most critical ones are scarcity of learning resources and inadequacy of qualified teachers (Mbelle et al., 2003; Wedgwood, 2005; WorldBank, 2004).

In 2006/07 another survey (survey II) was conducted in order to get a clear picture of the problems faced by the secondary schools in Tanzania. The survey was done in different secondary schools within four regions, Arusha, Ruvuma, Mbeya and Dodoma. At least 6 schools were reached in each region. The visited schools were both O- and A- levels, located in different environment. Some were easily accessible depending on roads conditions while others were not. Half of the visited schools are Government owned schools and half are private owned. Private ownership includes religious institutions, non-governmental organizations and wealthy individuals.

Five types of questionnaires were used in the data collection phase; the questionnaires were meant for Head Teacher, Teachers, Students, Librarian and for the MoEVT officials. The contents of the questionnaire was mainly based on getting information about teaching and learning activities, status of books and reference materials, teaching methodologies, ICT awareness, students' performance, teachers' qualifications and their deployment status. In some cases, interviews were conducted with students and teachers using open ended questions. The questionnaire for the Ministry officials focused much more on obtaining information about the National ICT policy, Ministry (MoEVT) ICT policy and integration of ICT in schools.

The summary of data from the survey II done in 2006/07 is shown in Figure 4.1. The data in Figure 4.1, presented in tabular and graphical formats clearly indicates the real situation in most of the rural and semi rural secondary schools in Tanzania and hence justifies the existence of the problems which are explained below:

4.3.1 Shortage of Learning and Reference Resources

The average percentages of secondary schools with shortage of books vary from 70% in Arusha region to approximately 100% in Dodoma region. Textbook to students ratio is about 1:28 in the rural secondary schools and 1:10 in the urban secondary schools (Wedgwood, 2005). School libraries are ill furnished and in many cases there are no libraries at all. Many schools depend on the availability of books in regional libraries.

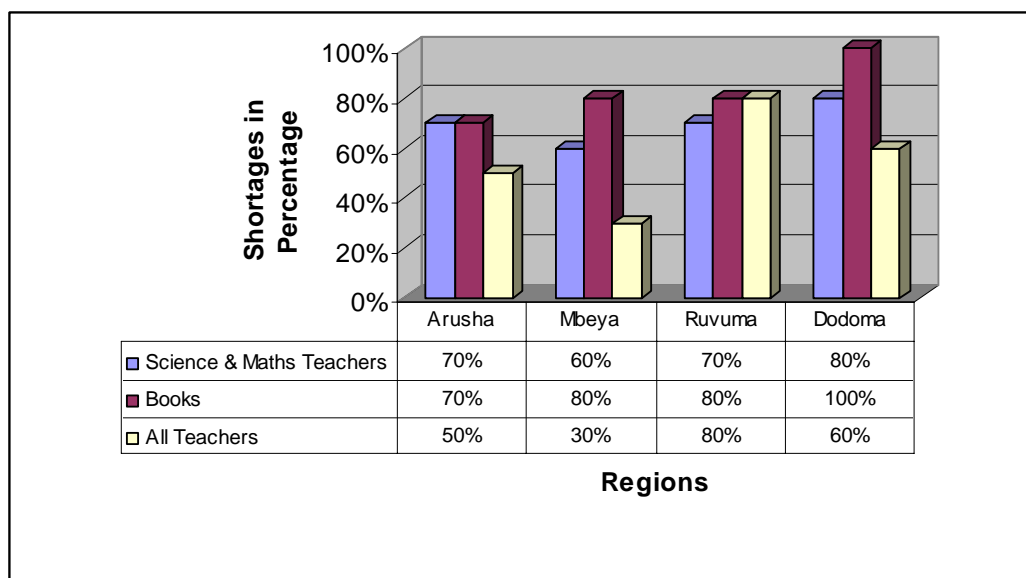


Figure 4.1: Shortages of Teachers and Books in Percentage (Lujara et al., 2007a)

4.3.2 Inadequacy of Qualified Teachers

Average Percentage of secondary schools with shortage of science and mathematics teachers in rural secondary schools lies between 60% in Mbeya region to 80% in Dodoma region. Low population, poor economic and social conditions in rural areas and unfavourable teaching environments are among the main factors, which force qualified teachers to concentrate in urban schools or even run for alternative highly paying jobs.

The average percentage of secondary schools with shortage of all teachers varies from 30% in Mbeya region to 80% in Ruvuma region. In 2004, the literature reported that the pupil to teacher ratio stands at 22:1 but this ratio hides rural – urban disparities and shortages in subjects such as science and mathematics (Sekwao, 2004). In 2006, data from MoEVT shows the pupil to teacher ratio stood at 29:1 (MoEVT BEST, 2006), this is an increase of almost 31.82% within a span of only two years.

The problems mentioned above account to a greater extent to the students' poor performance in the national Form IV examinations. Failure in mathematics for the period 1994 – 2002 was 73%, among other reasons was attributed to shortage of text books and reference materials (Mazigo, 2003). Table 4.3 shows the average failure rate for selected subjects for the years 1994 – 2005 at CSEE level (NECTA Examinations Results Statistics, 1994 - 2005). It can be observed that most of the subjects have average failure rates of more than 40% and the worst condition is seen in mathematics.

The failure factors given clearly indicate that there is a necessity to consider alternative methods to reduce the real problems faced by secondary schools in Tanzania. This necessity can be viewed as an opportunity to emerge to e-Learning solutions. Introduction of open source e-Learning environments and resources can be more of immediate solution to be looked upon which can at least minimize the mentioned problems.

Table 4.3: Average Failure Rate in CSEE Performance for Selected Subjects for the Period 1994 – 2005

S/no.	Subject	%Average Failure Rate
1.	Mathematics	70%
2.	Physics	46%
3.	Chemistry	42%
4.	History	51%
5.	Geography	54%
6.	Civics	44%
7.	Commerce	62%

Source: NECTA Examinations Results Statistics, 1994 - 2005

4.3.3 Participatory Activities with Stakeholders

The process of implementing the PAR approach in the current research reinforces the principles of the ISD process. Since the problem belongs to people, there is a need to incorporate users in all the ADDIE phases in order to arrive at relevant solutions. The PAR allows for extensive collection and examination of data which matches the approach based on the ISD model. The application of the principles of action research in which a change is created and its consequences observed, evaluated, and acted upon is basically equivalent to the ISD cycle of analysis, design, development, implementation and formative evaluation that instructional design maintain until the achievements of instructional effectiveness (Dick et al., 2005). The involvement of participatory activities is one of the practices of action research which leads to a context based solution to the problem.

Apart from the two surveys conducted in different secondary schools in Tanzania in 2004 (refer section 4.2) and 2006/7 (refer section 4.3), there have been a number of participatory activities conducted with the stakeholders in the course of this study. Some of the participatory activities are:

- In 2005/6, a number of visits were done to the two schools in the pilot site in connection with the design and development of a student registration management information system (Appendix A). The visits involved study of the manual students' registration system in the schools, establishing trust with the collaborators, study the ICT environment and also opened doors for the introduction of the ongoing e-Learning project.
- In September – October, 2007, there was a close collaboration with the stakeholders i.e. Teachers, Students and officials from the MoEVT. The collaboration involved visits to the two secondary schools in the pilot site, and to the ministry (MoEVT). This participatory was focused on obtaining more information for the proposed e-

Learning system for secondary schools in Tanzania i.e. TanSSe-L System. Visits to schools involved getting permission from the RAS, District Administrative Officers and the REO, hence introduction and discussion of the e-Learning project at the regional and district level was also part of the participatory methodology.

So far, the proposed TanSSe-L system has been presented to one of the two schools (Kibaha Secondary School) in the pilot area and at the ministry (MoEVT) at different times. The aim was to introduce the project to the stakeholders, for the purpose of getting their views about the project and also to obtain more information and clarification from the users' side on the issues which are not obvious to the researchers or not well covered in the literatures and surveys. In all presentations, time was given for discussion on the presentation and later continued with a guided discussion based on the open ended questionnaires for more clarification.

- In early November 2007, another participatory activity was carried out with a team of lecturers at the faculty of education, UDSM. The discussion was on the pedagogical principles for the learning materials and sharing their experience on pedagogy practicability for F2F form of teaching and learning and for distance learning mode of teaching and learning.
- In late November, 2007 a project awareness and publicity seminar was conducted at the CoET with the aim of formalizing the project to the MoEVT and also make it known to the public. The seminar participants came from the MoEVT, the two pilot schools, College Principal, Deans of the faculties in CoET, Research and Publication Coordinator at CoET, e-Learning project members, journalist, supervisors, PhD and MSc students involved with the project. The presentations for the seminar came from the project coordinator, PhD students and one MSc student. The seminar was very fruitful and participants contributed valuable suggestions for the benefit of the project.

Valuable information in terms of readily available reports, documents and verbally communicated details were obtained from the stake holders through all participatory activities. The information was in different areas including;

- Subject content structure
- Traditional pedagogical practices
- Clarification on the difference between school registration number and centre number
- School specialization/categories
- Students' assessment and evaluation
- Type of National Examinations and their levels
- MoEVT ICT policy for basic education
- ICT for Secondary Education in Tanzania – The eSchool Programme- eSchool Forum for MoEVT (Draft Programme Document)
- Education Sector Development Programme (ESDP) document
- Final SEDP (2004 – 2009) document of April 2004
- Presence of Education Resource Centres at district level in each region in Tanzania, these centres are at least equipped with ICT facilities hence to start with can be considered as resource centres in the process of introducing the system further from the pilot schools

5. e-LEARNING CONTENT ANALYSIS AND DESIGN

5.1 INTRODUCTION

This chapter describes the analysis and design phases in the establishment of an e-Learning resources environment for secondary schools in Tanzania. Mathematics will be the first subject to be worked out in the process of e-Learning content development and delivery for the reasons already mentioned in the Survey II conducted for secondary schools in Tanzania in 2006/7. The e-Learning content to be developed will be accessed through the e-LMS for online delivery or by using CD-ROMs for off-line delivery and F2F for classroom environment.

Effective instruction, whether occurring via conventional F2F methods, or e-Learning methods, does not happen by chance. It comes as a result of careful planning that follows a transparent process from project idea through to evaluation and revision. For successive e-Learning resources, designing instruction according to a systematic approach is a desired approach (Douglas, 2001). Designing online courses requires a very different approach to course development from that of a traditional course. Interactive components must be developed to introduce content, engage students and provide assessment information (Glenn, 2003).

In this research, students are the focal point of the e-Learning resources. The subject should be structured so that students can be able to interact with the contents independently. The e-Learning resources will be supporting the traditional F2F teaching hence increasing accessibility of the learning materials. This implies that students will still be attending classes as usual and use extra class hours for the e-Learning resources, hence implementing the student-centred learning environment. The ability to engage students, however, is not automatic with online courses. Careful course design and a command of the technology are required for successful learning environment. Technology provides the opportunity of knowledge presentation in diverse media formats, including textual, audio and visual representations, which is generally called “multimedia” (Brown, 1997). Technology can also integrate suitable pedagogical approaches for e-Learning resources.

5.2 NEEDS ANALYSIS

Analysis is the first phase in the ADDIE instruction design model (refer Section 3.2). The purpose of the analysis phase is to identify the instructional problem, to establish key learning outcomes and requirements in the design and delivery of learning materials. The analysis phase focuses on determining the gap between “what is” and “what should be” defined at the level of the learners for e-Learning resources (Gilbert et al., 2005). It is critical in most new design situations. It is important to conduct the analysis phase before trying to implement any training solution.

Data for the analysis was collected from the two surveys conducted in 2004 and 2006/7 respectively, and some participatory activities with the stakeholders. The practice of PAR is also integrated in order to incorporate users from the beginning, to get first hand

information from users themselves and as will still be applied as we progress with the research.

In this research, needs analysis was carried out which comprised of users' analysis, content analysis, technology analysis and context analysis.

5.2.1 Users Analysis

The information obtained from users' analysis also known as learners analysis, helps in designing the instruction to specific type of learners, levels of the subject and how best to deliver the e-Learning material to effectively produce the needed outcomes.

User analysis deals with potential participants involved in the process. The important questions being answered by this analysis includes; who will receive the training, their level of existing knowledge on the subject, what is the learning style used, who will conduct the training, etc.. This analysis is necessary in order to be able to design the structure of the e-Learning content to meet participants learning needs.

Some of the guiding questions which were formulated to guide the analysis are:

- Who are the target users?
- What is their level of education?
- Will they be able to access the e-Learning resources and perform all the necessary interactions?
- How will the student benefit from the e-Learning resources?
- How will the teacher benefit from the e-Learning environment?
- How can the student's progress be evaluated?

As with the case of e-Learning contents, the analysis identified that there will be mainly five types of users who are going to interact with the system directly, content administrator, system administrator, school administrator, secondary schools teachers and students. The other two user types MoEVT official and guest are expected to visit the contents occasionally or depend on the need.

Results from the surveys revealed that frequent e-Learning system users (teachers and students) are computer illiterate. Few students and teachers have basics of computer knowledge. It is learnt that MoEVT has introduced ICT in the secondary schools curriculum as part of the process of integrating ICT in education and that the Government also is working with Sida in the project to equip all teachers training colleges with ICT facilities and that teachers are trained in order to cope with fast changes in science and technology (Philemon et al., 2006). This will help teachers and students to be in a good position of accessing the e-Learning resources and perform all the necessary interactions, when the system is put in place and also to have the capacity of guiding the students how to access the e-Learning resources using the e-Learning system or computers in case of off line delivery via CD-ROMs.

From the analysis, students will benefit substantially from using the e-Learning resources;

- (a) Increase access to learning and teaching materials which are pedagogically designed (quality aspect) is one way to enhance the effectiveness of teaching (Edwards et al., 1997).
- (b) Establishment of the new learning approach to student-centred, in addition to teacher-led thus students achieving their goals more quickly.
- (c) Students can conduct self-paced learning at their own time and can access their learning material from anywhere (Brown, 1997) via Internet/Intranet or from the provided CDs/DVDs.

Teachers will also benefit from the e-Learning environment by simplifying their workload to a greater extent and being relieved to engage in other administrative and social activities. Teachers will use shorter time to prepare and update notes/lectures and will always have updated teaching materials and information. Since the majority of the participants are computer illiterate, there is a need for the teachers to undergo basic computer training before embarked on the actual practice of using the system. Students will first depend on their teachers before becoming conversant with the system.

5.2.2 Content Analysis

The content analysis gives the information on whether there exists any content that can be used whole, in part or with modifications. Get information about the content organization/structure and identify the size of the learning object to best suit the learners. Identify parts of the content which may need emphasis or presentation of some special kind for the users to understand, this has implication for selection of pedagogical approach and even multimedia application.

The content analysis seeks to identify content areas that could be enhanced, expanded, or initiated through e-Learning techniques. The analysis examined the instructional needs that are not met and determining if e-Learning could contribute. Potential areas could include subjects that have a high demand, but few teachers; subjects that have shortage of books and reference materials; and subjects that would benefit from remote experts.

Analysis from survey II conducted in 2006/7 has shown that most of the secondary schools suffer from acute shortage of reference books and learning materials, and shortage of teachers especially in science and mathematics subjects. Notes for Mathematics and Physics subjects were obtained from respective sources; the notes combined different kind of resources which include text and graphics. The format of the current materials (notes) is hard copy and hand written.

A thorough subject analysis was carried out and it was found that some of the vital information for the subject are missing; which include; learning objective(s), name(s) of book(s) for reference, examples etc. The following questions were formulated to give guidance of the analysis:

- Is the available information relevant?
- What is the structure of the future content? (Get to know the current structure also)
- Any pedagogical considerations?
- What about mode of subject delivery?

- How much of the total content is already available in electronic format?
- What about copy right issues?

In view of the above questions, the following information was obtained;

The available notes for the subject in consideration (mathematics) are pertinent though not adequate due to lack of reference books and illustrations/elaborations to some parts. The available resources are not motivating to work with the e-Learning environment hence needed to be re-designed to suit the new environment to be introduced.

Traditionally, subjects are designed with a view of learning (teacher-led) as a process of transmitting knowledge from the teacher (expert) to a passive learner (novice). With this research it is desired to introduce a constructivist pedagogical approach which promotes student taking authority of the learning activities (Borer, 2005).

By 2007, the subject delivery mode for secondary schools in Tanzania still uses conventional way of chalk and board. Teachers still prepare their notes in handwritten format. Up to the time of conducting this research, none of the subject content was in electronic form. This may be due to lack of computers and other multimedia tools in secondary schools. Generally subject content digitization process has not yet started in many schools.

Some efforts are still underway to look for better ways to deal with copyright issues and get approved contents to be used in the research. The quality of content will be tested by Tanzania Institute of Education which is currently dealing with the production of curriculum and text books.

Referring to the problems depicted in the problem statement, the research gave priority to the mathematics and science subjects to be addressed earlier than other subjects, beginning with mathematic subject as it has been poorly performed for more than 10 years (refer Table 4.3) and it is among the core subjects in the secondary schools' curricular. This study will start with Mathematics subject for Form III. The research also identified some parts of the contents in the mathematics notes that need to be emphasized during delivery and will need some special technological approaches to motivate students and enhance the learning process. The identified parts are examples, illustrations, strong concepts and assessments.

5.2.3 Technology Analysis

In this analysis, technical issues important for the e-Learning resource are analysed. Technical constraints like available technology infrastructure for ICT and electricity. To design instructions that fit the infrastructure like bandwidth problems, limitations of computers, software availability, and delivery methodologies.

Technology analysis is very important for this research due to many technological problems that Tanzania is facing. There are many commercially and free software in the market to be used for the e-Learning system but using them depends on the financial status, technological infrastructure that exist, if can support and if suitable in our context. Most of the platforms existing today are designed to suit higher learning institution

environments which is quite different from the secondary schools level which this research is working on.

The issue of using proprietary packages is out of question due to some reasons include the license cost and also the software incompatibility. Most of the commercial packages have high initial cost and high running cost (license). Many of them are developed in different context and user target group so most likely may not fit in Tanzanian environment.

There are also many OSS platforms which can be used but due to difference in purpose, context and target group can not be used as they are. Hence there is a need of customization in order to suit Tanzanian context and meet learners' needs. The option of using OSS with web based packages is the best option to be used under this scenario.

The compromise between the two extremes (Commercial and OSS) can be reached depending on the technological advancement that exists. The technology analysis resulted in opting for OSS LAMP environment and the use of web based technologies. With the use of OSS, customization is possible. Customization is a necessary step in this research due to a number of reasons including; looking for timely solution as the study has limited time span, starting building the platform from scratch is possible but takes very long time to be accomplished and put into operation. In the process of customization, so far two open source platforms have been identified to work with and these are Moodle and Claroline Platforms. LAMP has three basic components i.e. Apache, MySQL and PHP required in the development of the e-Learning system.

More analysis will be carried out for types of multimedia packages to be used for the contents which will need multimedia design and how to use XML technologies in the e-Learning content design and content repositories design.

5.2.4 Context Analysis

The analysis of the context in which learning will take place and the context in which the learners will eventually adapt to the new learning environment are among vital analyses to be conducted for the development of any e-Learning system. By conducting context analysis the contextual characteristics of where the actual instruction will take place can be described.

One of the main focuses of instructional design is the idea of individualized learning. Therefore, it is important to consider learners at the receiving end. This can better arrange the environment to increase the probability of individual student learning. Among factors which can be considered that affect how a person learns from a particular learning environment are; cognitive (mental) abilities of the learner, previous experiences of the learner, motivation, personal learning style, clarity of the message and interaction with the learning environment (Bee et al., 2003).

Referring to the type of the problems mentioned for secondary schools, a context analysis was conducted in order to justify the development of e-Learning resources. Some questions were formulated to give a guide line for the analysis;

- What is expected out of the e-Learning environment?
- What is the condition of the learning resources?

- Which mode of delivery is used?
- What are teachers' qualifications and deployment status?
- How is the performance in the examination?
- Which subjects are of high demand?
- Will it replace or supplement existing training?
- How is the current learning environment?
- Is an e-Learning content the best choice?

From the above questions, answers were developed which give a clear picture of the Kibaha (the pilot area) context;

What is expected from the e-Learning environment is as given in the research specific objectives; i.e. the increase of the learning materials availability and accessibility, a central repository for learning contents will be introduced and accessed by secondary schools registered to use the system. The accessibility aspect will also be covered since the delivery of e-Learning contents will be either in a web based environment using e-LMS (Internet/Intranet) for networked delivery, CD-ROM for off line delivery and F2F delivery for classroom environment.

The aim of the project is not to migrate from traditional F2F to e-Learning environment but is to support the conventional system in order to address the stated problems. However, the current status of ICT infrastructure in the Tanzanian Secondary schools has to be improved for the e-Learning resource environment to be extended to many schools. More results about the context have been discussed in Chapter 4. The following is a summary of the context analysis.

Secondary schools in Tanzania fall into two main categories, i.e. Government and non-government schools (MoEC, 2002). Government schools depend on constrained government budget which cannot facilitate all schools in terms of educational facilities, technology infrastructure, qualified teachers, learning resources etc. Lack of these necessary facilities to the government schools, have a negative impact to the performance in the National Examinations. With exceptional of very few schools, many schools perform poorly in the National Examinations at CSEE level. The context analysis gave a clear picture of what exists in reality considering the case of the pilot site.

5.3 NEEDS ANALYSIS OUTCOMES

In the analysis phase, the learner, the educational contents to be taught and the learning environment are analysed. Its purpose is to detect the learner's learning characteristics and needs, and ascertain the environment in which the learning is to take place and the available resources. The needs analysis phase also confirms that there is really a need to go for e-Learning solution and aids in the formulation of goals for the e-Learning environment and the specifications of the e-Learning resources.

5.3.1 Proposed Goals for the e-Learning Environment

The following goals are proposed in respect to the Kibaha context, a pilot site in Tanzania;

- (i) To develop a high-quality and relevant sharable e-Learning contents for secondary schools
- (ii) To improve access to teaching and learning materials to students/teachers
- (iii) To introduce a self delivery mode for e-Learning contents
- (iv) To promote ICT empowerment for students and teachers

5.3.2 Requirements for e-Learning Resources

The e-Learning content to be developed is required to meet some certain requirements to meet learners' needs and be context relevant. The following are some requirements obtained from the needs analysis.

- (i) Instructivist pedagogy (teacher-centred) will be used for traditional F2F teaching
- (ii) Constructivist pedagogy to be introduced for self learning environment (student-centred)
- (iii) Blended learning mode of delivery using F2F, e-LMS and CD-ROMs
- (iv) Strict use of multimedia contents due to bandwidth limitations
- (v) Assessment will be of multiple choice type of questions for self assessment and prompt feedback mechanism

The key of defining criteria for knowledge products and services is the needs of the end-user. In this research, user has been as a partner in the learning process, and not just a passive receiver, hence providing ample opportunities for feedback and also for contributing in the e-Learning contents development. Further learning goals for particular subject can also be determined.

5.4 THE EXISTING SUBJECT STRUCTURE - THE PILOT SITE EXAMPLE

The basic mathematics notes collected for the research are for Form III and Form IV respectively. The structure demonstrated here is for one chapter i.e. Chapter One of the Form III basic mathematics subject. The rest of the chapters have similar structure.

The Form III basic mathematics subject comprises a total of 10 chapters

- each chapter has more than one topic and one end of chapter exercise i.e. revision exercise
- each topic has more than one paragraphs of lecture notes, examples and one exercise at the end which contains more than one exercise question

The chapter into consideration i.e. Chapter One comprises of;

- Chapter Title i.e. Relations and one end of chapter exercise
- Four Topics titled; Relations, Graph of Relation, The inverse of a Relation, Graphs of Inverse of a Relation. Topics 1 – 3 each compose of lecture notes, concept definition, examples and one exercise. Topic 4 is composed of lecture notes and one exercise, there are no examples in this section
- The lecture notes include text, equations, tables and drawings. The drawings and tables are included to emphasise the concept

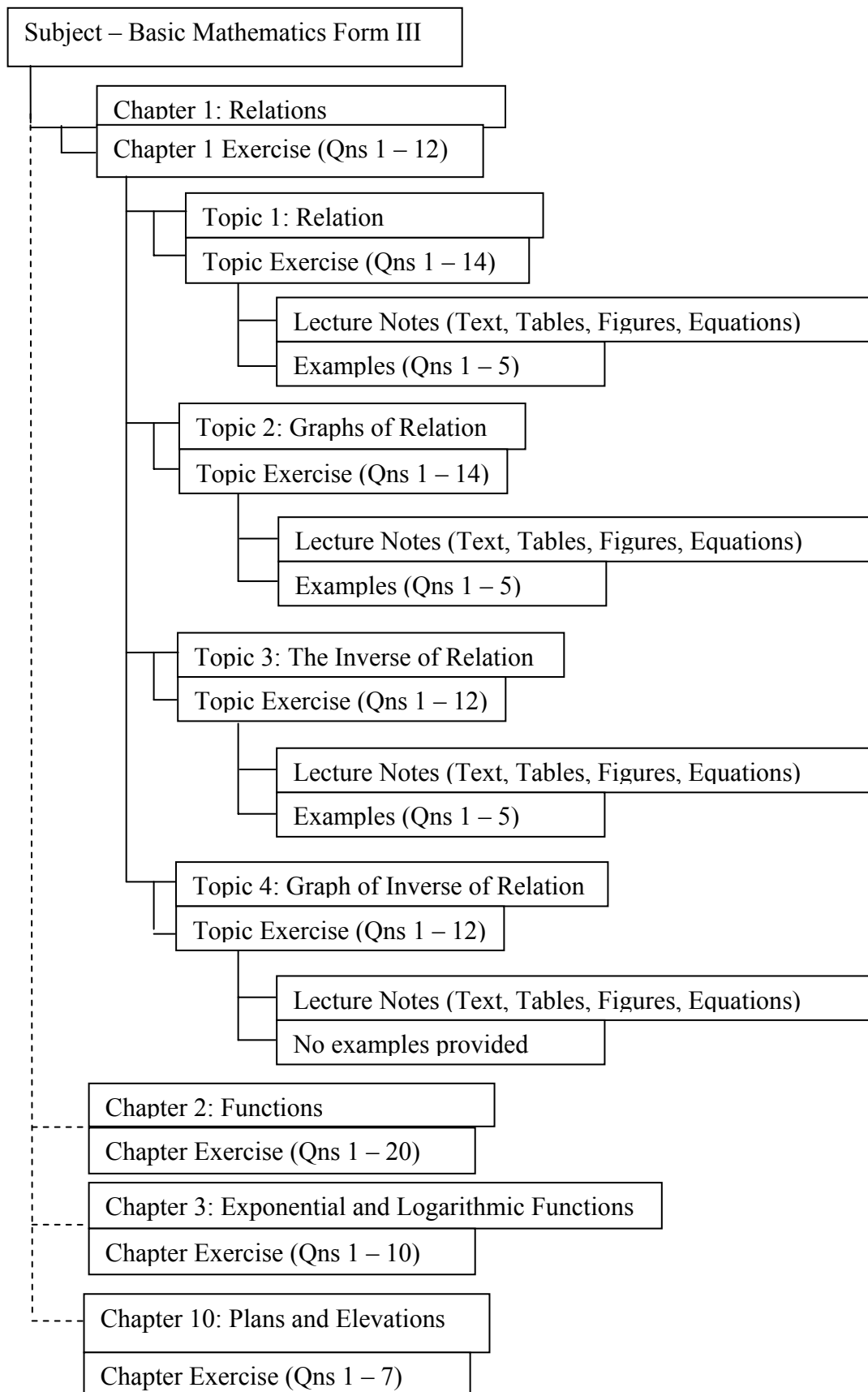


Figure 5.1: Typical Existing Subject Structure –Basic Mathematics Form III, Chapter 1

It was observed that there were no learning objectives specified at any level in the existing mathematics subject structure. Several other attributes were also found missing like, subject code, assessment strategy, and subject outline. These have to be thought of and included in the development of the new subject structure to fit in the e-Learning environment.

The content obtained is purely for traditional F2F delivery mode. It has to undergo some modifications based on the ID methodology in order to be converted and fit for e-Learning environment. The syllabus for basic mathematics for secondary schools has been obtained from the Tanzania Institute of Education (TIE) to provide guidance for the formulation of the learning objectives which will be required in the design of learning objects. Figure 5.1 shows the existing subject structure for basic mathematics Form III, chapter one.

5.5 CONCEPTUAL SUBJECT STRUCTURE

The conceptual subject layout has been designed from the existing subject structure obtained from the pilot site. A thorough analysis of the contents for the subject of Basic Mathematics Form III was done and it was found that the conceptual subject structure will be as shown in the Figure 5.2.

The structure of the current learning materials given for mathematics is comprised of several chapters, whereby each chapter consists of several topics, and each topic comprises of notes, example(s) and exercise(s). Adapting the learning content concepts, several learning objects are considered to make one topic, hence constituting 4 levels of the subject structure, i.e. Level 1 – Subject, Level 2 – Chapters, Level 3 – Topics and Level 4 – Learning objects.

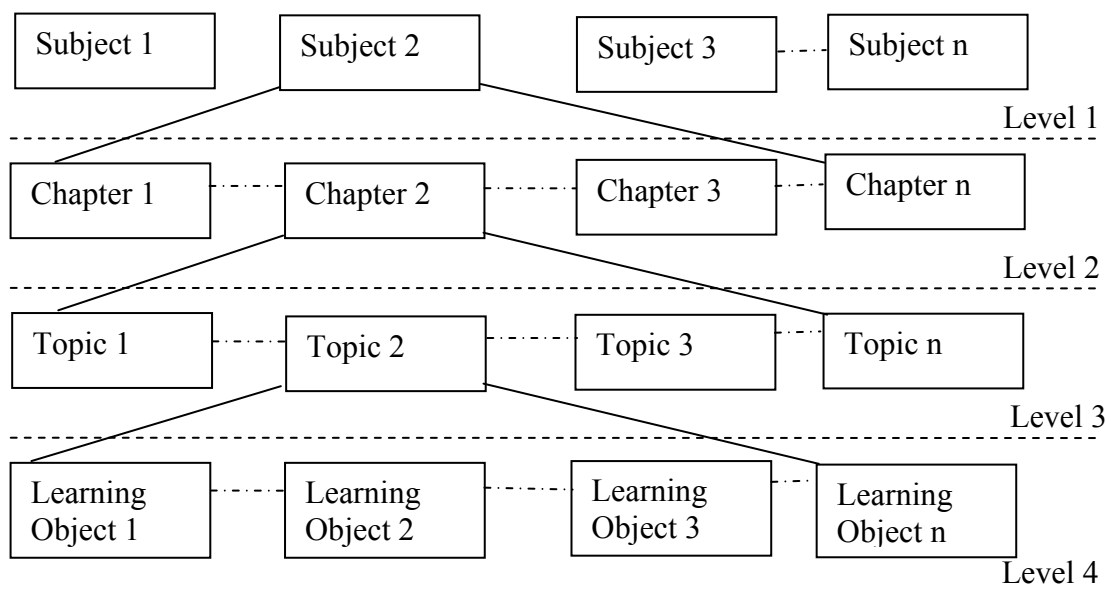


Figure 5.2: Conceptual Subject Layout (Smith, 2004)

Learning Objects in Figure 5.2 can be referred to basic learning units e.g. text, figure, table, equation, a page etc. A combination of learning objects can lead to Topics, Chapters and Subject. LOs are reusable learning resources that can be aggregated to compose higher-level units of instruction e.g. Subject, Chapters, Topics etc.

5.6 INSTRUCTIONAL DESIGN SUBJECT MODEL

Integration of the analysis of the current subject structure, the theory of the learning objects and instructional design concepts, resulted in the instructional design subject model which consists of five major objects: overview object, information object, summary object, assessment object and the practical object which is optional depending on the requirements of the subject context (Sun et al., 2004). The structure of the subject package is as shown in Figure 5.3.

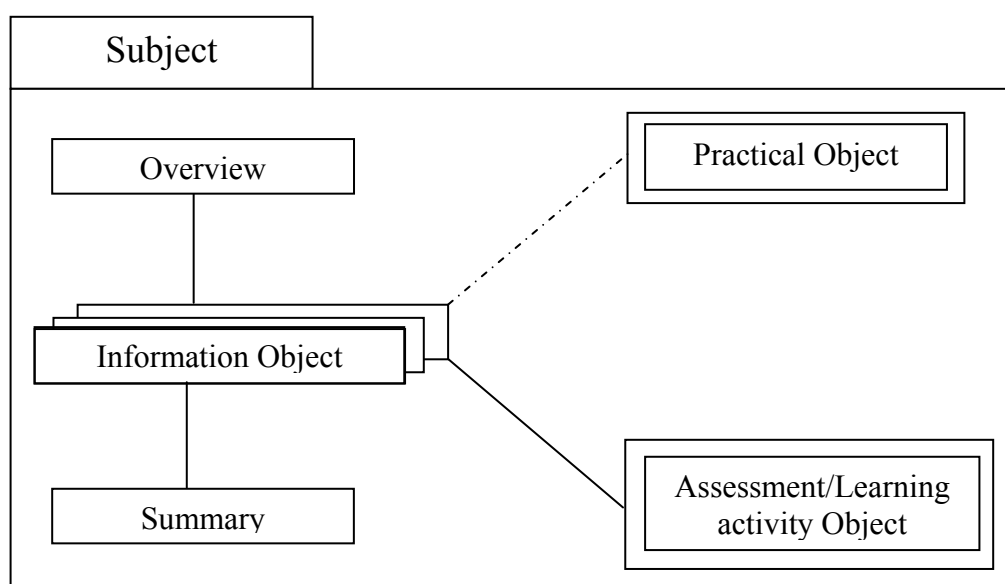


Figure 5.3: Template for Subject Package

Details of different objects of the subject package according to the Tanzanian context are as described below:

5.6.1 Overview Object

The overview object, offers general information about the subject. The information to be described in this object includes but not limited to the attributes mentioned. It depends on the context of the learning environment.

The attributes are: subject code, subject name, subject aim, learning outcomes, subject outline, indicative content, and assessment details. Figure 5.4 shows the overview object and its attributes.

The following is an explanation of the attributes in the overview object based on the Tanzanian secondary schools context:

- **Subject code:** Uniquely identifies the subject. Each subject will be identified by its subject code as will be determined in the implementation phase
- **Subject name:** Gives the name of the respective subject
- **Subject aim(s):** Give in broad sense the statement of rationale. It describes what learners will be able to do upon completion of the subject
- **Subject learning outcomes:** Gives students expectations at the end of the subject i.e. specify the skills, competencies, understandings that the students should have acquired as a result of having completed the program of study and should be measurable
- **Subject outline:** Gives a light to students what they are supposed to learn in the respective subject
- **Indicative content:** Is associated with the information object which is the core of the learning object, it represents a set of selected topics at appropriate granularities. It is what the student is expected to learn in order to fulfil the subjects' objectives. The content at subject level can include chapters, topics and notes in the form of learning objects
- **Assessment details:** Embodied in the subject, tells if assessment is present or not present. The assessment in this case is incorporated in terms of learning activities. Learning activities engage students with the content to achieve learning objectives or outcomes for the subject. Learning activity indicates any activities that assist students in learning the subject content. The learning activities may be graded, given marks or may be included for the student's use to learn subject material

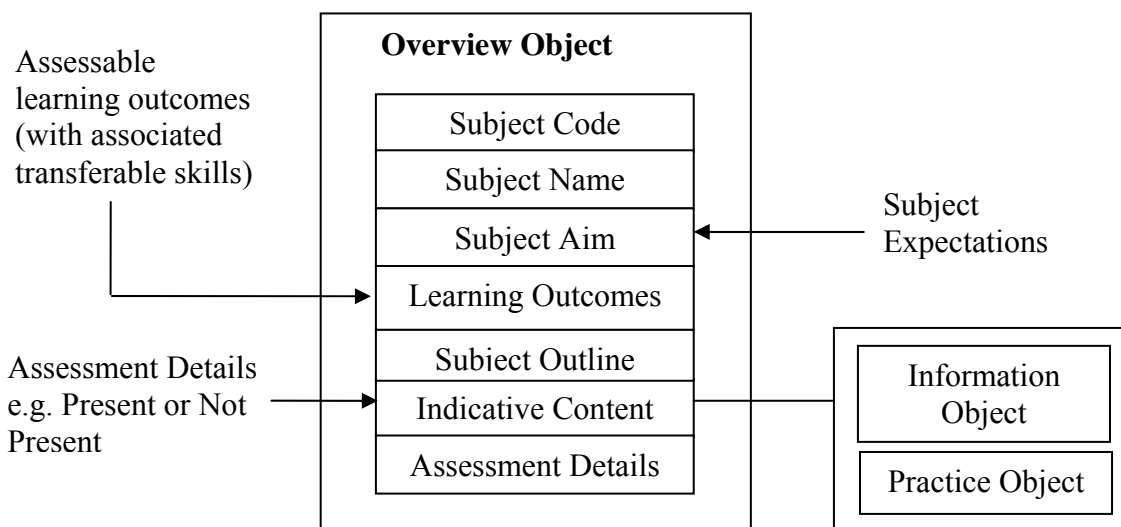


Figure 5.4: Template for Overview Object

5.6.2 Summary Object

The summary object summarizes the subject by reviewing the area that has been covered, giving extra references and exercises. The designed template for the summary object is as shown in Figure 5.5. Recommendation on related areas may be provided to guide students to extend their knowledge for deeper learning. The related areas are offered in the form of extra exercises and past papers so that students can have chances to solve more exercises apart from the ones provided under chapter or topic level. Past papers also can be another

form to engage students in solving problems. The other option is of providing additional resources and documents relevant to the subject context.

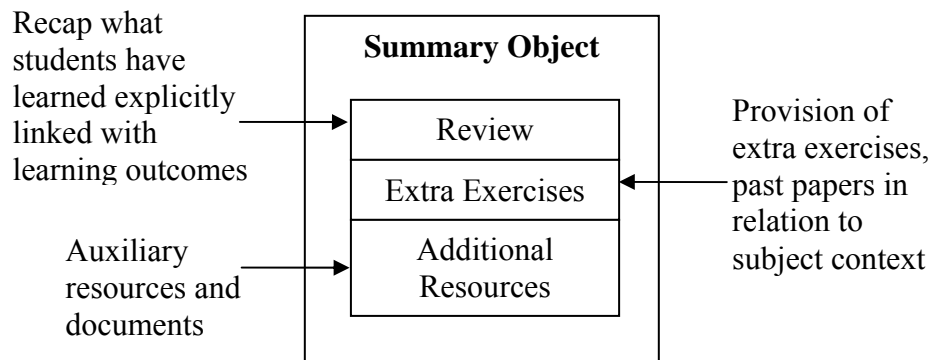


Figure 5.5: Template for Summary Object

5.6.3 Information Object

The information object contains the core content of the subject. The information object may represent a topic in the subject learning object. Pedagogical considerations are also included in the design of the information object for effective learning. The attributes of the information object have respective content objects such as Introduction, Concept/Principle and examples. The template for information object is as shown in Figure 5.6.

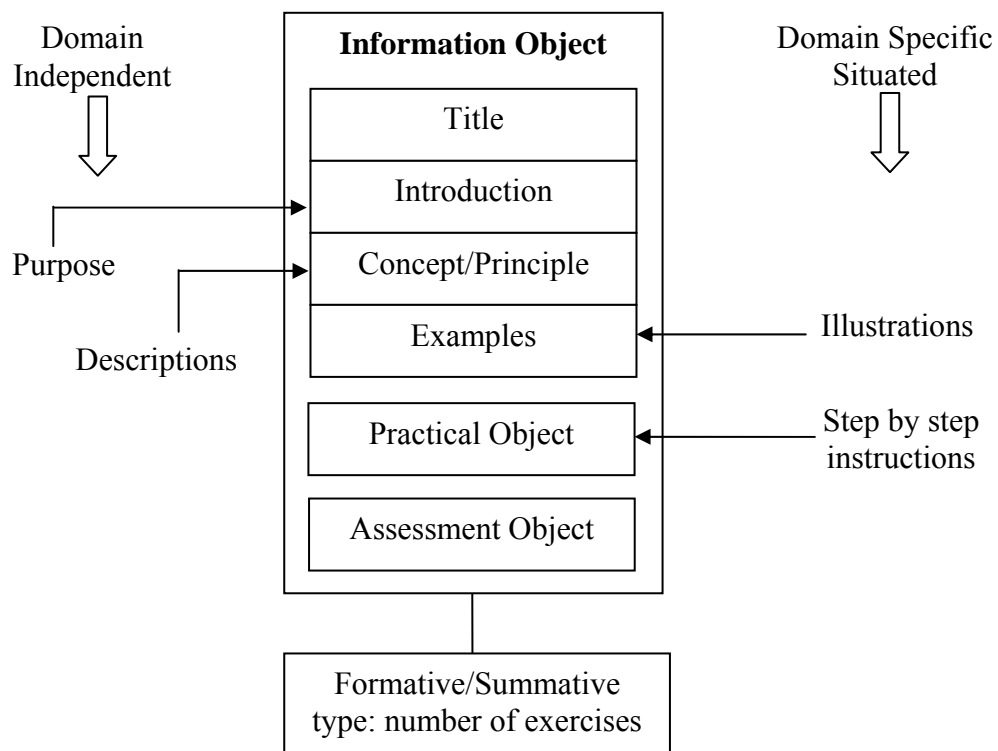


Figure 5.6: Template for Information Objects and Content Objects

There are different kinds of content objects falling into either domain-specific or domain independent categories. The content objects that are considered to be domain-independent are highly shareable and reusable e.g. Purpose and description content objects in Figure 5.6. Example of the domain independent objects may be the purpose of learning Mathematics Form III, or the purpose of learning a certain chapter in the subject of Mathematics Form III. Basically purposes must appear the same in all domains as they carry the same meaning.

The content objects that are considered to be domain-specific contain general information which sets the scope of the topic e.g. Illustrations and step by step instructions in Figure 5.6. The illustrations and step by step instructions may differ as one move from one domain to the other depending on the contextual situations of the domains under consideration, and hence they cannot be re-used in different domains. The content object Illustration: includes a number of examples which demonstrate how concepts can be applied in a context. These content object aid knowledge construction in solving problems. An illustration object should perform personalised learning functions which allow students to engage interaction and self-direction while they are learning.

During the design of an information object, it is also important to identify necessary practical objects and assessment objects which are integrated with the corresponding information object. Practical objects can be optional and delivered in a mixed mode of on-line and off-line. The assessment objects are used as mechanism to obtain feedback of learner's performance and to determine sequencing of information objects during learning process.

5.7 SPECIFICATIONS FOR A NEW SUBJECT STRUCTURE

From the analysis of the instructional design model, the specifications for the new subject structure were determined. Table 5.1 summarises the specifications of the new subject structure modified to suit the e-Learning environment. The new subject structure will have mainly four levels i.e. Subject, Chapter, Topic and Learning Object though there will be some integration from one level to another using reference and/or intermediate elements for fully functioning of the structure. The attributes for each level have been modified to combine the current subject structure and the instructional subject model so as to suit the e-Learning environment. For this purpose, the assessment attribute in the Chapter and Topic levels are to be carried at the end of the chapter or topic depending on the level of knowledge completion.

The subject structure is comprised of three types of elements; the main elements, reference elements and further elements. The main elements are Subject, Chapter, and Topic. The reference elements may include all reference information that is required in order to accommodate information from one level to another i.e. Category Ref, Subject Ref. Further elements provide extra information on the subject i.e. Chapter Solution, Topic Solution, Extra Chapter Exercises and Past Papers.

The design of e-Learning content will mainly base on the learning object approach (Lujara et.al. 2007b). The learning object is not treated as a particular level in this case since it appears at all levels. It is composed of chunks of disintegrated notes, examples,

exercises etc. Learning object is designed to compose three components; lecture notes as the main content, examples being activities to enhance the learning activity and exercises to test whether students have understood the concepts. The analysis of the subject contents should clearly identify which part of the notes goes where depending on the learning object components.

Table 5.1: New Subject Structure Summary

Element	Attributes	General Description
Subject	Subject Code Subject Name Form ID Category Objectives Syllabus Learning Outcomes Online Assessment Status	Details of the subject; the code, name, for which level of study, belongs to which category. It also shows the objectives of the subject, the syllabus, if there is online assessment and the status if the subject is active or not active.
Chapter	Chapter No Subject Code Form ID Chapter Title Objectives Status	Information regarding the chapter number and title for a particular subject and level. Information of where one can get the contents and the exercise, objectives and status if active or not is also provided.
Topic	Topic No Topic Title Chapter No Subject Code Form ID Worked Examples	Information regarding the topic number and title for a particular chapter, subject and level. Information of where one can get the contents and the exercise, objectives. Some examples are also provided for each topic.
Subject Ref	Subject Code Subject Name	Each subject is designed to have a name and a corresponding code; the information can be easily provided with this.
Category Ref	Category	Subjects belongs to some category, therefore Category Ref provides information regarding subject categories
Chapter Solution	Chapter No Subject Code Form ID Exercise No Answer Q1...Qn	Chapter exercises have been designed to have corresponding solutions which will be provided for a particular chapter, subject, exercise number and level of study.
Topic Solution	Topic No Chapter No Subject Code Form ID Exercise No Answer Q1...Qn	Topic exercises have been designed to have corresponding solutions which will be provided for a particular topic, chapter, subject, exercise number and level of study.
Extra Chapter Exercise	Subject Code Chapter No Form ID Exercise No	More exercises are required apart from normal chapter/topic exercises. These will be provided for a particular subject, chapter and level of study.
Past Papers	Paper Year Subject Code	A provision of past papers for a certain year per subject and level of study have also being

	Form ID Paper Path	considered
Learning Object	Chunks of disintegrated learning materials (Notes, Examples, Exercises etc)	Appears in all levels at it is the basic of the learning content. It is the smallest re-usable component in the learning environment.

5.8 TYPICAL DESIGN OF MATHEMATICS FORM III - CHAPTER 1

According to the basic mathematics syllabus for secondary schools in Tanzania, Mathematics Form III has a total of eight chapters with titles Relations, Functions, Statistics, Rates and Variations, Sequences and Series, Circles, The Earth as a Sphere and Accounts. Each chapter has more than one topic. The chapter under consideration (i.e. Chapter 1) has four (4) topics. Sample learning objectives will be determined and the structure for the whole chapter 1 will be considered in 5.8.2. The learning objects are based on learning objectives as given in the Basic Mathematics Syllabus for Tanzanian Secondary Schools (MoEC, 2005) provided by the Tanzania Institute of Education.

5.8.1 Determination of Learning Objects for Topic 1

Application of the learning object approach is necessary in the design of e-Learning content. The LO do not have a fixed size, the consideration given in this approach is that one or an aggregation of several LOs can be best used to suit a learning objective. This can add quality to the content since LOs can be treated accordingly to meet learners' needs. Table 5.2 gives an illustration of how LO can be determined from the raw contents. For simplicity some of the worked examples and exercises are not shown in the figure, and consideration is made on the first topic only.

It can be clearly seen that the main learning objectives of the topic 1.1 are given and the chunking down of the material must be in such a way that the use of LOs will meet all the objectives mentioned.

The determined LOs in Figure 5.2 are identified by specific names depending on what is represented in the LO. For the purpose of useful learning material a topic can be considered to be an aggregated LO which will satisfy all the learning objectives given and also will comply with the formulation of the LO, in this case a topic is considered to be the LO granularity.

Table 5.2: Sample of LOs for Mathematics Form III Chapter 1 Topic 1

Chapter 1- Topic 1.1 Title: Relations	Learning Objectives 1. Find the relations between two sets 2. Find relations between members in a set 3. Demonstrate relations pictorially
LO1 – Definition of Relation: A relation is a set of <u>ordered pairs</u> . The set of all the first coordinates is the <u>domain</u> of the relation. The set of all second coordinates is the <u>range</u> of the relation	

LO2 – Concept

It is often convenient to display information in a chart like the one shown below.

TEST GRADE	STUDENTS
83	Mex, Mary
87	Sara
92	Ellen, Tom, Sue
98	Maria, Tina

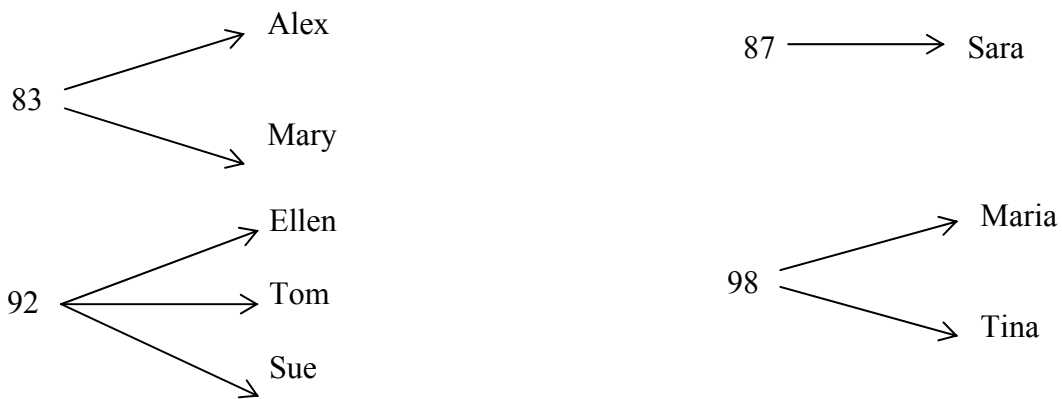
This particular chart lists students who received the given test scores.

The information in the chart can also be displayed as a set of ordered pairs; i.e. $\{(83, \text{Mex}), (83, \text{Mary}), (87, \text{Sara}), (92, \text{Ellen}), (92, \text{Tom}), (92, \text{Sue}), (98, \text{Maria}), (98, \text{Tina})\}$.

The first member of each ordered pair is the test score of the second member. In mathematics any set of ordered pair, such as the above is called a relation.

LO3 – Illustration

Sometimes the ordered pair of relation are illustrated by an arrow diagram like the one shown below:



LO4 Worked Examples

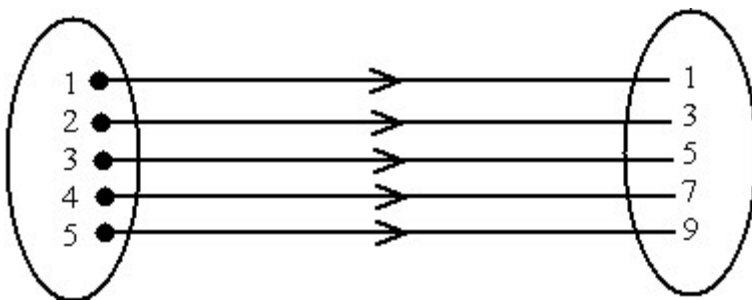
EXAMPLE 1

Graph the relation $R = \{x, y; y = 2x - 1, x \in A\}$, where $A = \{1, 2, 3, 4, 5\}$
What is the range of R?

Solution:

The set of pairs can be obtained by substituting the value of x in $y = 2x - 1$

x	1	2	3	4	5
$y = 2x - 1$	1	3	5	7	9



$R = \{(1,1), (2,3), (3,5), (4,7), (5,9)\}$
 The range of $R = \{1,3,5,7,9\}$

EXAMPLE 2

If $R = x, y : x$ and y are real numbers and $y = 2x^2$.

Find the ordered pairs belong to R when the domain is $\{0, 1, -2, 3, 4\}$.

Solution

The set of ordered pairs that satisfy the equation $y = 2x^2$ is obtained by substituting the values of x in the equation:

x	0	1	-2	3	4
$y = 2x^2$	0	2	8	18	32

$R = \{(0,0), (1,2), (-2,8), (3,18), (4,32)\}$

LO5 Exercise 1.1

Write a rule for each of the following relations and list its domain and range:

- $\{(1,3), (2,5), (0,1), (-2,-3), (10,21)\}$
- $\{(3,9), (-3,9), (0,0), (1,1), (5,25)\}$
- $\{(-3,3), (-5,5), (5,5), (3,3), (0,0)\}$
- $\{(-3,-3), (-5,5), (-6,6), (-10,10), (0,0)\}$
- What is the range of the relation $\{(x, y), y = 3x - 4\}$, when the domain is $\{x : -2 \leq x \leq 4\}$
- $R = \{(2,3), (5,4), (3,8), (9,7)\}$, What is the domain and range of R .
- Find the domain of the relation: $\left\{ (x, y) : y = \frac{2}{\sqrt{x-1}} \right\}$

5.8.2 Subject Design Based on Learning Object Approach

Table 5.3 summarizes the chunking down of chapter 1 into four (4) topics. The specific objectives which are given under each topic explain what students should be able to do at the end of the topic and in-turn each chapter. Assessments also are captured for each specific objective.

Table 5.3 shows different parts of the LO which the contents may be chunked down into. The Overview part of LO can have an aggregation of all LOs which give an introductory information of the subject, the information object is the one which carries all the required learning material, concepts, description, worked examples etc. The summary part of LO can have an aggregation of all LOs which provide reviews or additional resources. The plan for this research is to accommodate extra exercises in addition to the ones obtained from the notes and recommended books and past papers, these can be accomplished by the use of summary LOs.

Table 5.3: Summary of LO samples for Mathematics Form III - Chapter 1

(Overview Object)		
Subject Name: Mathematics Form III		Status: Active/Not Active
Subject Code: MFIII		Objectives: General subject objectives
Form: Form III		Learning Outcomes: Learning outcomes in general
Category: Mathematics		Syllabus: A guide in brief of what is to be covered
Online Assessment: YES		
(Overview Object)		
Chapter No 1: RELATIONS		Objectives: General Chapter objectives
(Information Object) Topic	(Information Object) Specific Objective(s)/Learning Outcome(s) (The student should be able to:)	(Information Object or Overview Object or Summary Object) Assessment/Learning Activities
1.1 Relations	1.Find relations between two sets	Can the student find relations between two sets
	2. Find relations between members in a set	1. Is the student able to find relations between members in sets? 2. Can the student write relations using notations?
	3.Demonstrate relations pictorially	Can the student represent relations pictorially?
1.2 Graph of a Relation	1. Draw a graph of a relation represented by a linear inequality	How accurately can the student draw the graph of a relation?
1.3 Domain and Range of a Relation	1. State the domain of a relation	Can the student state the domain of a relation?
	2.State the range of a relation	How correctly can the student state the range of a relation?
1.4 Inverse of a Relation	1. Explain the inverse of a relation	Can the student explain the inverse of a relation?
	2. Show the inverse of a relation	Can the student show inverse of

	pictorially	a relation pictorially?
	3. Find the inverse of a relation	Can the student find the inverse of a relation?
	4. Draw a graph of the inverse of a relation	How well can the student draw the graph of the inverse of a relation?

An instructional based pedagogy will be applied to the general content subject and constructivist pedagogy will be applied to the activities. The assessment will be of self-assessment in the form of multiple choices. Multimedia approach will be incorporated for the portions which will be identified for interactivity.

Some information in Table 5.3 like Subject Code:MFIII have been used for the case of understanding since the subjects are not coded but for the e-Learning environment a mechanism of coding the subjects must be taken into consideration.

5.9 CONCLUSION

e-Learning environments are expected now, more than ever, to deploy and manage learning content that can be easily searched and retrieved during an auto-learning phase as well as to be reused for different educational purposes. With e-Learning environment learners are allowed to easily locate and access the content of their preference. The learning object approach is considered to be an effective way of chunking down the materials to suit users' needs. LO approach is based on the learning objectives given for a particular topic/chapter. To have a meaningful learning, one or an aggregation of learning objects should be able to fulfil the learning objective.

Furthermore, the learning object approach will make the possibility of learning content to be easily accessible and reused. With learning object approach, SCORM standards can be used to provide standard ways of content aggregation, packaging and transportation to the end users. Future work in the design and other remaining stages in the ADDIE Model will be explained in the next chapter for implementation later in the PhD thesis. Next chapter gives the concluding remarks and future work for the PhD thesis.

6. CONCLUDING DISCUSSIONS

6.1 LICENTIATE WORK SUMMARY

6.1.1 Work Done so Far

The research started with two preliminary surveys conducted in secondary schools within different regions in Tanzania (Lujara et al., 2007a). The first survey, the e-readiness was conducted in 2004 resulted in obtaining the information about the ICT awareness, ICT infrastructure, ICT literacy and how ready are the stakeholders (Secondary schools teachers and students) as far the implementation of ICT is concerned. The selection of the pilot site – two schools in Kibaha district Pwani region was based on the analysis of data collected for this survey.

The second survey was conducted in 2006/7 in different secondary schools within regions in Tanzania. In this survey, a justification of the real situation of having inadequacy of learning materials and qualified teachers in mathematics and science subjects was reached. The analysis of data collected from NECTA for the CSEE (National Form IV Examination) also showed the average failure in almost all subjects with highest failure percentage in Mathematics (Lujara et al., 2007a).

Several participatory action research activities have been conducted at the pilot site, and at the MoEVT, in the process of acquiring first hand information from the stakeholders. Most of the information collected from the stakeholders (mainly teachers and students) is used in the design of the e-Learning material and also in the design of the TanSSe-L system table structure. Data from the MoEVT and some readily available reports gave information on how the Government of Tanzania through the MoEVT and other educational organizations is supporting the integration of ICT in the secondary schools education and other educational institutions for better quality of education and improved access to learning materials. A project awareness and publicity seminar was conducted at CoET, UDSM in Tanzania, stakeholders from the MoEVT, and the two schools from the pilot site were among the participants who contributed valuable comments and suggestions to the on going e-Learning project.

The design of the e-Learning material involved the integration of the instructional design methodology using the ADDIE model. In the analysis phase of the ADDIE model, the needs analysis was conducted which involved user analysis, content analysis, context analysis and technology analysis. The design phase in the ADDIE Model integrated the learning object approach (Lujara et al., 2007b) for e-Learning contents for secondary schools in Tanzania.

The design of the e-Learning material also involved some e-pedagogy considerations for the contents to be of self learning environment. The approach of learning objects devised a possibility of chunking down bulky learning materials into small objects each with a learning objective. Taking into consideration the pedagogical concerns, each learning object has to be composed of mainly three elements, the overview, the content and the assessment.

The subject which has been worked out so far in the analysis and design phases is Mathematics Form III. The contents (subject notes) were obtained from the competent teachers assigned to prepare notes from the secondary schools in the pilot site and from the respective books. The design of the proposed subject layout has been accomplished with the help of the basic mathematics syllabus for secondary schools in Tanzania from the Tanzania Institute of Education. TIE is the agent for publishing text books and syllabuses for Primary and Secondary schools in Tanzania, approved by the MoEVT. For the scope of this licentiate the analysis phase is almost covered, the design phase is partially covered in the e-Learning content development. The evaluation phase is also partially covered since to proceed from one stage to another some evaluation (formative evaluation) must be done.

The design of the TanSSe-L system is also on-going. This is a joint work with a colleague in the e-Learning project who deals with the development of a learning management platform. My part in this, deals with the design of the subject structure to be compatible with the TanSSe-L system and user interfaces for the content administrator and later to find a way to provide the communication between the LMS and the content repository (not in the scope of this licentiate). The design of TanSSe-L has so far involved familiarization of the OSS platforms, getting knowledge of Linux open source operating system, web based technologies, PHP scripting language and MySQL database engine since TanSSe-L is designed under the LAMP environment.

6.1.2 Original Contribution

In respect to this licentiate thesis, the following contributions are found to be new to the Tanzanian context.

- (i) Introducing learning object design approach for e-Learning resources with constructivist pedagogical approach

Learning resources for secondary schools in Tanzania are normally in bulky format in the form of a books or handouts, not giving a chance for a learner to navigate according to his/her likings. e-Learning resources designed using learning object paradigm can easily accommodate the e-pedagogy to make the resources self learning which is an advantage for schools with not enough learning resources and qualified teachers. The current pedagogy used is instructional which promote teacher led learning style where students are passive and teachers are leading the learning process. Constructivist pedagogy changes teacher-led to student-centered learning style, student become active and constructs the knowledge. For the observed situation, the teacher-led approach will continue to be practiced with the normal class teaching F2F orientation and the constructivist approach will be used by the students to enhance what has been learnt in the class.

- (ii) The application of participatory action research methodology towards software engineering development

The participatory action research is not commonly used in Tanzania in the field of software engineering and system development. The methodology was incorporated with the instructional design methodology in the analysis and

design of e-Learning content. The participatory methodology is best used to solve the real societal problems at hand; both the researcher and the client participate in forming the action to be taken to solve the prevailing problem. For a functional solution, users must be incorporated from the beginning and the process is iterative.

- (iii) Design of a context based sharable e-Learning content repository for secondary schools in Tanzania

The current trend of acquiring learning resources for students/teachers/schools is via physical access. One has to physically possess a book or get a copy of the required information from a reliable source. This method is expensive, books are few and very costly and not all students/teachers/schools can afford to possess enough learning materials. The method which is being introduced in this research is more convenient, reliable and cheap, one can have the material via the e-LMS or CD ROM. Content repositories store the learning content and can be accessed by any student/teacher anywhere and anytime. The user must have been granted access rights to access the learning material. The use of content repository increases access and availability of up to date learning resources hence reduce the problem of lack of books and non functional libraries remarkably, in turn improves the book to students ratio.

- (iv) Establish self remedial classes via blended learning delivery approach for secondary schools in Tanzania

Blended learning is a new delivery approach for secondary schools in Tanzania. The normal trend is face to face for both normal classroom and for remedial classes. With this new blended learning delivery approach, students can do remedial classes at their own time without the facilitator; normally remedial classes are conducted with an aid of a facilitator. The pedagogic approach used will also improve students' performance due to the emphasis on activity based learning. Students will have goal oriented learning activities which have measurable outcomes.

- (v) Development of the final product (TanSSe-L system) using OSS for use with secondary schools education – Add something to the OSS community

The use of OSS platforms for secondary schools in Tanzania is a new experience. Due to the high costs of proprietary software, the option is to go for OSS solutions. Most of the OSS platforms so far initiated in the developed and developing countries even in Tanzania are in favour of the higher learning institutions. These platforms may not suite well when applied for lower level of education like secondary schools education due to difference in purpose, user group and education context in general. For this case, the emphasis on the study on use of OSS is also commendable, since software is a sustainability issue, many projects using closed software fail or face problems due to license fee which in so many cases is very high and not affordable. Development of TanSSe-L will involve customization of existing OSS platforms; the process requires coding and debugging, which may add something to the OSS community.

(vi) Scientific Contributions to conferences and journals

Two conference papers were developed as a result of this licentiate

- (a) “Introduction of Open-Source e-Learning Environment and Resources: A Novel Approach for Secondary Schools in Tanzania”. S. K. Lujara; M. M. Kissaka; L. Trojer; and N. H. Mvungi. Proceedings of World Academy of Science, Engineering and Technology (PWASET) Vol. 20, April 2007, ISSN 1307-6884, pp 331-335.
- (b) “Learning Objects: A New Paradigm for e-Learning Resource Development for Secondary Schools in Tanzania”. S. K. Lujara, M.M. Kissaka, E. P. Bhalalusesa and L. Trojer. Proceedings of World Academy of Science, Engineering and Technology (PWASET) Vol. 24, October 2007, ISSN 1307-6884, pp 103-106.

The two papers are also published in the journals

- (a) “Introduction of Open-Source e-Learning Environment and Resources: A Novel Approach for Secondary Schools in Tanzania”. S. K. Lujara; M. M. Kissaka; L. Trojer; and N. H. Mvungi. International Journal of Social Sciences Volume 1 Number 4, World Academy of Science, Engineering and Technology (WASET) pp 237-241.
- (b) “Learning Objects: A New Paradigm for e-Learning Resource Development for Secondary Schools in Tanzania”. S. K. Lujara, M.M. Kissaka, E. P. Bhalalusesa and L. Trojer. International Journal of Social Sciences Volume 2 Number 3, World Academy of Science, Engineering and Technology (WASET) pp 151-155.

6.1.3 Conclusions

The situation of scarce learning resources and inadequacy of teaching staff is almost across all secondary schools in Tanzania. The theme of this on-going research is development of e-Learning content and delivery for self learning environment by using ICT tools to reduce the existing problems. e-Learning resources will improve the scarcity situation and boost the educational qualities of the secondary schools in Tanzania. The research is conducted at Kibaha district, Pwani region in Tanzania where a pilot site has been established with two secondary schools, Kibaha boys’ secondary school and Wali-UI-Asr girls’ seminary. The study focuses on these two schools as a starting point, for the period of the licentiate and doctoral thesis.

In this licentiate research, the design of e-Learning content integrates the instructional design methodology and participatory action research methodology. The two methodologies contribute equally in the establishment of new e-Learning environments. The integration of the two methodologies will result in a quality learning materials and a functional solution to the stated problem.

The instructional design methodology assures that e-Learning content design follows a systematic content development approach and that the contents are not designed in a haphazard manner (Douglas, 2001). The most effective e-Learning, whether it is delivered as an e-Learning or F2F instruction occurs as a result of careful planning derived from the needs of the learner (Kabita, 2003). The instructional design forms a roadmap for the entire e-Learning content development (Kabita, 2003). The instructional designs of the learning materials are stable because they have been based firmly on sound, proven learning theories. The application of instructional design in this research is essential in the determination of subject structure, appropriate pedagogy and selection of proper media.

On the other hand, the participatory action research methodology emphasizes on developing a functional system suitable for the users in consideration (Ferrance, 2000). Users appear in all phases of the instructional design and are linked in all analyses. Participatory action research methodology also gives priority to users as it takes users suggestions and opinions in solving a problem on board from the beginning (O'Brien, 1998). The use of participatory action research methodology leads to contextual solutions, which is one of the main aspects of this research, for providing a solution that will suit the reality hence the consideration of a pilot site.

Instructional design methodology involves different phases - analysis, design, development, implementation and evaluation (Dick et al., 2005). The analysis phase being the most crucial one as it is linked to get the requirements of the e-Learning resources to be developed by defining what is to be learned. In the scope of this licentiate in the analysis phase, needs analysis has been considered which covered users' analysis, content analysis, content analysis and technology analysis. The analyses are used to capture the possibilities and limitations to be considered for the development of quality instructional contents.

The importance of needs analysis in the e-Learning content design gives the real picture of the users of the system, the context of where the learning is going to take place, guides also on the design of the structure of the contents and options of the technology appropriate to be used (Gilbert et al., 2005). This implies that for well designed contents, needs analysis must be conducted, which gives the situational requirements of the e-Learning content (McGriff, 2000). If needs analysis is not done properly, it may be difficult to determine the scope, context and performance augmentation for the e-Learning content profile or establish target audience and their learning needs (Kabita, 2003).

The context analysis must be conducted in order to know exactly the environment of the area under consideration. The ICT infrastructure plays an important role in the design of e-Learning contents in the determination of use of appropriate media for the existing infrastructure. An understanding of the technological background of the intended users is crucial including their access to the internet, their bandwidth limitations and other pertinent information about their preparedness and ability to participate equally and fully in the learning experience. The connectivity to both schools can be easily reached by using TTCL, if resources are available. The cost of the Internet access in Tanzania is very high depending on the type of connection and bandwidth requirements. Table 1.6 gives the costs for the basic bandwidth of 64kbps, the costs increase for higher bandwidth.

Limitations on the bandwidth reflect on some problems for the multimedia design for e-Learning contents. Multimedia contents may be limited to a low level integration since high level integration involves audio, video or animation or the combination thus requires high bandwidth which will not be possible for this case. As has been shown by (Lating et al., 2006) CD-ROMs for local e-Learning use might here be an appropriate technique.

Access to electricity is another limitation to this project. Many rural areas have got no power from the national grid. Data from MoEVT shows that education centres at district level are powered with electricity and fully equipped with ICT facilities. These centres can be used to facilitate the e-Learning project for further implementation. Context analysis reveals that many of teachers and students are computer illiterate. The MoEVT is encouraging secondary schools and teachers' training colleges in the use of ICT in education by introducing an ICT syllabus for secondary schools and also introduced an ICT program in the teachers' training syllabus. These initiatives can be used as catalyst to make sure that ICT illiteracy to both teachers and students is reduced. This has impact to the proper usage of the e-Learning resources when comes into practice.

The e-Learning content to be designed introduces a new pedagogic approach in the current learning environment in Tanzania specifically in the pilot site. The e-Learning content is going to support the tradition F2F, the integration of the e-Learning content and the traditional F2F is a new teaching paradigm in the pilot area. Both teachers and students at the pilot site will benefit from using the developed e-Learning resources hence reduce the problems of inadequacy of learning materials. A mixture of both F2F and e-Learning also known as blended delivery mode and is considered to be most appropriate for the target group.

The delivery of e-Learning content must be designed for self learning environment where students get the autonomy of the learning content. This will help students to study at their own pace and time without a facilitator. In order to achieve this, a constructivist pedagogy approach is applied. With constructivist pedagogy (Borer, 2005) students can be able to access many activities to work out in their spare time, individually or in groups thus enhancing the knowledge imparted in the class rooms.

In the design of e-Learning resources, content analysis gives a guide to develop a subject structure which will be suitable to the users. The subject structure design also accommodates relevant pedagogic principles. For the content to be properly analyzed, the involvement of teachers and some students from the pilot site is very crucial and has to be considered. Through participatory action research methodology a contextual subject structure is realized since users are engaged from the beginning. Teachers are also persuaded with a new pedagogy to be introduced in the course of design, hence can easily adapt to it during its implementation. Therefore, working together with teachers and students from the beginning is a *co-developing process* which takes into account users ideas and makes users well aware of the system. In this way, users can easily adapt to the system functionalities when implemented. The analysis of the content also guides on the chunking down of the learning materials using learning object approach, a concept to be employed for the design of the learning materials.

The learning object approach is used in this research. The principal benefit of learning object comes from their reusability. As discrete units, they can be incorporated into a wide range of subjects or learning scenarios. Their standard-based structure makes them available for use in many different LMSs and other applications. They also appear pedagogically effective.

This licentiate research is one of the three main elements so far identified in the ongoing e-Learning research for secondary schools in Tanzania, i.e. the development of e-Learning content and delivery for self learning environment, other two parts are the development of a e-LMS and system configuration and connectivity which are carried by the two PhD candidates respectively.

The e-Learning project is going to introduce an e-Learning system for secondary schools in Tanzania. The proposed system is named Tanzania Secondary Schools e-Learning (TanSSe-L) system. TanSSe-L is developed by using OSS packages due to the many advantages of OSS against closed source software, which include the freeness from paying license fee, the freedom of using the source code hence possibilities of customization to suit our learning environment, reduced time for getting a solution as compared to starting from scratch, which may take longer time in the realization of the real solution, and the technological support from the open source community in the development of the system. The system is using the Linux Apache MySQL and PHP environment. Moodle and Claroline open source platforms will be used in the development of the TanSSe-L system.

The challenge of project sustainability is still in question. Sida/SAREC is the only donor supporting the project by facilitating the researchers in terms of ICT facilities, travel costs, and stipend. Some means should be thought of for the implementation of the project beyond the pilot area.

In view of the foregoing discussions and for the scope of this licentiate, a summary of answers to the research questions is as given below;

RQ1: What can be done to improve the availability and accessibility of learning contents for secondary schools in Tanzania?

Summary of Answer to RQ1: Development of e-Learning resource and content repository will improve the availability and accessibility of learning materials for secondary schools in Tanzania.

RQ2: What factors need to be considered for delivery of e-Learning content for self learning environment in Tanzanian secondary schools?

Summary of Answer to RQ2: Factors that need to be considered for delivery of e-Learning content for self learning environment in Tanzanian Secondary schools are based on two major perspectives, pedagogy and technology. The pedagogical factors will lead to the appropriate presentation of learning contents to learners and technological factors will lead to appropriate use of technology in content development and proper delivery approaches.

6.2 FUTURE WORK

The instructional design methodology for the e-Learning content development involves five main phases which are analysis, design, development, implementation and evaluation. As far the licentiate research is concerned, the analysis phase is nearly completed. The design phase and evaluation phase are partially covered. It is not very easy to say that some phase has been fully completed as in many cases the work in the phases overlap, but due to the iterative nature of the process it is possible to go back and incorporate modifications for better results. The Development, Implementation and Evaluation phases for the e-Learning contents are to be carried out in the near future for the completion of the PhD work. A summary of the future work is as given below:

6.2.1 Identification of Multimedia and Web Based Packages

Development of the e-Learning content will involve the use of multimedia packages and web based technologies. A through literature review and practice of multimedia packages for the determination of multimedia packages to be used will be carried out at this stage. The aim is to use OSS for all packages though it must be noted that some of the packages which are not OSS but are free or need a small license fee may also be considered for application like Micromedia Flash, Dreamweaver etc depending on the availability and compatibility with the system to be developed.

A theory of the web based packages must also be taken into consideration. For the OSS environment, XML technologies have been widely used in the content creation and management. This will be studied for further implementation of content development.

6.2.2 Development of Learning Objects

The learning objects will be developed based on the design of the e-Learning content. For the e-Learning content to be engaging and of meaning to the learners, two pedagogic approaches will be integrated. The instructional pedagogy for normal class contents and the activity based pedagogy for the self learning environment. The advantages with the two approaches will give students both teaching approaches opportunities, the content based which will be used to impart subject knowledge to the students and the activity based which will help students in doing more engaging activities hence build skills and competency. Learning materials used in the pilot site are not digitized. These materials have to be digitized to easy its application in the e-Learning environment.

6.2.3 Design and Development of Content Repository

The plan is to store e-Learning contents in a repository so as to facilitate sharing and reusing of the learning contents. This will involve the literature review and thorough understanding of the XML and its technologies in comparison to the relational databases for easy storing and retrieval of hierarchical documents like the subject structures obtained in this licentiate. Due to learning object nature of e-Learning content design, some considerations must also be taken care in the process of content packaging and transportation mechanisms.

6.2.4 Customization of Identified OSS Platforms

For the development of the TanSSe-L system, two OSS platforms Moodle and Clalorine have been identified and some customization work has already started. Customization work will continue for the development of the context based e-Learning system.

6.2.5 Participatory Activities

In order to develop a functional e-Learning environment more participatory activities are expected for the benefit of the researcher and the end user. Visits to the pilot schools are a must in all the remaining phases in order to capture all events which are necessary for the system to be functional before the implementation of the prototype.

6.2.6 Implementation Phase

The learning objects developed will be aggregated and stored in the developed content repository. The implementation phase will involve testing of the e-Learning system prototype at the pilot site. The subject of mathematics Form III will be the first subject to be tested. A blended delivery method will be used. The contents will be accessed using the e-LMS (online) and using CD-ROMs (for off line delivery). The normal F2F teaching approach will also proceed normally.

In the evaluation phase, formative evaluation will be carried out in parallel with all phases until implementation of the system. Summative evaluation is out of bond of the research scope.

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Part II - Publications

Brief Summary of the Appended Papers

In the course of conducting this licentiate, two papers have been published in international conferences and journals.

Paper I: Lujara, S. K., Kissaka, M. M., Trojer, L., Mvungi, N. H. ***“Introduction of Open-Source e-Learning Environment and Resources: A Novel Approach for Secondary Schools in Tanzania”***

Published in the:

Proceedings of World Academy of Science, Engineering and Technology (PWASET)
Vol. 20, April 25 – 25, 2007, Barcelona, Spain, ISSN 1307-6884, pp. 331-335

International Journal of Social Sciences (IJSS) Volume 1 Number 4, World Academy of Science, Engineering and Technology (WASET) pp. 237-241

This paper deals with a novel approach for Open Source e-Learning resource environment for secondary schools in Tanzania. The e-Learning resources and Open Source Software (OSS) environment are quite new to the secondary education in Tanzania. The paper identifies and justifies the basis for students' poor performance in the National Examinations (CSEE). The paper discusses the initiatives made to introduce the use of ICT tools to some pilot secondary schools using OSS for e-Learning content development to facilitate self-learning environment. The paper emphasizes on the use of Participatory Action Research methodology of involving users in solving a societal problem. The paper also suggests on blended delivery approaches for the e-Learning content i.e. the use of LMS for networked environment and CD-ROM for offline delivery.

Paper II: Lujara, S. K., Kissaka, M. M., Bhalalusesa, E. P., Trojer, L. ***“Learning Objects: A New Paradigm for e-Learning Resource Development for Secondary Schools in Tanzania”***

Published in the:

Proceedings of World Academy of Science, Engineering and Technology (PWASET)
Vol. 24, October 12 – 14, 2007, Nice, France, ISSN 1307-6884, pp 102-106.

International Journal of Social Sciences (IJSS) Volume 2 Number 3, World Academy of Science, Engineering and Technology (WASET) pp 151-155.

The paper focuses on design of e-Learning content based on Learning Objects (LOs) approach. The paper explains the concepts of LOs and gave a rationale of using the LO approach in e-Learning content design for developing countries. Different analyses are narrated the purpose of designing context based learning materials. The paper also gives guidance on the pedagogy implications in the case of the LO design. With the LO design approach, learning materials can be easily created, discovered, updated and aggregated from simple assets into more complex learning resources.

Paper I

Introduction of Open-Source e-Learning Environment and Resources: A Novel Approach for Secondary Schools in Tanzania

¹Lujara, S. K., ¹Kissaka, M.M., ²Trojer, L., ¹Mvungi, N.H.

Abstract—The concept of **e-Learning** is now emerging in Sub Saharan African countries like Tanzania. Due to economic constraints and other social and cultural factors faced by these countries, the use of Information and Communication Technology (**ICT**) is increasing at a very low pace. The digital divide threat has propelled the Government of Tanzania to put in place the National ICT Policy in 2003 which defines the direction of all ICT activities nationally. Among the main focused areas is the use of ICT in education, since for the development of any country, there is a need of creating knowledge based society. This paper discusses the initiatives made so far to introduce the use of ICT tools to some secondary schools using **open source software** in **e-content** development to facilitate a self-learning environment

Keywords—e-content, e-Learning, ICT, Open Source Software

I. INTRODUCTION

Tanzania, like any other developing country in the sub-Saharan Africa faces many problems as far as education is concerned. One among the problems is lack of education and learning materials for secondary schools. This leads to inequality in accessing learning materials among schools or individual students. The problem has been there for a long time due to the economic hardships faced by the Government which has been the sole supplier of text books and learning aids to Government secondary schools. This problem hinders better performance of secondary schools in the compulsory National Examinations.

In March 2003, the National Information and Communications Technology (ICT) policy was formulated in Tanzania. This ICT policy is a reflection of National goals, objectives and aspirations as expressed in Vision 2025. One among the focused areas in the Vision 2025 is a well educated and learning society. It is also noteworthy that the Vision 2025 explicitly includes ICT by noting “The new opportunities that ICT is opening up can be harnessed to meet goals of the Vision” [1]. The emphasis is on; (i) Educational Access to ICT, (ii) Enhancing Education using ICT and (iii) Developing the ICT workforce [2]. One of the policy objectives is to promote the use of ICT in developing and sustaining local multi-media content for schools. Preliminary survey conducted in 2004/5 in different secondary schools in Tanzania has shown that most of these schools face similar problems, which are lack of text books and/or reference books and teaching aids. Most of the schools have semi furnished or no libraries at all and where there are libraries they are poorly stocked. The problem is compounded by the lack of qualified teachers. Data from the National Examinations Council of Tanzania (NECTA) for the period 1994 – 2005 shows that performance in most of the subjects is poor, but that of mathematics and physics were comparatively poorer. There is a big performance disparity between schools in the rural areas and those in urban areas. Gender imbalance was also an issue.

This paper presents the results of the surveys conducted and proposes how best the problem can be solved using ICT in order to improve the accessibility of learning materials and improve secondary schools standard of education. The accessibility of learning materials can be improved by the use of ICT. The concept perceived makes use of open source software (OSS) packages to develop the learning content, store the content in a repository and make it available to schools with Internet access or distributed in Compact Discs (CDs) to schools which possess computers. Other options are being explored.

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II. PROBLEMS FACED BY TANZANIAN SECONDARY SCHOOLS

A. Tanzanian Educational System

The educational system in Tanzania is based on the 7-4-2-3 system: 7 years of primary school education, followed by 4 years of secondary school education known as Ordinary Level (O-level), where students are required to sit for National Examinations and get Certificate of Secondary Education Examination (CSEE). Then followed by 2 more years of Advanced Level (A-level) secondary school education where students are required to sit for National Examinations and get Advanced Certificate of Secondary Education Examination (ACSEE). The CSEE and ACSEE are both administered by NECTA. After the secondary school A-Level, one can join university for a three years degree programme but some degree specializations require more time.

B. Data Collection Methodology

To get a clear picture of the common problems faced by secondary schools in Tanzania, in 2006/7, we conducted another survey in the secondary schools. The survey was conducted in four regions; Arusha, Mbeya, Ruvuma and Dodoma. At least 6 schools were reached in each region and about five types of questionnaires were used in the data collection phase. The questionnaires were for Students, Teachers, Head Teacher, Librarian, and for the Ministry of Education and Vocational Training (MoEVT) as the education authority in Tanzania. The content of the questionnaires mainly focused on getting information about teaching and learning activities, status of books and reference materials, teaching methodologies, ICT awareness, students' performance, teachers' qualifications and their deployment status. In some cases, we conducted interviews with students and teachers using open ended questions. The questionnaire for the Ministry officials focused much more on obtaining information about the National ICT policy, Ministry ICT policy and integration of ICT in schools.

The visited schools were both O- and A- Levels, located in different environment. Some were easily accessible depending on roads conditions while others were not. Half of the visited schools are privately owned and half are Government schools. The Government schools are owned by the Government, and the private ownership includes religious institutions different non-governmental organizations and wealthy individuals.

In general, private schools seem to be in a better position on the issues of ICT awareness, facilities, learning and reference materials as compared to Government schools. This is mostly due to inadequate funds allocations to Government schools to cater for facilities and learning materials.

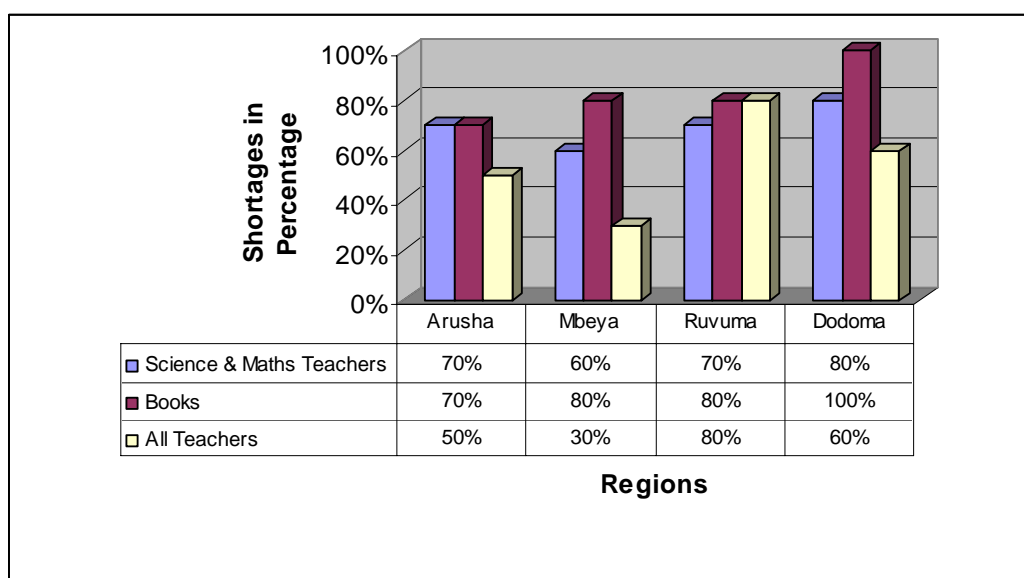


Fig. 1: Results of the ICT Survey Conducted in secondary schools within four regions in Tanzania

C. Data Analysis

The data in Fig. 1, presented in tabular and graphical formats clearly indicates the real situation in most of the rural secondary schools;

1) Shortage of learning and reference resources

The average percentages of secondary schools with shortage of books vary from 70% in Arusha region to approximately 100% in Dodoma region. Textbook to student ratio is about 1:28 in the rural secondary schools and 1:10 in the urban secondary schools [3]. School libraries are ill furnished or there are no libraries at all. Many schools depend on availability of books in Regional Libraries.

2) Inadequacy of qualified teachers especially in mathematics and science subjects

Average Percentage of secondary schools with shortage of science and mathematics teachers in rural secondary schools lies between 60% in Mbeya region to 80% in Dodoma region. Low population, poor economic and social conditions in rural areas and unfavourable teaching environments are among the main factors which force qualified teachers to concentrate in urban schools or even run for alternative highly paying jobs. The pupil to teacher ratio stand at 22:1 but this ratio hides rural – urban disparities and shortages in subjects such as science and mathematics [4].

Failure in mathematics for the period 1994 – 2002 was 73%, which is attributed to among other things; shortage of text books and reference materials [5]. Table I shows the average failure rate for selected subjects for the years 1994 – 2005. It can be observed that most of the subjects have average failure rates of more than 40% and the worst condition is seen in mathematics.

Table I: 1994 – 2005 Subjects Performance at CSEE Level

Sn	Subject	%Average Failure Rate
1	Mathematics	70%
2	Physics	46%
3	Chemistry	42%
4	History	51%
5	Geography	54%
6	Civics	44%
7	Commerce	62%

Source: NECTA Examinations Results Statistics, 1994 - 2005

The failure factors given above clearly indicate a situation where radically changes have to be developed. While waiting for fundamental transformations and increased capacity in the whole education system, more immediate solutions have to be looked for. One of them is as presented in this paper, introduction of open source e-Learning environments and resources.

III. STRATEGIES FOR ESTABLISHING AN OPEN-SOURCE e-LEARNING ENVIRONMENT

A review of e-Learning activities in Tanzania was made. It was found that currently there are very few e-Learning initiatives in Tanzania and the focus is on the higher learning institutions. At the University of Dar es Salaam, there are two e-Learning developments; the African Virtual University (AVU) which uses the WebCT e-Learning platform and Technology Independent Learning (TEIL) based on Black Board e-Learning platform. In the case of secondary schools e-Learning, there is only one website with url <http://www.distancelearning-tz.org> which provides notes for secondary schools in different subjects, it is maintained by a non-governmental organization, International Institute for Communication and Development (IICD).

The Swedish International Development Cooperation Agency (Sida) and its Department for Research Cooperation (SAREC) - Sida/SAREC in supporting rural development in Sub-Saharan Africa has initiated and is funding an e-Learning ICT research, conducted at the University of Dar es Salaam in collaboration with the Blekinge Institute of Technology in Sweden. The research has three main components; the development of the learning management system, the network connectivity and

configuration and the development of e-Learning contents. The MoEVT is also supported and assisted by Sida to work on two country-wide interventions; all teacher training colleges in Tanzania will be equipped with computers and Internet Connectivity and the e-schools programme, a programme aiming at equipping a number of secondary schools with ICT facilities [6].

This research work is concerned with the development of e-Learning contents starting with the subjects of worst performance i.e. mathematics and science subjects. The content will be developed using open source software package which is free, comes with source codes which can be modified to suit our context and have a great technological support from the people all over the world for its sustainability.

The e-Learning content will be developed with a participatory approach and based on instructional system design, learning theories and pedagogical principles. Since if technology is applied together with pedagogical concepts it can create an effective student-centered environment and enhance learning outcomes [7], [8]. A participatory practice is incorporated in the development process.

The raw materials (notes) collected from the respective teachers are chunked down to form learning objects. Learning objects are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science [9]. Learning objects allow instructional designers to build small (relatively size of an entire course) instructional components that can be used a number of times in different learning contexts with the aim to increase the flexibility of training, and make updating courses much easier to manage [10].

The chunked material is stored in a content repository to be designed using MySQL open source database management system. The content is packaged based on Sharable Content Object Reference Module (SCORM) and Instructional Management System (IMS) standards to facilitate transfer and interoperability across systems. A content repository will allow users to find, retrieve publish or submit learning objects via a network, thereby allowing a sharing of objects across a wide variety of subjects and authors.

A self learning environment is going to be established in order to help students get control of the subjects even in the absence of a teacher or during self study. An instructionally user interface will be designed to provide this facility. The user interface is designed using open source software languages, mark-up languages; eXtensible Hypertext Markup Language (XHTML) and eXtensible Markup Language (XML), Scripting Languages; PHP: Hypertext Preprocessor (PHP) and Java Script, Cascading Style Sheet (CSS) and eXtended Style Sheet Language Transformation (XSLT).

IV. PROPOSED SYSTEM ARCHITECTURE AND COURSEWARE TREE

A. Proposed System Architecture

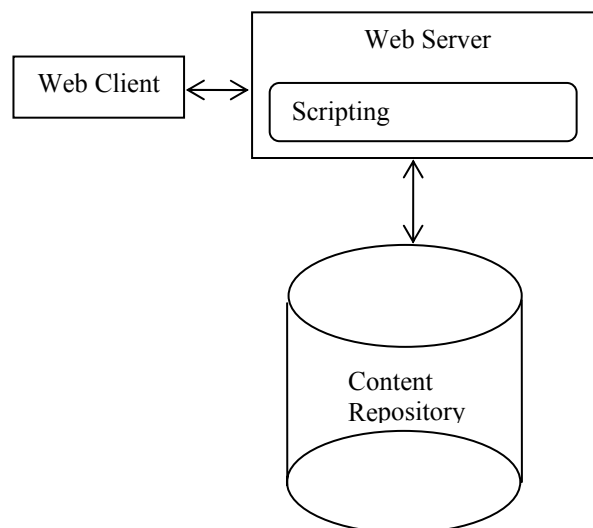


Fig. 2 Proposed System Architecture

Fig. 2 shows proposed system architecture, it will be of three tier architecture, composed of three main components; web client, web server and the e-content repository.

The web client allows users to create, edit and access learning contents. The Web Server which stores scripting codes will provide scripting interface to allow communication between the web and the database. The repository stores the learning content.

B. Courseware Tree

The courseware tree is as shown in Fig. 3. It will be of modularized in nature designed based on the top-down approach. It will be composed of four levels which are; Course, Chapter, Topic, and Learning Object levels. The number of levels will depend on how the learning environment is planned. The learning objects will be accessible and reusable and could be linked to more than one to form a complete course.

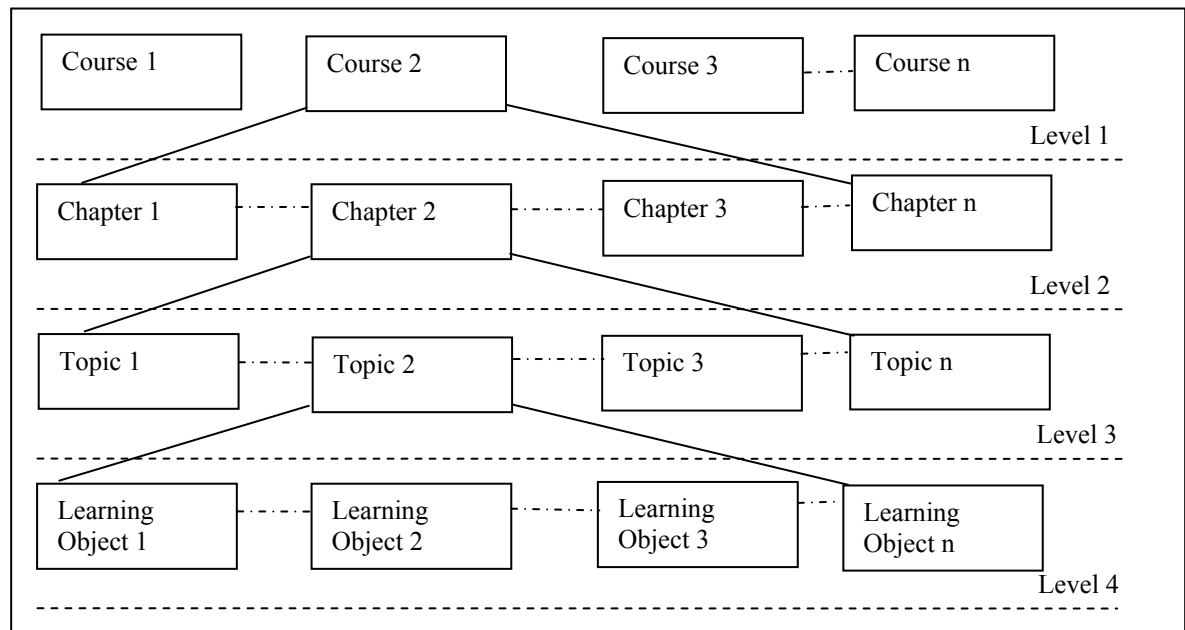


Fig. 3 Courseware Tree

V. e-LEARNING CONTENT DELIVERY APPROACHES

Various approaches can be used to make learning materials available over the web. The simplest approach is to generate web pages containing the resources and make the web pages available through a web for the course. The other approach is to use a full-fledged course management system such as Learning Content Management System (LCMS). The research is going to use any readily available LMS initially while developing one and/or off-line using Compact Discs (CDs).

VI. CONCLUSION

The paper has narrated clearly the problems faced by many secondary schools in Tanzania and have proved the existence of the problems through the conducted surveys. Although we are now in the 2007, still many schools in the urban areas do not have libraries at all and if there is one then the resources are very scarce and outdated hence depend on regional libraries; the case is much worse in rural areas schools as this option is not there. The use of ICT tools and especially e-Learning will be a viable solution to encounter the situation of the scarce resources. The choice of the open source software is the best, due to its many advantages over the proprietary packages; license free, can be customized to suit our context, has support for its sustainability etc. If up to now we cannot afford to buy text books, how can we afford the closed source licenses? The benefit of a modularized courseware approach is on the students' choices

of learning by maximizing the benefits obtained in the combination of the face to face classroom teaching and the e-Learning teaching, since e-Learning is going to provide support and flexible learning environment. This will also address the rural-urban education achievement and raise the livelihood of the rural community.

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Paper II

Learning Objects: A New Paradigm for E-Learning Resource Development for Secondary Schools in Tanzania

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Abstract— The Information and Communication Technologies (ICTs), and the Wide World Web (WWW) have fundamentally altered the practice of teaching and learning world wide. Many universities, organizations, colleges and schools are trying to apply the benefits of the emerging ICT. In the early nineties the term learning object was introduced into the instructional technology vernacular; the idea being that educational resources could be broken into modular components for later combination by instructors, learners, and eventually computes into larger structures that would support learning [1]. However in many developing countries, the use of ICT is still in its infancy stage and the concept of learning object is quite new. This paper outlines the learning object design considerations for developing countries depending on learning environment.

Keywords—e-Learning resources, granularity, learning objects, secondary schools

I. INTRODUCTION

Secondary schools in Tanzania lack reference books and learning materials [2]. The problem has prevailed for quite some time now, causing inequalities in accessing learning materials among students. Therefore, students' performance at the National Examinations levels has been seriously affected. Among other solutions [3] which may be applied to minimize the problem is the introduction of open source e-Learning content for the secondary education in Tanzania.

The aim of this paper is to present the development of learning objects for e-Learning system secondary education in Tanzania. The paper explains the concepts of learning objects, the size of granularity, which is still a problem when implementing different forms of e-Learning education. The manner in which considerations for the introduction of learning objects have been arrived at is also explored.

II. THE CONCEPTS OF LEARNING OBJECTS

Learning objects are potentially reusable components from which study courses may be constructed. In the current practice, a learning object can be a single idea or it might be a cluster of several concepts to deliver a more substantial chunk of learning [4].

Learning objects have no single definition but can be best defined according to the IEEE Learning Technology Standards Committee (LTSC) which states that learning objects are “any entity, digital or non-digital, which can be used, reused, or referenced during technology-supported learning” [5]. Technology supported learning includes computer-based training system, interactive learning environments, computer aided instruction systems, and all forms of distance learning systems.

III. THE SIZE OF GRANULARITY

Granularity is the process of breaking down the digital content into small pieces or chunks. It directly deals with the size of the learning object. The purpose of the granularity is to combine learning objects to be shared and reused in a variety of contexts [6]. A learning object in its ideal form can be considered to be a combination of different raw materials also known as assets, like text, graph, an equation, a link to a page etc. Assets are the smallest items of the learning objects without any specific learning objective; hence with individual assets acting independently in the learning environment learning can never be complete. The granularity of learning objects has a crucial impact on the ability to adapt, aggregate, and arrange content suiting the needs and preferences of the learner [7]. According to the presented approach, a learning object can be formed by combining different assets and the combination must focus on at least three necessary objects; an overview, content, and an assessment.

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IV. WHY LEARNING OBJECT APPROACH?

Most of the learning objects existing today were developed and are still developed in the high income countries. Studies show that the focus of the learning objects is mainly on the higher learning institutions [8]. Due to basic differences in the learning environments between the developed and developing countries; the ICT infrastructure, the digital divide and also target level of education, it is not easy to directly adopt what already exists. Some considerations must be made for the concepts of learning objects to be adopted in the developing countries.

Majority of current learning materials such as textbooks and computer-based instructions are designed as large integrated packages rather than as collections of small independent components that can be individually used and modified for multiple purposes [9]. The development of the learning object approach makes it possible for the reuse of learning materials between schools, over a long period.

With the learning object approach, it is possible to develop high quality, local and appropriate e-Learning content for Tanzanian secondary schools and make use of open source software to give openings for customization to suit any other developing country with similar learning environments. With the adoption of the learning objects, new learning environment will be introduced which will support the traditional face to face (F2F) environment. Students will continue to attend classes as usual and will go for e-Learning resources whenever possible to enhance the knowledge imparted in the classroom. With this approach, the use of instructional design process in the analysis and design of learning object will ensure that learning .does not occur in a haphazard manner.

V. CONSIDERATIONS FOR LEARNING OBJECT DESIGN

A. Needs Analysis

The purpose of the needs analysis is to establish key learning outcomes and requirements for the learning objects and the new e-Learning environment. There are several analyses which can be done at this stage, but for the purpose of this paper only four analyses have been considered; users, context, content and technology. Techniques used in the analyses are questionnaires, interviews (students and teachers), direct observation (students, teachers and lecture notes), report studies (National Examinations Council of Tanzania - NECTA statistical performance reports), review of relevant literatures, consultation with key persons in the Ministry of Education and Vocational Training. Needs assessment is critical for completing an evaluation. Without it, it is not possible to measure if the learning object meets a performance gap, or increases the learner's knowledge and skills [10].

1) Users' Analysis

The users' analysis identified three types of users for the e-Learning environment; i.e. students, teachers and system administrators. Teachers and students at the level of secondary school education form the main target group. Students are from both junior and senior secondary school levels i.e. Form I (grade 9) to Form IV (grade 12), this is also known as Ordinary (O) level and Form V (grade 13) to Form VI (grade 14) also known as Advanced (A) level. So far, secondary schools students and teachers are computer illiterate and know nothing or very little regarding computer applications for education purposes. For this level of education, the learning objects to be designed should be instructive such that the students can easily follow the learning materials.

2) Context Analysis

Formal secondary education in Tanzania is based on traditional F2F class teaching environment which uses teacher-led approach, where the teacher is the master of the learning process and students are passive. Teaching materials are not digitized and the delivery is still 100% talk and chalk. Generally, there are inadequate and obsolete physical facilities and infrastructure, inadequate qualifying teaching staff, inadequate teaching and learning materials and equipment, curriculum is not demand driven and inadequate funding for education programme [11]. Shortage of teachers is almost in all subjects, with acute condition in mathematics and science subjects. Due to the disparities in rural and urban areas - poor economic and social conditions - many schools are not in a conducive teaching environment. Hence

teachers tend to concentrate in urban areas which have better opportunities for their welfare. Secondary Schools in Tanzania differ very much in terms of facilities, teachers' employment, number of students enrolled, performance, school ownership, school location (urban/rural), financial capability etc. In all circumstances, the magnitude of the problems is significant in schools within rural areas. With exceptions of very few private schools, the rest of the private and all government schools follow the National curricular set by the ministry of education and vocational training.

3) Content Analysis

The pilot subject under examination is mathematics at the level of form III (grade 11). The sources of materials examined came from secondary schools' teachers, lecture notes and reference books. The subject of mathematics was chosen due to increasingly average failure rate in the National Examinations for many years now [12]. In Tanzania, the subject of mathematics has been given special criterion in the National Examinations, that students must pass mathematics; otherwise there is a penalty which affects the overall grading of the students' performance in the National Examinations. The current subject structure was found to compose of chapters, topics, end of chapter exercise and end of topic exercises. One chapter is composed of one or more topic(s), a topic is composed of a combination of either text and figure, or equation. This analysis decided on the learning object size.

4) Technical Analysis

The ICT infrastructure is not very good for most of the secondary schools in Tanzania. The Ministry of Education and Vocational Training and schools management cannot afford to buy and maintain the commercial learning management systems or content management systems. Owing to this limitation, the use of open source software and web technologies in the implementation of the new e-Learning environment is proposed. With the open source environment it is easy to adopt code re-use and customization techniques to come out with e-Learning content that is suitable in our Tanzanian learning environment.

B. Instructional Design Subject Model

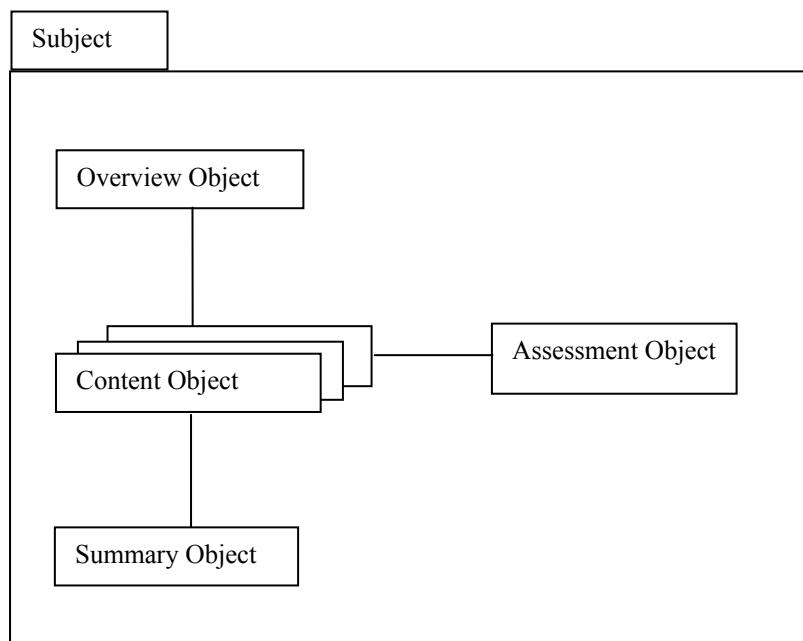


Fig. 1: Template for Subject Model

Integrating the analysis of the current subject structure and instructional design concepts, the instructional design subject model will consist of four major objects: overview object, content object, summary object and assessment object. The structure of the subject model is as shown in Fig. 1

1. Overview Object

The overview object, offers general information about the subject. In reference the learning environment in Tanzania, the information to be described in this component includes the following attributes: subject code – uniquely identifies the subject, subject name – name of the subject, category (science, arts, mathematics, language, etc), objectives – subject objectives, learning outcomes – students expectations at the end of the subject and content path – associated with the content object. The latter is the core part of the overview object and represents a set of selected chapters at appropriate granularities.

2. Content Object

The content object contains the core content of the subject. The learning object in this case has been treated to have two levels, the first being the chapter level and the second being the topic level. The topic level is formed with a combination of assets, such as a learning objective, required notes, examples and an end of topic exercise. While a chapter level is considered to have aggregation of topics and end of chapter exercise.

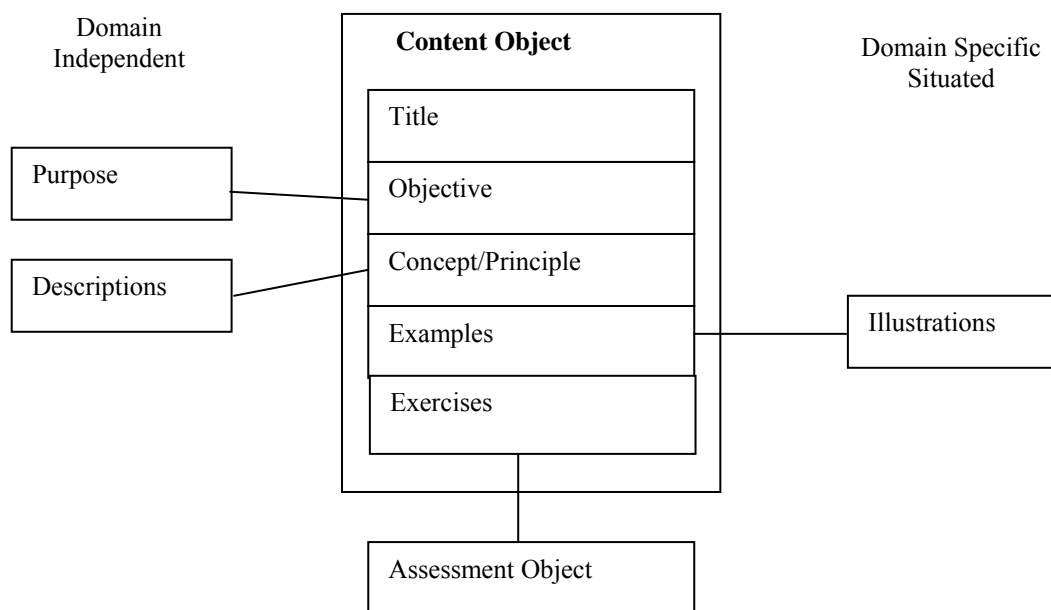


Fig. 2: Template for Content Object embedded with Assessment Object

The attributes of the content object for the chapter level include; chapter number, respective subject code, level of education, chapter title, learning objectives aggregation of topics to accomplish the respective learning objective. The attributes of the topic level include a topic title, some text and examples. This will give freedom to students while accessing learning material, give the possibility to choose either the whole chapter or just go for certain section(s) of their need. The assessment object is embedded in the content object and can be presented in two forms of exercise; the end of chapter exercise and the end of topic exercise. The design is to be of self-assessment type, where students will attempt to answer the questions and compare the results with the hidden solutions to be provided for each chapter/topic. The template for content object is as shown in Fig. 2.

3. Summary Object

The summary object concludes the subject in consideration. It provides information on extra exercises and collection of National Examinations past papers for students to apply their knowledge in solving more problems apart from the ones given straight under each chapter and also extend their knowledge for deeper learning. The designed template for the summary object is as shown in Fig. 3.

Recommendation on related areas may be provided to guide students to extend their knowledge for deeper learning. These related areas are offered in the form of learning objects which are associated with the defined aims and learning outcomes rather than general reading.

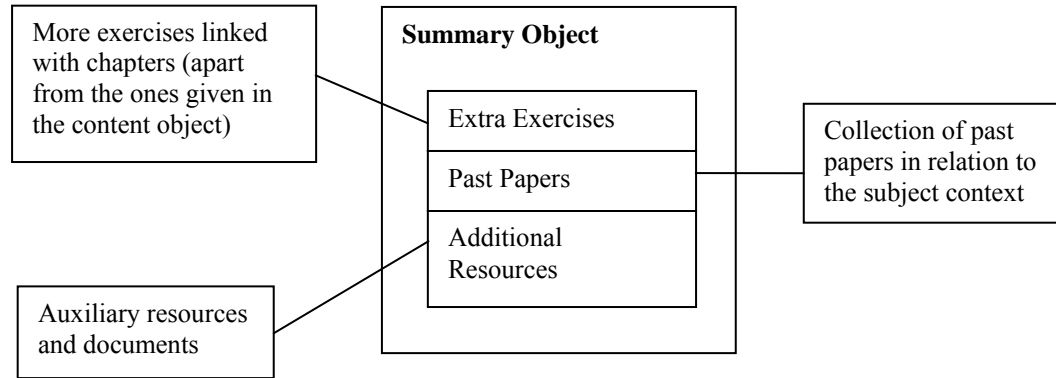


Fig. 3: Template for Summary Object

During the design of the learning objects, it is very important to identify necessary assessment objects which allow students to engage into exercises and tests for self understanding of the topic/chapter while learning. In the context of the Tanzanian environment these can be used to test the students if they have understood the materials given in different topics and chapters.

C. Pedagogical Implications

The pedagogical implications determine the quality of the learning objects hence directly affecting learning. The design of learning object should clearly indicate part of the contents where emphasis is necessary e.g. difficult concepts, specific illustrations, etc. The presentation of these specific contents should be made different from the normal lecture presentation for better perception, this will enable students to easily follow and understand the learning contents. The learning objects can be classified according to their pedagogical functions such as exercises, assessments, class activities, past papers etc.

IV. CONCLUSION

Learning objects have gained much popularity in recent years, principally because they offer a means of reusing educational material. However, they have been used relatively little in secondary schools education specifically in developing countries. In this paper, considerations for learning object designed suitable for developing countries have been elaborated.

The considerations narrated in this paper will lead to a subject structure which will suit Tanzanian secondary school education learning environment. With the learning object approach, learning materials can be easily created, discovered, updated and aggregated from simple assets into more complex learning resources that can be used in different ways.

This paper provides a paradigm for providing e-Learning form of learning to enhance secondary education in Tanzania because of ill-equipped and inconsistently equipped secondary schools. The learning objects approach radically alters how educational material is written. This includes the authoring style, the subject pedagogy and the subject narrative. The demands of learning objects (autonomy, format, structure, etc) mean that many of these aspects are compromised or altered from conventional learning material. However, the approach also offers potential benefits for both teachers and students, in that it condenses production time, facilitates reuse and divides study material into convenient manageable time-chunks.

For the future work, the learning object structure can be packaged using the Content Aggregation Model (CAM) and be transformed into the Sharable Content Reference Model (SCORM) for further implementation. The content packages can then be stored in the repositories and be accessed via Learning Management System (LMS) and/or delivered through CD-ROMs [13], [14].

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Part III – Appendix A

A Practical Example of Participatory Research Methodology – Design of a Students’ Registration Information Management System (SRMIS) for Secondary Schools in the Pilot site

1.0 Introduction

The progress of this research depends on strong collaboration with users of the e-Learning system to be developed. The research team came up with an idea of establishing strong relationships and trust with secondary schools by designing a generic students’ registration information system to support record keeping of students’ registration in secondary schools. To start with as a case study, a generic students’ registration information system has been designed and a prototype already installed in the two schools in the pilot site for testing purposes, and give time for familiarization, any modification or improvement of the system. This work was carried out by the three PhD students involved in the e-Learning project.

Student Registration Information Management System (SRMIS) involved a design of a database for storing students’ records. A database is a collection of relevant data. A database management system (DBMS) is a set of computer-based application programs that support the processes of storing, manipulating, retrieving and presenting the data within the database. The term database refers to the collection of related records, and the software should be referred to as the database management system or DBMS.

Advantages of using DBMS include; provide flexibility to the user - easy data creation, storage, update and retrieval, centralized data management, better back-up facility, system integration - all data are stored in one place hence reduce redundancy and improve data management, improved security – authentication possibilities do not allow equal rights to all for data accessibility.

The design of the database management system was based on the information obtained through participatory activities with stake holders. Interaction with users (school administration, teachers and registration officers) resulted in the determination of the user’s requirements for the system. The database structure was obtained based on the student’s application form from Wali-Ul-Asr girls seminary.

2.0 Analysis of the Existing Manual Students’ Registration Process

The analysis part relied on information obtained from the Wali-Ul-Asr girls’ seminary. Through data collected in Survey I and discussion with the school’s administration it was found that the school has many computers but not fully utilized to the opportunities rendered by the ICT. The current students’ registration process is still done manually. The records of each student were written in the application form and stored in the files, i.e. one file for each student. Samples of application forms were also taken for further analysis.

From the analysis of the information obtained from the school, it was found that there were many problems which were associated with the existed manual system. The problems include:

- (a) **Poor information storage**
Information storage was always at risk, files were put on shelves or in cupboards, which may be attacked by rats, rain, and fire or worn-out easily due to bad handling
- (b) **Missing documents**
Part/whole document may be misplaced which may lead to misleading information
- (c) **Difficulties in retrieving/updating information**
Retrieving any kind of information or a report was very involving and wastage of time, furthermore reports were static in nature. It was also difficult to implement records updates to maintain the current records. Any modification may require a student to fill another form
- (d) **Chances of Redundancy**
With manual systems there is high chance of information duplication. A student can be registered more than once, or one registration number can be given to more than one student
- (e) **Information not secured**
Easy bleaching of information, any illegal modification of information can be done in collaboration with the person in-charge
- (f) **High running costs**
Stationary stationery costs -files, papers, pens, shelves, cupboards etc and personnel cost clerical officers, secretaries etc.

Analysis of the application form resulted in the identification of tables and their attributes. Some of the details were taken as they appear in the form, and some information had to be modified in order to suit the computerization process.

2.1 SRMIS Specifications

The students' registration information management system designed is a generic model and can be modified accordingly to suit different context of the secondary schools in Tanzania.

- (a) The system has been designed to work in a multi-user environment. The database is stored in one computer and the application can be stored in more than one computers. Two levels of security are provided, the system full access rights (Read and Write) normally granted to administrators and semi access rights like read only, granted to other members depending on the permissions decided by the school management.
- (b) The system will keep current and previous records of students' registration records.

- (c) The system will produce different standard reports as per the design based on user requirements.
- (d) The system allows easy updates of student's registration information. The information to be changed must be physically brought to the person in-charge to effect the changes

3.0 Development of the SRMIS

The access software package was used to create database objects like Tables, Forms and Queries. The tables represent the entities, all attributes with their data specifications were easily placed in their respective tables. The Entity Relationship (E-R) diagram was also developed. Forms were developed either directly from table's attributes or based on a query.

Tables are used to store data in the database. Forms are used to input data into the database, and edit or view database information. Queries are used to inquire for specific information from the database. Queries can be formed from a single table or multiple tables. Reports are designed based on the information directly from the tables or queries.

Tables identified in the SRMIS are: Student, Staff, Dormitory, Combination, FeeRef, Country, Nationality, Vaccination, Student_Accommodation, FeeTransaction, Student_Vaccination, Student_Class, Year.

The access software was also used to create the user interface; the interface is the application which is separated from the database; in this arrangement the database contains only tables and relationships, while the application contains all programs, forms, reports and queries. This separation allows for multi-user environment i.e. a client-server architecture which separates data from the working environment. Any changes in the application will not affect the data in the database.

4.0 SRMIS Prototype Implementation

The students' registration information system is designed to have a friendly user interface which makes it easy for non-programmers to use without any problem.

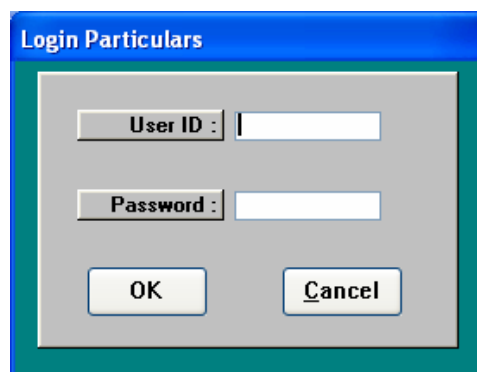


Figure 1: Users Login Window

System users must be registered by the system administrator/in-charge and granted respective access rights. Users have to log in through a login pop up window as shown in Figure 1. The user has to log in with correct User ID and Password. When the user has logged in correctly a front page of the information system will appear as shown in Figure 2.

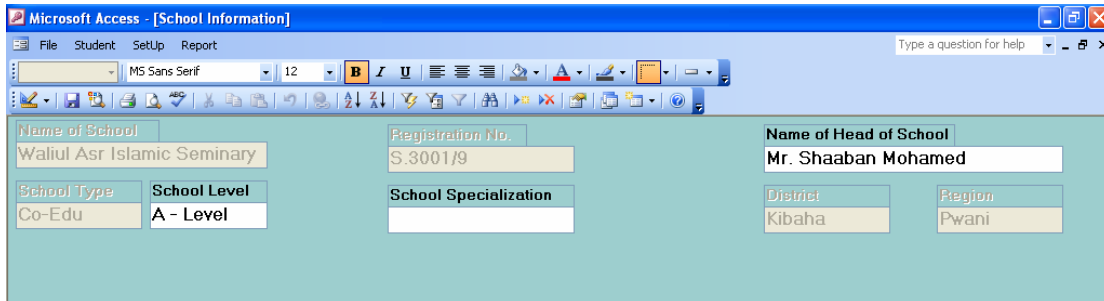


Figure 2: A Front Page of Students' Registration Information Management System

The front page is comprised of the main menu bar for the information system which gives the user a clue of what is contained in each menu. Any information may be displayed on the front page, for this trial version only few information are displayed, the information may include school name, school registration number, name of school head master/mistress etc, the information to be displayed must be agreed with the school administration. The main menu bar comprised of four main menus i.e. File, Student, SetUP and Report. When one of the main menus is clicked, a drop down list of submenus appears for further exploration. Figure 3 shows when one of the main menus is clicked i.e. the SetUp menu.

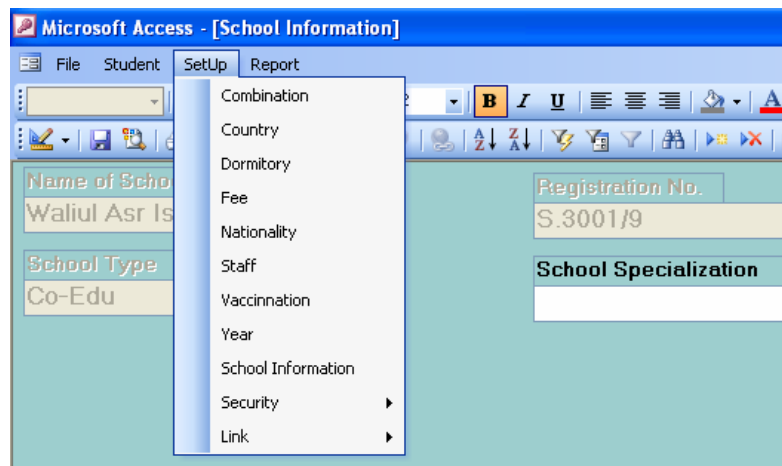


Figure 3: Submenus of the SetUp main menu.

Each of the main menus has one or more submenus for more details. The File main menu has one submenu which represents the Exit to the database action when clicked. Each sub menu in the Student and SetUP main menus represent a form for entering some information in the database. The submenus in the Report main menu represent the standard reports of the system.

5.0 Conclusion on the SRMIS Designed

The prototype of SRMIS was first presented at Wali-ul-Asr girls' seminary in 2006 and some modifications were made to suit users needs. In September, 2007, the modified prototype was presented and installed in both schools; Wali-ul-Asr girls' seminary and Kibaha secondary schools. Training of system usage was also conducted to members who are expecting to use the system at both schools. Supporting document i.e. user manual to help them with system familiarization was also provided. Close monitoring of system usage will be done by research members in order to get views of the users and collect any requirements which are not met in this first version of the prototype.

The SRMIS has been designed to suit the Tanzanian Secondary Schools environment. The system is expected to; simplify storage of students' registration data, provide easy updates of registration information, track particular student's information at any time 't' given and create up-to-date reports whenever required. The database can easily be customized to suit any particular Tanzania Secondary School environment.

This database is just a one of the examples of showing the powerfulness of ICTs in peoples daily activities, and it can also prove to a greater extent how ICT can simplify or change the way people live, socialize and even learn. It's expected that introduction of this system will stimulate teachers and students to participate more in ICT based activities. It is also learned that the use of PAR methodology has played a major role in shaping this system to suit users' needs.