Development of e-Learning Content and Delivery for Self Learning Environment:

Case of Selected Rural Secondary Schools in Tanzania

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Blekinge Institute of Technology

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Acknowledgements

In the memory of my beloved
Dad Mr. Kwegyir McDonald Munthali and
Grandparents Mr. Waddy Juttu Munthali & Mrs. Ella Gondwe Munthali

Abstract

The effective use of Information and Communications Technology (ICT) in developing countries like Tanzania is crucial in order to overcome the challenges that are faced countrywide in many sectors, and to reduce the digital divide and improve the economy. ICT is becoming more and more integrated in societies worldwide, its effects are clearly seen in people's lives as well as on countries' economy as it opens doors for new opportunities and change the attitude of people towards learning.

Secondary schools in Tanzania are facing many problems which hamper students' learning. This in turn affects their performance in the National examinations hence reducing the growth of a learned society. This research specifically addresses the problem of lack of learning and teaching materials by using ICT tools for the development and delivery of e-Learning content. The research focused on two secondary schools, namely, the Wali-Ul-Asr Seminary and Kibaha Secondary School as pilot schools in Kibaha district Pwani region.

The research used courseware engineering methodology which integrated instructional design and software engineering. The research was also inspired by the concepts of participatory action research, Mode 2 knowledge production and triple helix, which incorporated stakeholders' participation throughout the research. The main stakeholders are researchers, students, teachers, head teachers, and Ministry of Education and Vocational Training officials.

This is an applied type of research addressing a practical problem in society. The outcome is a pilot package of e-Learning material comprised of sample chapters of Mathematics form III at the pilot site. Blended mode of delivery has been considered using Compact Disc/Digital Versatile Disc Read Only Memory, the Tanzania Secondary Schools e-Learning (TanSS-L) System, a customized Moodle platform and by using face to face learning.

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List of Abbreviations and Acronyms

ACSEE	Advanced Certificate of Secondary Education Examination
ADDIE	Analysis Design Development Implementation Evaluation
A-Level	Advanced Level
BEST	Basic Education Statistics in Tanzania
BMP	Bitmap
BTH	Blekinge Tekniska Högskola (Blekinge Institute of Technology)
CD-ROM	Compact Disc Read Only Memory
CEM	Courseware Engineering Methodology
CoET	College of Engineering and Technology
CS	Creative Suit
CSEE	Certificate of Secondary Education Examination
CSS	Cascading Style Sheets
CMS	Content Management System
DLES	Distance Learning and Education Services
DUCE	Dar es Salaam University College of Education
DVD	Digital Versatile Disk
ECSE	Electrical and Computer Systems Engineering
e-LMS	e-Learning Management System
F2F	Face to Face
GIF	Graphical Interchange Format
HTML	Hyper Text Markup Language
ICT	Information and Communications Technology
ID	Instructional Design
IEEE	Institute of Electrical and Electronics Engineers
IICD	International Institute for Communication and Development
IMS	Instructional Management System
IO	Information Object
ISD	Instructional Systems Design
JPEG	Joint Photographic Experts Group
JS	Java Script
LAMP	Linux Apache MySQL PHP
LAN	Local Area Network
LMS	Learning Management System
LO	Learning Object
LOM	Learning Object Metadata
LTSC	Learning Technology Standards Committee
MoCT	Ministry of Communications and Transport
MoEC	Ministry of Education and Culture (old name)
MoEVT	Ministry of Education and Vocational Training
NECTA	National Examinations Council of Tanzania
O-Level	Ordinary Level

OSS	Open Source Software
PCs	Personal Computers
PDF	Portable Document Format
PEDP	Primary Education Development Plan
PHP	PHP: Hypertext Preprocessor
RAS	Regional Administrative Secretary
REO	Regional Education Officer
SAREC	Swedish Agency for Research Cooperation
SCO	Shareable Content Object
SCORM	Shareable Content Object Reference Model
SDLC	Software Development Life Cycle
SDR	SmartDraw
SE	Software Engineering
SEDP	Secondary Education Development Plan
Sida	Swedish International Development Agency
SWF	Shockwave Flash
TANESCO	Tanzania Electric Supply Company
TanSSe-L	Tanzania Secondary Schools e-Learning
TIE	Tanzania Institute of Education
TIFF	Tagged Image Format File
TZS	Tanzanian Shilling
UDSM	University of Dar es Salaam
UML	Unified Modelling Language
URL	Uniform Resource Locator
URT	United Republic of Tanzania
USD	United States Dollar
W3C	World Wide Web Consortium
WAMP	Windows Apache MySQL PHP
WYSIWYG	What You See Is What You Get
XHTML	eXtensible Hyper Text Markup Language
XML	eXtensible Markup Language

CHAPTER 1
INTRODUCTION

This thesis constitutes one part of the e-Learning project for rural secondary schools in Tanzania. The project consists of three main parts which focus on the development of learning management platform, cost effective connectivity solution for e-Learning as well as development and delivery of e-Learning content.

The thesis is mainly concerned with the participatory development of e-Learning content employing Information and Communications Technology (ICT) as a tool, particularly the use of open source software (OSS), freeware software and readily available proprietary software for developing and delivering learning material.

The end product of the whole e-Learning project is the e-Learning Management System (e-LMS) with the proposed name of Tanzania Secondary Schools e-Learning (TanSSe-L) System. TanSSe-L system is based on a customized Moodle platform to fit the Tanzanian secondary schools context. Furthermore, it hosts, manages and serves as one of the delivery modes of the developed TanSSe-L content.

The Swedish International Development Agency (Sida/SAREC) in supporting rural development in Sub-Saharan Africa has initiated the funding of the e-Learning project for rural secondary schools in Tanzania. As a result this research is under the ICT Sida/SAREC extended support which is a collaborative project between the Universiy of Dar es Salaam (UDSM), College of Engineering and Technology (CoET) in Tanzania and the Blekinge Institute of Technology (BTH), division of Technoscience in Sweden.

The research is in line with National strategies of having a learned society, the Tanzania Development Vision 2025 and the National ICT Policy. The Government of Tanzania 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 (Tanzania Development Vision 2025, 2006).

1.1 EDUCATION CONTEXT IN TANZANIA

1.1.1 Structure of the Education System

Tanzania follows a 2-7-4-2-3+ system of education which consist of two (2) years of pre-primary education, seven (7) years of school education, i.e. standard 1 - 7, followed by four (4) years form I – IV of Ordinary level (O-level) secondary education, and two (2) years form V – VI of Advanced level (A-level) secondary education. University education normally covers a minimum of three (3) years though some university programmes take more than three (3) years (MoEC, 1995).

The Ministry of Education and Vocational Training (MoEVT) has the jurisdiction on all education levels, primary, secondary, vocational training, tertiary and higher learning institutions. The Ministry also has several independent semi-autonomy agencies responsible for some core functions in the educational arena such as the National Examination Council of Tanzania (NECTA), the Tanzania Education Authority, the Tanzania Institute of Education (TIE), the Tanzania Library Services Board, the Institute of Adult Education, Teachers Service Department, the Agency for Development Education Management, and Vocational Education and Training Authority (Philemon, 2007).

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 pursuing undergraduate studies (MoEC, 1995). The three sets of National Examinations which are conducted throughout Tanzania and governed by NECTA are as follows;

i.   Primary School Leaving Examination, the National standard 7 Examina tions, used as a criterion for selection of standard 7 candidates to join the Government O-level secondary schools

ii. 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 institutions like teachers', technical, social welfare, and business education colleges

iii. Advanced Certificate of Secondary Education Examination (ACSEE) the A-Level National Examinations used as one of the criteria for the selection of the candidates to join higher learning institutions

1.1.2   Importance of Secondary Education

Tanzania has put education at the centre of its National Strategy for Growth and Reduction of Poverty, in Swahili also known as "Mkakati wa Kukuza Uchumi na Kupunguza Umasikini Tanzania" (2005-2010). It aims at 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). Education is central to development and a key to attaining the Millennium Development Goals. It is one of the most powerful instruments for reducing poverty and inequality and lays a foundation for sustained economic growth.

Secondary school education occupies a strategic place in social-economic systems in Tanzania. 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 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 school 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).

The importance of secondary education consists of the following (MoEC, 2004a):

i. Supplying the needed educated and trainable labour force with secondary education as the minimum qualification

ii. Improving the quality and retention in primary education

iii. Serves as a necessary condition for economic competitiveness in the context of globalization and liberalization

iv. Serves as one of the major components of the poverty reduction strategy in Tanzania

v. Provision of social benefits, such as improvement in health standards, the lowering of fertility rates, containment of the spread of Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome and greater social participation in the democratization and development process

vi. Expansion of secondary education especially at advanced level, in order to enlarge the supply of students for expansion of tertiary and higher education

vii. Achieving gender balance in tertiary and higher education which depends on increased number of girls graduating from secondary education.

1.1.3   Selected Educational Statistics

This section consists of the selected educational statistics regarding the comparison of number of primary and secondary schools, teachers' qualifications, teacher-students ratio, standard 7 leavers and Form I enrolment and budget allocations for the secondary education.

(i) Number of primary and secondary schools

Table 1.1: Number of Primary and Secondary Schools in Tanzania for the period 1997 - 2008				
Year	Number of primary schools	% increase	Number of secondary schools	% increase
1997	10927	-	721	-
1998	11130	1.86	781	8.32
1999	11290	1.44	826	5.76
2000	11654	3.22	927	12.23
2001	11873	1.88	937	1.08
2002	12286	3.8	1024	9.28
2003	12815	4.31	1083	5.76
2004	13689	6.82	1291	19.21
2005	14257	4.15	1745	35.17
2006	14700	3.11	2289	31.17
2007	15446	5.07	3485	52.25
2008	15673	1.47	3798	8.98
	Average	3.38	Average	17.2
Source: MoEVT BEST, 2008				

Data from MoEVT Basic Education Statistics in Tanzania (BEST) shows that in the period 1997 – 2008 the total number of primary schools was 15,673 and the average increase in primary schools was 3.38%. The number of secondary schools was 3,798 with an average increase of 17.2%. Out of 3,798 secondary schools, 91 are Government schools, 2,948 community-based schools and 759 non – government schools.

(ii) Teachers' Qualifications in Secondary Schools

There are 66 teachers training colleges in the country, of which 32 are Government and 34 are non-government (MoEVT BEST, 2008). The number of teachers and their qualifications in secondary schools is shown in table 1.2. In 2008, out of a total of 32,835 teachers only 14.5 % were graduates, 58.6% were diploma holders, 1.5% were grade A holders and 25.1% were holders of grade B and grade C. The number of teachers has been increasing each year, a remarkable increase appeared in 2006 – 2008 where the number of qualified teachers rose from 23,252 in 2006 to 29,858 in 2007, and from 29,858 in 2007 to 32,835 in 2008.

Table 1.2: Number of Teachers Grouped by Qualification					
Year	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	16,498
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
2008	4,775	19,326	489	8,245	32,835
Source: (MoEVT BEST, 2006; MoEVT BEST, 2007)					

(iii) Teacher to Student Ratio

Table 1.3 shows the teacher-to-students ratio in secondary schools for five consecutive years. In 2007, the average teacher-to-students ratio was 1:34 (MoEVT 2007) but this aggregate figure does not reflect the real situation in the field and the ratio does not reflect shortages in mathematics and science subjects (Oluchi, E., 2006). It was noted that the ratio keeps on increasing year after year.

Table 1.3: Teacher-to-Student Ratio for Secondary Schools in Tanzania for the Period 2003 - 2007			
Year	Government Schools	Non Government Schools	Total
2003	1:20	1:20	1:20
2004	1.23	1:23	1:23
2005	1:26	1:16	1:22
2006	1:31	1:25	1:29
2007	1:38	1:25	1:34
Source: (MoEVT BEST, 2006; MoEVT BEST, 2007)			

(iv) Standard 7 Leavers and Form I Enrolment

The number of students selected to join form I has increased each year. The trend has not been satisfactory in previous years as seen from figure 1.1, which shows that the rate of increase of students completing standard 7 does not cope with the rate of increase of students enrolled in form I, there are many more standard 7 leavers than those enrolled in form I.

Number of Students

900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
■ Standard 7 Leavers	386,584	359,337	414,069	364,014	426,562	389,746	444,903	494,504	490,018	499,241	493,946	664,263	773,553
□ Selected to Join Form I	56,414	60,641	62,182	69,571	80,013	84,709	99,752	107,282	147,490	180,239	240,389	448,448	438,901

Years

Figure 1.1: Standard 7 Leavers and Form I Enrolment (MoEVT BEST, 2007)

(v) Budgetary Allocation for Secondary Education

The Government through the MoEVT is responsible for the sustainability of the Government secondary schools in terms of supply of books and learning resources, the deployment of qualified teachers and their welfare. Community-based schools depend partially on the Government and partially on the local government, while privately owned schools have their own mechanisms to sustain them. Moreover, the budget for secondary education is very limited and cannot meet all the educational requirements.

Table 1.4: Budgetary Allocation to Education Sector 2002/03 – 2007/08					
Financial Year	Total Education Sector	Primary, Non-Formal and Supporting Services	Secondary Education (% of total)	Teacher Education	Tertiary and Higher Education
2002/03	396,780	289,718	29,876 (7.53)	6,646	70,540
2003/04	487,729	361,425	32,464 (6.7)	7,700	86,140
2004/05	504,745	322,196	92,045 (18.2)	6,189	84,315
2005/06	669,537	418,455	104,483 (15.6)	8,540	138,059
2006/07	958,819	618,534	119,987 (12.5)	10,439	209,859
2007/08	1,100,188	618,828	127,227 (11.6)	19,257	287,876
Source: (MoEVT BEST, 2008)					

Table 1.4 gives the statistics for the budgetary allocation for the education sector for the financial year 2002/03 – 2007/2008. The budget allocations increase yearly, though the trend shows that the allocation for secondary education is very small as compared with the allocations for primary, tertiary and higher education.

In the financial year 2006/07, the budgetary allocation for the education sector stood at Tanzanian Shillings (TZS) 958 Billion ≈ United States Dollar (USD) 740million

with 64.5% going to primary education, 12.5% to secondary education, 1.1% to teacher training and 21.9% to tertiary education (MoEVT BEST, 2006). Data in table 1.4 show that there has always been insufficient budgetary allocation for secondary education i.e. 2002/03 (7.5%), 2003/04 (6.7%), 2004/05 (18.2%), 2005/06 (15.6%). (MoEVT BEST, 2006). Insufficient budgetary allocations for the Ministry to run and manage secondary schools result in many problems that are commonly faced by a number of secondary schools in Tanzania.

1.1.4   Educational Pyramid

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 primary school leaving examination and 448,448 enrolments in Form I. The primary net enrolment ratio for 2006 was 96.1% with a primary school pupil population of 7,063,362 while the net enrolment ratio for O-level secondary schools was only 13.1% and for A-level secondary schools was 1.0% (MoEVT BEST, 2007).

Table 1.5 shows the number of students enrolled in different levels of education, the transition from standard 7 to form I, and form IV to form V and the ACSEE results for the period 2003 - 2007.

Table 1.5: Student Enrolment from Lower to Higher Educational Levels for the Period 2003 - 2007					
Students/Year	2003	2004	2005	2006	2007
Std. 7 Leavers	490,018	499,241	493,946	664,263	773,553
Joined Form I	147,490	180,239	243,359	448,448	438,901
Sat for CSEE	62,359	63,487	85,292	85,865	125,288
Passed CSEE	54,876	58,091	76,166	76,505	113,135
Joined Form V	17,200	18,893	27,780	33,088	37,916
Sat for ACSEE	12,003	13,975	16,884	21,126	24,813
Source: (MoEVT BEST, 2007)					

Table 1.6 gives the ACSEE results in percentages for the period 2003 to 2008. Data from table 1.5 and table 1.6 show that the number of students decreases as they progress from lower to higher levels of education.

A clear picture of the reduction in the number of students is seen in figure 1.2 where the change in the number of students is traced from when the students finished standard 7 from 2000 to 2007 when students completed form VI. Out of 389, 746 (100%) students who completed standard 7 in 2000, only 84, 709 (21.7%) students were enrolled in form I in 2001. From the same group, 63,487 (16.3%) students sat for CSEE in 2004 and the students who passed in the level of division I – division IV comprised 58,091 (14.9%) of whom only 18, 893 (4.9%) joined form V in 2005. In 2007, from the same group 24,813 (6.4%) students sat for ACSEE and the results

showed that 1,911 (0.49%) students got division I, 4,590 (1.2%) students got division II and 10,471(2.7%) students got division III.

Table 1.6: ACSEE Performance in Percentages for the Period 2003 - 2008						
Performance/Year	2003	2004	2005	2006	2007	2008
Division I	16.5	26.6	20.1	18.1	7.7	11.1
Division II	30.8	32.2	28.9	31.7	18.5	22.9
Division III	40.9	32.4	39.1	36.8	42.2	40
Division IV	9.1	6.8	8.8	9.7	23.9	19.2
Fail	2.5	1.9	3.1	3.7	7.7	6.8
Source: (MoEVT BEST, 2007)						

Students who are eligible to go to university are normally those who obtained division I and II, though depending on the overall performance. Those who obtained division III may also be considered for admission. In the NECTA examination results division I is the highest rank while division IV is the lowest rank, and 'FLD' indicates failure.

4.39% (16,972) Passed ACSEE expected to join higher learning institutions in 2008 (Div I - 0.49%, Div II - 1.2%, Div III - 2.7%)
6.4% (24,813) Sat for ACSEE in 2007
4.85% (18,893) Joined Form V in 2005
14.9% — Passed CSEE in 2004
16.3% — 63,487 - Sat for CSEE in 2004
21.7% — 84,709 - Joined Form I in 2001
100% — 389,746 Standard 7 Leavers in 2000
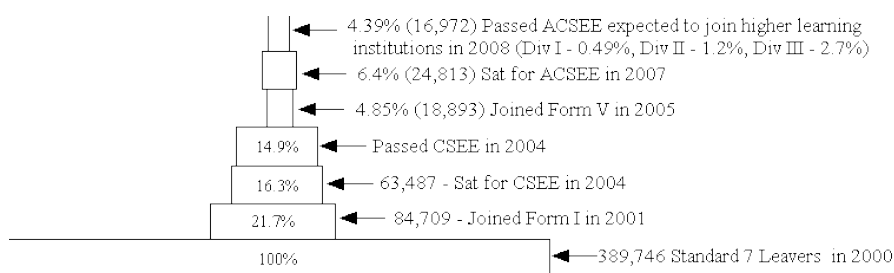
Figure 1.2: Students' Transition at Different Levels of Education

Figure 1.2 also shows that the number of students who sat for the ACSEE in 2007 is more than the number of students who joined form V in 2005. This increase is due to the fact that a number of re-sitters were not taken into account when counting the students newly selected to join form V.

1.1.5   Secondary Education Reform through SEDP

For Tanzania to be a learned society, and to achieve higher levels of economic growth and productivity, it has to adequately invest in education. In view of this, the Government has made concerted efforts to revitalize the education system by establishing the Education Sector Development Programme. Under this umbrella, two plans were established, namely the Primary Education Development Plan (PEDP) 2002-2006 and the Secondary Education Development Plan (SEDP) 2004-2009 (MoEC, 2004a). When PEDP started, almost 1,600,000 pupils were enrolled in standard 1, an increase of 143% as compared to the enrolment in 2001. This increase in number of pupils in the primary education forced the Government to set the target of having almost 50% of pupils joining secondary education by 2009 (SEDP, 2005). Hence the Government,

in collaboration with the community, built more day community secondary schools, which again increased the need for more trained teachers to meet the demand of the new community schools.

The Government launched the SEDP in 2004, with the aim of increasing access, equity and quality in education, conducting management reforms, building capacity and addressing cross-cutting issues (MoEC, 2004a). SEDP was established to address some weaknesses encountered in secondary education in Tanzania and to increase the proportion of Tanzania youths completing secondary education with acceptable learning outcomes, high quality competences, the required aptitudes and the right attitudes in all subjects. Particular attention was paid to competences in sciences, mathematics and languages, especially those of instruction and learning, which are also the medium of dialogue, as well as intellectual and commercial transactions. The Plan had five areas of concentration; improvement of access, equity improvement, quality improvement, management reforms and devolution of authority, and education management system improvement (MoEC, 2004a).

The percentage increase in form I enrolments is clearly seen when the implementation of SEDP started. Figure 1.1 shows that the percentage of students selected to join form I was 44, 48.7, 67.5 and 56.7, respectively for the period 2004 – 2007. One of the concerns in implementing SEDP was that the rapid expansion in the number of secondary schools would hinder an improvement in the quality of education. In many developing countries, the rapid expansion of formal education resulted in shortcomings in learning conditions in schools, shortcomings in the training of teachers, high dropout rates of students, low motivation of teachers and relatively low educational achievements (Stronkhorst, 2001). Moreover, a rapid increase in student enrolment brings to the school a group of low level students who may not be able to follow the subject content in the current elite curriculum (O-saki, 2004).

1.2   ICT AND BASIC EDUCATION IN TANZANIA

Developments in ICT have opened new doors in every profession and segment of society worldwide. The introduction of electronic mail, personal computers (PCs), the Internet and its application to education have produced amazing results. The health of the economy of any country, 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).

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. 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 with other regions of the world

(UN ICT Task Force, 2002). Sub-Saharan Africa remains at the bottom of the list of developing regions in terms of Internet usage around the world (ITU Website, 2006).

1.2.1 National ICT Policy

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

In 2001, the Government of Tanzania recognized the development potential of ICT and appointed the Ministry of Communications and Transport (MoCT) as the National ICT coordinator and a focal point of all ICT related issues. This was done in order to avoid dangers posed by the digital divide and the risk of being further from the knowledge economy and social development. The main tasks of the MoCT were to formulate and prepare the National ICT policy document that would guide the provision of ICT services in Tanzania. The policy was launched in 2003 (MoCT, 2003).

Under the National ICT policy, among focus areas drawn from the aspirations of Tanzania's Vision 2025 is the education sector. There are new opportunities for applying ICT to enhance education, including curriculum development, teaching methodologies, simulation laboratories, life-long learning and distance education (MoCT, 2003).

Information technology has entered the world of learning and its application keeps on expanding, from using a PC in the classroom to the creation and delivery of entire online courses. The development of the Internet has made it possible to deliver educational materials in electronic format to anyone, anywhere, and at any time. Similarly developments in educational technology promise that educational resources in electronic formats can change the ways in which we teach and learn (ADL, 2003).

1.2.2 ICT Policy for Basic Education

The MoEVT is responsible for promoting the introduction of ICT in basic education, teaching and learning as well as administration and management. 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 the 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 a need to provide schools with the required ICT know-how and resources.

Among the objectives of the ICT policy for Basic Education are to promote the harmonization of activities and standards in the educational uses of ICT, to ensure that there exists equitable access to ICT resources by students, teachers and administrators in all regions and types of educational institutions and offices, to facilitate the use of

ICT as a tool from assessment and evaluation of education as well as administration and management, to facilitate the use of ICT resources in schools and colleges in the neighbouring community, to 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 to promote the development of local content for basic education and other stakeholders (MoEVT, 2007).

1.2.3   ICT Integration in Basic Education

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

The Bagamoyo round table conference of 2002 could be considered as the beginning of ICT integration in secondary schools in Tanzania. The workshop was called by the then Ministry of Education and Culture (MoEC) currently changed to MoEVT with support from the International Institute for Communication and Development. The round table conference identified areas of ICT interventions and eleven (11) project proposals were generated. These proposals helped to raise awareness of the benefits and potential gains in adopting ICT in the education sector which elevated ICT to a priority area in education planning (Hare, 2007).

According to the MoEVT, 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 the relevance of basic education. ICT will be used to increase the 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).

In line with the integration of ICT in secondary education, MoEVT prepared a 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 in computers and the use of multi-media equipment are among major reasons for the slow take up of computer studies in primary and secondary schools. Generally, the use of ICT enhances the effective delivery of education, although, this benefit is only evident in some schools and colleges in urban areas (MoCT, 2003). In this respect, private schools are doing far better than public schools.

1.2.4   ICT for Education Programmes

The Swedish International Development Agency (Sida) has been supporting and assisting MoEVT to work on the country-wide ICT for Education (ICT4E) programmes at secondary education level. These programme are, the implementation of ICT in teachers' training colleges, the e-School programme (ICT for secondary schools in Tanzania) and the Education Management Information System project (Philemon et al., 2006). The following sections give explanation of the programmes.

1.2.4.1   ICT Implementation in Teachers' Training Colleges

This project deals with the plan to equip all teachers' training colleges in Tanzania with computers and Internet connectivity, which will allow teachers to acquire computer skills to use in their work in schools. The main aim of the project was 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 ICT tutors.

1.2.4.2   The e-School Programme

The e-Schools programme being formulated is 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 being reviewed by the MoEVT. The proposed programme includes ICT infrastructure and technical resources, an integrated educational management system, curriculum and e-content, sensitisation and human resources. A phased approach was suggested, starting with 400 schools (within 2 years), followed by 2,000 schools (within 5 years), and nationwide coverage by 2015 (MoEVT, 2007).

1.2.4.3   The Education Management Information System Project

The aim of this system is to collect, process, utilize and disseminate education data as well as related information to educational stakeholders on a timely basis. By 2007, the MoVET had provided computers and printers to all region and district education offices, and carried out computer training for staff in these offices (MoEVT, 2007).

1.3   SUMMARY OF IDENTIFIED PROBLEMS

There are a number of challenges facing the education sector in Tanzania, which affect the development of education. The problems include, inadequate and obsolete physical facilities and infrastructure, inadequate number of qualified teaching staff, an acute shortage of teaching and learning materials and laboratory equipment, curriculum not demand driven; low enrolment, inadequate capacity in relation to 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).

Many schools have insufficient ICT infrastructure and lack of ICT facilities. In 2007, very few schools had computers, computer laboratories, Internet access and other multi-media facilities. Educational opportunities are highly stratified, as decent schooling is increasingly the preserve of small elite. With regard to computers in schools, their presence is minimal with major computer access being confined mostly to the private/elite schools, thus intensifying the inequality (Esselaar, et al., 2001).

The majority of secondary schools in Tanzania lack access to learning resources and necessary information. Due to the shortage funds and poor governance schools are left with non-functioning or empty libraries and non functioning laboratories. Owing to this situation, students are denied the chance to actively participate in the learning process and this seriously reduces the quality of education provided (Senzige et al., 2004).

Due to the real situation in rural and semi-rural areas, poor living and working conditions, low morale amongst teaching staff and competition from private industry, qualified teachers tend to be concentrated more in the urban areas than in the rural areas, as schools in wealthier areas tend to attract better qualified teachers (Wedgwood, 2005). This in turn leads to the problem of shortage of teachers. In 2007, the average pupil teacher-ratio stood at 1:34, but this ratio hides rural-urban disparities and shortages in subjects, such as science and mathematics. Literature reviews and studies showed that the most critical problems which are faced by secondary schools in Tanzania are scarcity of learning resources and shortage of qualified teachers (Mbelle et al., 2003; Wedgwood, 2005; World Bank, 2004).

The overall outcome of the aforesaid problems is the poor performance of students in the National Examinations at CSEE level as exemplified in table 1.7 for the period 1998 – 2007.

Table 1.7: CSEE Performance in Percentages for the Period 1998 – 2007								
	Division (No. of students in Percentages)					Number. of Students Examined	Number. of Students Passed	Number of Students Selected to Join Form V
Year	I	II	III	IV	Fail			
1998	5.5	5.5	18.0	46.8	24.3	42,887	32,465	11,972
1999	4.3	6.2	18.4	51.1	20.0	44,172	35,338	12,548
2000	4.1	5.7	16.0	52.6	21.6	47,389	37,153	13,090
2001	4.5	5.7	18.2	49.1	22.6	50,820	39,335	14,129
2002	6.4	8.2	21.6	50.1	13.7	49,512	42,729	14,210
2003	7.2	7.3	23.6	50.0	12.0	62,359	54,876	17,200
2004	4.8	8.4	24.6	53.7	8.5	63,487	58,091	18,893
2005	5.2	6.5	21.9	55.7	10.7	85,292	76,166	27,780
2006	4.5	6.9	24.3	53.2	10.9	85,865	76,506	33,088
2007	5.1	8.6	21.9	54.7	9.7	125,288	113,135	37,816
Source: MoEVT BEST, 2008								

The average pass in percentage terms for the period 1998 – 2007 is 5.16% at division I, 6.9% at division II, 20.9% at division III, and 51.7% at division IV. The average percentage in the same period of candidates who were selected to join A-Level was 30.55%, which is just above a third of the total number of students who sat for the National Examinations in that period. Over 50% of students who ended up with division IV had no chance of pursuing higher studies.

In view of the above discussion the research is addressing the problem of scarcity of learning and reference materials by using ICT tools for the development of e-Learning content for self-learning environment hence increasing availability and accessibility of the learning content.

1.4   RELATED WORK

There are very few e-Learning activities for secondary schools in Tanzania and those that do exist have been the result of the efforts of individual schools' efforts or the support of non-government organizations.

Distance Learning and Education Services (DLES) is a project which was supported by the International Institute for Communication and Development in collaboration with the Royal Dutch Embassy in Tanzania. The project objective was to improve the quality of education for secondary schools through providing broad access to educational materials and tutorial services via web based systems (Paul, 2008). The project developed a website with the website Universal Resource Locator (URL) address "*http://www.diles.or.tz/index.htm*" to provide notes and exercises for various subjects for secondary schools at O- and A- levels. The material available in the Website is updated from current books by competent teachers from various secondary schools

(http://www.diles.or.tz/index.htm). However, the project seems to have stopped, the website does not have all subjects' material in full, and it shows that it is still under construction.

Developed learning materials can be accessed through the DLES home page where navigation to subject at either O-level or A-level is provided. Each form level has its own page where there is navigation to all subjects. The smallest unit of the learning material is the topic, which contains all the materials to be covered in that topic, worked examples, exercises and the corresponding answers to the questions.

Pedagogically, DLES content structure lacks some design aspects which this research has considered for providing the self-learning environment. There is limited opportunity for students to navigate to the areas of their choices or level of understanding. The learning content does not contain self-test exercises which are very important for students' motivation to learn in a self-learning environment. Delivery of learning content has considered only the one option of using web page delivery. This could be improved by having a hybrid or blended mode of delivery by using Compact Disc/ Digital Versaltile Disc Read Only Memory (CD/DVD-ROMs) and also make use of open source learning management systems (LMSs). The use of graphics and colouring is minimal, and the use of illustrations and animation have not been considered in the DLES learning content, which makes it unappealing to students to continue using the learning material. This research has considered integrating graphics, illustrations and animations whenever possible to improve concept retention of students.

1.5   RESEARCH OBJECTIVES, QUESTIONS AND SIGNIFI-CANCE

1.5.1   Main Objective

The main objective of this research work is to develop and deliver appropriate, self-learning and pedagogically sound e-Learning content using ICT tools.

1.5.2   Specific Objectives

(i)   The specific objectives of this research are:

(ii)   To design and develop shareable e-Learning content for secondary schools

(iii)   To determine pedagogical and technological factors in the design of e-Learning content for the self-learning environment.

1.5.3   Research Questions

(i)   What can be done to improve availability and accessibility of learning content for secondary schools?

(ii)   What factors need to be considered in the design of e-Learning content for the self learning environment?

1.5.4   Significance of the Research

Academically, this research intends to:

i.   Increase availability and accessibility of learning resources
ii. Enhance the quality of learning resources
iii. Improve students' learning
iv. Raise the standard of performance at CSEE level
v.   Empower rural secondary schools by providing teaching and learning sup port using ICT-based content

Socially, the research will:

i.   Promote awareness of the potential of ICT in education for teachers, stu dents and the community
ii. Encourage schools and communities to engage more in ICT-based activi ties
iii. Improve communication among stakeholders (student-student, student- teacher, teacher-teacher and university-secondary schools-Government)

1.6   RESEARCH CONTEXT

The research is framed by the contextual definition of rural schools, the pilot site and the pilot e-Learning content.

1.6.1   The Concept of Rural Schools

The term rural in the developed world means sparsely populated and geographically isolated areas. When defining the term rural, population and remoteness are important considerations as these factors influence school organization, availability of resources, and economic and social conditions. Rural schools face many challenges in acquiring the financial and human resources necessary to offer the quality of education students need. Rural schools have a harder time attracting and retaining teachers and administrators (Rural Schools FAQs, 2006).

In the context of this research, rural schools are defined as any school with limited educational resources in terms of, reference and teaching materials, qualified teachers, laboratory equipment, functioning libraries, ICT facilities and access to the Internet. In this study, this definition is intended to be sufficiently flexible to allow schools in different contexts whether in urban, rural or semi-rural areas, to be included.

1.6.2   The Pilot Site

The research was conducted in two schools, Kibaha secondary school and Wali-Ul-Asr girls' seminary in Kibaha district, Pwani region in Tanzania. The two schools were chosen as they were considered appropriate for the study.

1.7 THESIS OUTLINE

Chapter 1 introduces the research by explaining the education context in Tanzania, states and described the problem, efforts to support secondary education using ICT, and the e-Learning project for rural secondary schools in Tanzania. The chapter also covers the objectives, the questions and the significance of the research. The context of the research is also given in this chapter.

Chapter 2 focusses the literature review in relation to the study and discusses the concepts to operationalize the problem. The concepts include e-Learning, pedagogy, instructional design, software development, learning objects, e-Learning standards, content repository, overview of multimedia content, e-Learning content delivery approaches, open source software, web based technologies, and open source platform.

Chapter 3 covers the research methodology used, which consists of the Courseware Engineering Methodology (CEM) integrating Instructional Design (ID) and Software Engineering (SE). It also introduces the concepts of triple helix and mode 2 knowledge production in relation to this research.

Chapter 4 discusses the general e-Learning content requirements gathering and analysis. It covers the first phase in the ADDIE model, methods of data collection, information regarding the surveys, collaborative activities conducted during the study and the needs analysis. The chapter also discusses on pilot site selection and the existing subject structure.

Chapter 5 describes the TanSSe-L content pedagogical design based on the learning object (LO) approach. The chapter also gives information regarding the new subject structure, the typical sample base LO and chapter designs. The pedagogical design considered Transmissive, Constructivism and the Hybrid pedagogy.

Chapter 6 covers the creation of multimedia TanSSe-L content, which includes determination of technical requirements, identification of software packages, raw material digitization, multimedia content considerations, development of learning objects at the topic level, testing of the TanSSe-L content and collaborative activities accompanying the content development phase.

Chapter 7 describes the implementation of the TanSSe-L content, content modification to suit both CD-ROM and TanSSe-L system delivery modes, online and offline learning. It also covers demonstration of TanSSe-L system and content and suggestions given.

Chapter 8 discusses the research results, the challenges experienced in the research, the contribution of the research, e-Learning project sustainability, recommendations and proposed ideas for future work.

CHAPTER 2
LITERATURE REVIEW

2.1 INSTRUCTIONAL DESIGN

Instructional design 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 ID is effective because it focuses attention on what is going to be learned (learning objectives) and what must have already been 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 an ID model, the end result is effective instruction, regardless of who is teaching (Morrison et al., 2003).

ISD 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 on appropriate planning, and so the instruction has to be planned if it is to be effective and designed in some systematic way (Dick et al., 2005).

2.1.1 Learning and Instructional Theories

Learning theories describe how learning occurs and they identify the concepts that describe the knowledge to be learned. Instructional theories on the other hand prescribe rules for the effective acquisition of knowledge and skills, and the procedures for the development of instruction (De Villiers, 2002).

A strong relationship exists between these theories, in that learning theories facilitate an understanding of why instructional theories work. In the absence of an instructional theory, the learning theory helps in selecting instructional methods that meet the given needs (Reigeluth, 1999). Both instructional and learning theories explain how learning occurs and how it can be facilitated in some disciplines. This includes the demographics of learners, the purpose of instruction and the cognitive abilities of learners.

Instructional theories have a long history, one being behaviourism, which mainly sought to describe and prescribe the instruction process, and was implemented as system theory due to its prescriptive sequence and interrelated organization. Then there was the cognitive idea of the information processing whose focus shifted to the organization of content in relation to how the mind processes the information. Later, on came the constructivist literature whose focus was now on how learners construct knowledge and make meaning through mental activities in relation to their environment (Duffy et al., 1996). Traces of these different theories appear side by side in classrooms today, and have impact on students' learning experience. Hence, for example, learning by heart and written exams co-exist with problem-based group projects and oral presentations.

2.1.1.1 Gagne's Events of Instruction

Gagne's events of instruction are the optimal principles that are chosen for specific instruction for each objective and for different types or levels of learning (Moallem, 2001). Gagne suggests that learning tasks to improve an individual's skills can be organized in a hierarchy according to complexity. The primary significance of the hierarchy is to identify the prerequisites that need to be in place to facilitate learning at each level. Learning hierarchies provide a basis for the sequencing of instruction (Gagne et al., 1992). Gagne's theoretical framework covers all aspects of learning and emphasizes the things teachers should do to best promote the desired learning outcomes of students. Gagne's events of instruction are:

(i)   Gain attention – For any learning to take place, gaining learners' attention by using either a multimedia programme or by throwing out a thought-provoking question or interesting fact is essential or fundamental. Curiosity motivates students to learn.

(ii) Inform the learners of the objectives (expectancy) – Students should to encounter a list of learning objectives. This helps in initiating the internal process of expectancy and helps motivate the learners to complete the lesson.

(iii) Stimulate recall of prior learning (retrieval) – An association of new information with prior knowledge can facilitate the learning process. A simple way to stimulate recall is to ask questions about previous concepts or experiences.

(iv) Present the stimulus material (selective perception) – Present the new con

tent to the learner. Content should be chunked and organized meaning
fully. If possible a variety of media should also be used.

(v)   Guide learning – Present instructions in small steps leading from simple to
complex ones. Guidance strategies include the use of examples, case stud
ies, and graphical representation.

(vi) Elicit performance (responding/practice) – Involve learners in questioning,
discussion and demonstration to confirm that they correctly understood
the content.

(vii) Provide feedback (reinforcement) – Specific and immediate feedback
should be given as learners respond to questions. Provide them with
remediation or reinforcement where necessary.

(viii) Assess performance (retrieval) – Upon completion of the instruction, stu
dents should be given a quiz or assignment to confirm mastery of the
objectives

(ix) Enhance retention and transfer (generalization) – Provide the opportunity
for learners to apply the outcome of their training in the real world by giv
ing them realistic assignments

Gagne pointed out that these events of instruction do not always occur in this exact
order. Practically all learners have experience of some events and so they do not need
to be mentioned again to learners. According to Gagne's aspect of learning hierarchy,
prerequisite skills must be attained before moving on to more complex training, and so
he developed hierarchy for learning to ensure that these skills were acquired.

2.1.2   Types of Learners

There are three primary types of learners, visual, auditory and kinesthetic learners.
Learners learn in different ways and no single learning style is better for a diverse group
of students with different backgrounds and learning styles. Visual learners learn by see-
ing and visualizing. Auditory learners prefer to have things explained to them verbally
rather than to read written information, hence they learn by listening and verbalizing.
Kinesthetic learners like the hands-on approaches to things, learn by doing and solving
real life problems (Friedman, 2008). Awareness of different types of learners and learn-
ing styles leads to the need for a variety of instructional strategies in schools, in order
to meet the needs of all students in a group.

2.1.3   Instructional Strategies

Instructional strategies are what instructors or instructional systems have in order to
facilitate student learning (Dabbagh, 2005). Instructional strategies can also be de-
scribed 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 by putting them into practice. Therefore instructional strategies are derived from pedagogical models, which in turn are derived from learning theories.

Some of the examples of instructional strategies are promote or support authentic learning activities, facilitate problem-solving, promote collaboration and social negotiation, and provide scaffolding (Dabbagh, 2005). Instructional materials that have been effectively designed with a sound instructional strategy will facilitate the desired learning outcomes of students, enabling them to acquire higher order skills (Teo et al., 2006). Instructional methods can be grouped into the following categories; presentation, demonstration, discussion, drill-and-practice, tutorial, cooperative learning, playing games, simulation, discovery, and problem solving (Heinich et al., 2002).

The variety of teaching strategies applied should be able to meet the needs of different types of learners as mentioned in section 2.1.2. The strategy for visual learners should include the use of demonstrations and visually pleasing materials. The strategy for auditory learners should use good, planned and well delivered oral instruction in the form of organized conversation. The strategy for kinaesthetic learners should include hands-on demonstrations and case examples to be discussed and solved (Friedman, 2008). Therefore, familiarity with different types of learning styles and associated strategies may enable teachers to formulate instructional strategies which will meet learners' needs.

2.1.4   Instructional Design Models

Models for ID provide a procedural framework design of modes of instruction. They incorporate fundamental elements of the ID process, including an analysis of the intended audience or determining goals and objectives. There are many ID models, used in many settings and to varying degrees but all of them share some basic features such as needs assessment, goal and objective identification, audience and setting analysis, content development and delivery as well as evaluation and redesign (Thompson, 2001).

The ID model speeds up the course planning process, helps internal communication (by transferring goals and objectives from thoughts to paper clarifies them and focuses design efforts), and ensures that no phase of ID will be forgotten or short-changed. An ID model can also be used to evaluate existing instruction (Thompson, 2001).

Instructional system design provides a road map to guide designers and instructors from analysis, design, development, implementation, and evaluation to the goal, and provides a route to many different destinations depending on the turns one chooses to make. At its most basic level, ID 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. ID models have the ability to provide a link between learning theories and to the building of instructional systems (Gros, 1997).

The generic ADDIE Model is shown in figure 2.1 uses a systematic approach to the ID process and serves as the foundation for most ISD models in use today. The ADDIE approach to designing instruction is similar to the SE approach.

ADDIE is an acronym derived from the following words namely; Analysis, Design, Development, Implementation and Evaluation. These word forms phases with ongoing and iterative activities that continue throughout the life of a training programme (Dick et al., 2005). The ADDIE model analyzes the needs; designs the instruction and presentation, develops materials, implements activities and evaluates the effectiveness instructional materials.
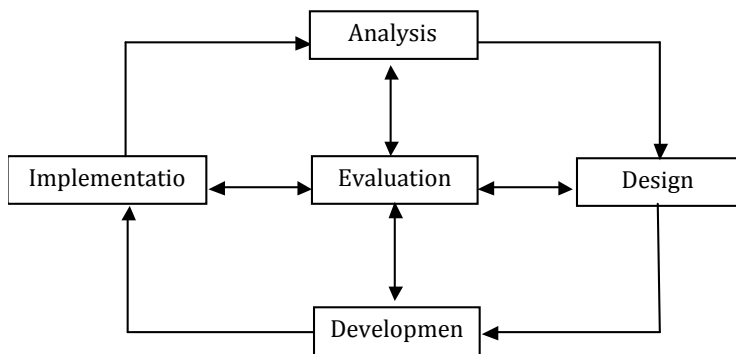
Figure 2.1: ADDIE ID Model (Clark, 1995)

2.2 OVERVIEW OF PEDAGOGICAL APPROACHES

Pedagogy is the method by which educational content is exposed to learners. It includes teaching methods relating to the presentation of experiences, the 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).

In traditional face to face (F2F) teaching, teachers have the ability to vary their approach to teaching to suit learners even during the class. In the e-Learning environment the teacher may or may not always be available to make such variations. The need to have the content fully planned in advance is crucial in such an environment. This calls for the pedagogical approach to be selected in advance to guide the planning and design of e-Learning content. Most of the pedagogical principles, such as discussion, demonstration and collaborative learning that apply to the traditional classroom delivery method also apply to e-Learning. However, these principles need to be extended to accommodate rapid changes in technology. Pedagogically designed learning content increases the interactivity and hence improves retention (Govindaswamy, 2002).

Pedagogical approaches vary in terms of the educational context, purpose and user group. For example because education contexts be it primary, secondary, vocational training or university, are different, pedagogical approaches are also different with each demonstrating a particular emphasis (Herrington et al., 2002). There are pedagogical approaches which guide and inform development and those that evaluate the nature of existing resources. Furthermore, the guidelines differ in terms of the user group at which they are directed. Pedagogical considerations as regards learning and 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 a good pedagogical design theory of learning must be adopted (Mayes, 2004).

Several instructional theories have been studied and developed that suit diverse ID purposes. As far as the design of this research is concerned, there are basically two categories of instructional practices, namely, instructivist or transmissive, essentially replicating the traditional teacher-led learning environment and the situational (i.e. embedded in social relations) and constructivist environment which takes the form of student-centred learning, in which the student is an active collaborator in the learning process and in the production of knowledge (Cullen et al., 2002).

2.2.1   Teacher-Centred Approach

Teacher-centred learning is the traditional transmissive view of learning, reflecting the objectivist ID approach, where the agent is the instructor or teacher who constructs the learning environment and specifies what the students should do and how they should do it (Diaz et al., 2000). Teacher-centred learning involves methods, activities, and techniques, through which 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 lectures and notes-taking ("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 a transmissive ID environment, the process is sequential and linear, planning is top-down and systematic, and objectives guide the development of learning content, resulting in well-defined and well-structured information that has to be transferred to learners. This method is mostly used by novice learners in order to provide direct instructional guidance on concepts and procedures in a particular discipline (Kirschner, 2006).

Within the Tanzanian education system, the teacher-centred approach is the major pedagogical method. Due to lack of learning materials like school books, libraries and

computer-based local educational material sites, the teacher's lecturing in the classroom is the main way in which students acquire knowledge.

2.2.2 Student-Centred Approach

In a student-centred environment, learners are seen as creating new knowledge for themselves, extracting information from the environment as they see fit, and meshing it with existing knowledge. Learners decide for themselves what content to bring forward and the tutor's 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 learning approach has many different names and forms, the best known of which are discovery, problem-based, inquiry, experiential and constructivist learning (Kirschner, 2006).

The student-centred approach demands participation at all levels and moves responsibility and empowerment down the hierarchy, thereby flattening it. Constructivist learning is a process which is goal-oriented, self-regulated and dependent on prior knowledge/experience through the 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) and also promotes students taking control of the learning activities (Borer, 2005).

Instructional teaching may be used where the need is to establish a common task, give a quick overview, introduce 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). In practice, instructional teaching and student-centred methods are often combined in education and courses. Lectures where the teacher provides examples and explains basic concepts are followed by group work, where students actively search for and share knowledge.

2.3   e-LEARNING CONCEPTS

e-Learning is another way of teaching and learning. It comprises instructions delivered through electronic media, including the Internet, Intranets, Extranets, satellite broadcasts, audio/video tapes, interactive television and CD-ROMs (Govindaswamy, 2002). e-Learning facilitates access to knowledge that is relevant and useful to anyone, at any time and anywhere. The development and delivery of e-Learning materials is underpinned 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. 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).

2.3.1   e-Learning Definition

There is no clear and explicit definition of the concept of e-Learning. Definitions in the literature are partially exclusive and sometimes contradictory, and few common terms are 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 literature, 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 it can be defined as the use of Internet and digital technologies to create experiences that educate fellow human beings (Horton, 2001).
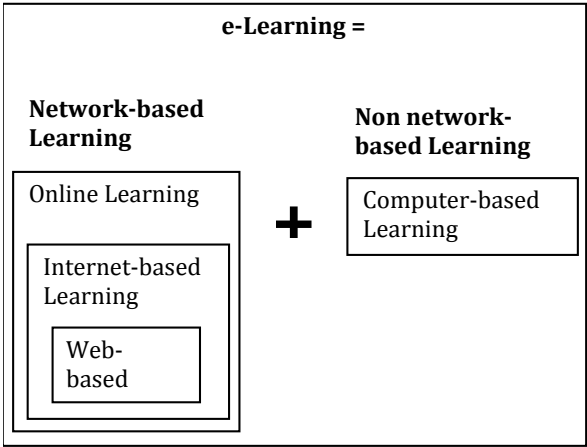
Figure 2.2: e-Learning Dimensions from a Technological Point of View (Hadjerrouit, 2007)

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

Figure 2.2 show the concepts of e-Learning from technological point of view. The Internet-based learning is broader than Web-based learning, the Web is just one of the Internet services that uses Hypertext Markup Language (HTML), browsers, and

URL. Internet offers many other services, like e-mail, file transfer facilities, etc. Learning could be based on the Web or through correspondence via e-mail. Online learning could be organized through any network, Internet-based learning being one of the subsets of online learning. e-Learning may take place via either a network-based environment (online, Internet-based and web-based) learning or a non-network-based environment (computer-based learning that is not network-based).

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 various time limits (Wentling et al., 2000).

2.3.2 Purpose of e-Learning Resources

The creation of e-Learning resources has many purposes which include the following (Kabita, 2003).

(i)   The Flexi-Time Approach

An e-Learning resource offers the flexi-time, flexi-location approach since it enables learning to take place in a variety of different places and times, both physical and virtual. e-Learning may take four time-location approaches i.e. same time–same place, same time–different place, different time–same place, different time–different place. Students and teachers need not be at the same place and time while learning is in progress

(ii)   The Mixed-Mode, Blended Approach

Most people learn well when computer-mediated lessons are combined with virtual classes, study groups, team exercises, offline and online assignments. With e-Learning, an integration of F2F and computer-mediated learning can be realized hence form a blended approach.

(iii)   The Student-Centred Approach

It is an approach upon which 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 learners by offering choice and a 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 the 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.

2.3.3   Pedagogical Considerations for e-Learning

The e-Learning pedagogy focuses on adapting ICTs to suit the various learning environments and meet diverse student needs. Successful learning pedagogy requires teachers to understand how students learn, and they must have the capacity and autonomy to design, implement and assess educational activities that meet the needs of all students (Chao et al., 2006). e-Learning pedagogy must therefore be sensitive to current learning practices and the context in which is to be used. In practice, no single pedagogy is considered the best or able to meet all learning needs equally well, which is why the methods need to be combined for the best results.

The introduction of e-Learning technologies has converged with new trends in pedagogy that allow for greater student control, personal responsibility and collaboration. Creating a collaborative learning environment embraces the concept of active learning (Roschelle et al. 2001). Technology-supported settings such as e-Learning technologies attract self-directed students who want meaningful and engaging activities (Wagner et al., 1995). Courses conducted through computer technologies require active learning strategies and participation, and online pedagogy tends to be more student-centred than F2F teaching and learning (Berge, 1997). Approaches include online collaborative teaming, online questioning and answering, technology resource searching and evaluation, co-ordination and students publishing their work (Levin et al., 1998).

As regards e-Learning content, it is crucial that its development is based on students' learning needs. There are basically three levels of students regarding knowledge acquisition, novice, intermediate and high, in a particular subject or part of a course. For introductory learning where students have little directly transferable prior knowledge of a skill or subject area, the transmissive approach can be used because it is predetermined, constrained, sequential and criterion-based. When students are at the early stage of learning, drill-and-practice can help them to acquire initial knowledge and provide an anchor for the future learning endeavours. For advanced knowledge acquisition in the intermediate level, the preliminary constructivist approach may be introduced, where tasks require students to have an increased level of processing ability. In the final stage of knowledge acquisition, students are able to make advanced decisions within the learning environment. The full constructivist approach will work well in this setting, where the tasks demand a high level of processing. The best learning approach is more likely to require the combination of several media rather than a single medium. This model offers a structured approach to learning basic skills or the content of a lesson (transmissive principles), while the constructivist design of a course includes motivating and empowering students in their course of study (Juhary, 2007).

The instructional design of the courseware should be such that it promotes critical thinking skills in students, making use of with student-centred options in e-Learning. The courseware should not be over-designed which would hinder the possibility of students being free and more creative when going through the content. Over-design of e-Learning content threatens to undermine the whole principle of student-centred learning.

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

It is crucial that the development of e-Learning content is based on students' learning needs. Since education in Tanzania to a large extent is based on teacher-centred methods, the introduction of e-Learning needs to adjust and take this into consideration, while also opening up the opportunity for the development of student-centred knowledge.

2.4   LEARNING OBJECTS

Learning object is a term that originated from the object-oriented paradigm of computer science. It has proved to be valuable in the areas of knowledge management and e-Learning and it builds 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 LO refers to a generally small-sized, reusable instructional component, normally designed for distribution over the Internet, and used 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 an LO, almost all of them state that the function of an LO is to facilitate learning. The best definition according to the Institute of Electrical and Electronics Engineers (IEEE) Learning Technology Standards Committee (LTSC) states an LO is any entity, digital or non-digital, which can be used, reused or referenced during technology-supported learning (IEEE LTSC, 2000). LO may also be defined as a potentially reusable component from which study courses may be constructed. An LO can be a single idea or it might be a cluster of several concepts to deliver a more substantial chunk of learning (Polsani, 2003).

An LO describes 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 amount of knowledge that once developed, can be exchanged among organisations, and be used to build individual lessons and courses (McGreal et al. 2001). LOs are often used as components to assemble larger learning modules or complete courses, depending on different educational needs. They allow instructional designers to build small (relative to the entire course) instructional components that can be reused a number of times in different learning contexts, with the

aim of increasing the flexibility of training, and making the updating courses much easier to manage (Muzio et al., 2002).

The definition contains the important characteristics of an LO that are referred to in the literature which include:
  i.   Reusability – be able to be used in different learning contexts
  ii.   Flexibility - easy to update
  iii. Accessibility - easy to locate and use (metadata mechanism)
  iv.   Durability - retain utility over a long period of time
  v.   Interoperability - can be used on a variety of platforms or course management systems
  vi.   Shareability - content from several different sources may be accessed by multiple users (simultaneously) with different e-Learning systems
  vii. Activity-size based - to be used as an activity within a lesson or module, or large enough to be a lesson by itself

By definition, an LO should have the potential for reuse (IEEE LTSC, 2000). Reusability is a core characteristic of an LO as evidenced by the fact that nearly all definitions of an LO refer to it.

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

2.4.2   Learning Object Granularity

LOs 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 arranged in a logical order, but without a clear and measurable educational objective, the collection remains just a collection (Smith, 2004). Digital LOs open up possibilities that traditional materials may not. Within a single LO, information can be presented in several different ways, allowing students to explore a topic from various perspectives, engaging interactive elements and giving learners a chance to put into practice what they are studying. In object design, learning content is prepared as modular small "chunks", or LOs, that can be used alone or dynamically assembled to provide "just enough" and "just-in-time" learning (Wieseler, 2000).

When creating LOs, two issues are of important to consider; the granularity and combination (Wiley, 2000). Granularity refers to the size of an LO while combination refers to the manner in which LOs are assembled into larger structures to facilitate instruction. 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 LOs, granularity is the smallest item that is found inside a course or other deliverable created from LOs. An 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 the instruction, making it a measurable guide to accurately assess student accomplishment (Wiley, 2000).

2.4.3   Learning Object Composition

From the learning point of view, an LO can be composed of information objects (IOs), an overview, summary and assessment. The number of IOs depends on the its granularity, and it can also be determined by the materials needed by the objective that has to be fulfilled. Figure 2.3 shows the composition of an LO, comprising several IOs, overview, summary and assessment objects.   .
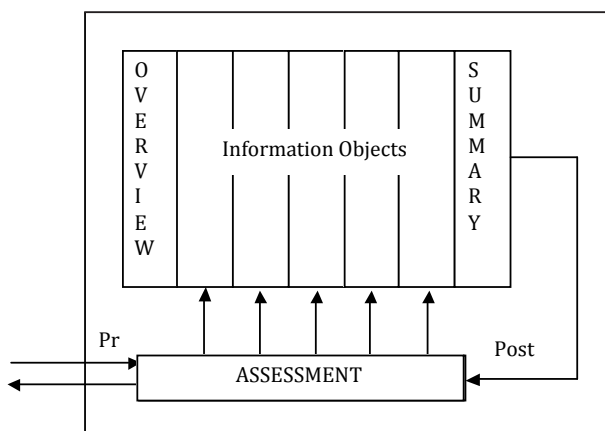
Figure 2.3: Composition of a Learning Object
(CISCO Systems, 2000)

2.4.3.1 Overview Object

The overview object offers general information about the subject, subject code, level, aims, prerequisites, co-requisites, learning outcomes, indicative content (information object), assessment strategy and credits.

2.4.3.2 Information Object

This contains the core content. The pedagogical and technical considerations determine the quality of the information object (IO), hence directly affecting learning. The attributes of the IO are the respective content objects (i.e. introduction, concept/principle and examples), practice element (learning activities) and assessment item. Figure 2.4 gives an example of components of the IO. Each IO is built upon a single objective and is classified as being a concept, fact, process, principle or procedure (CISCO Systems, 2000).
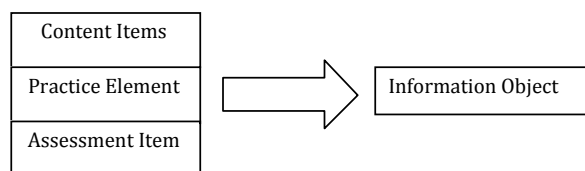
Figure 2.4: Composition of an Information Object
(CISCO Systems, 2000)

2.4.3.3 The Summary Object

The summary object reviews the subject by assisting in reflecting how well the topics have been understood and applying the gained knowledge and skills to solve the problems, hence the summary object concludes the subject.

2.4.4   Learning Objects Standards and Specifications

To facilitate the widespread adoption of the LOs approach, the LTSC of the IEEE standard group was formed in 1996 to develop and promote instructional technology standard that deals specifically with learning objects (IEEE LTSC, 2003). Standards impose a certain order providing more uniform and precise access to and manipulation of e-Learning resources and data (Babu, 2001). The desired features of learning content which are interoperable, reusable, discovered and properly attributed, characterize e-Learning and hence cannot be achieved without standardization.

The IEEE approved a metadata framework simply called Learning Object Metadata (LOM) standard which is necessary to describe a learning object or learning content and can be applied to any type of object digital or non digital (Hillmann, 2000). Metadata is also the 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 LO, 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). The IEEE LOM draft standard for learning object metadata 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 (IEEE LTSC, 2000). Metadata standards are very important when storing and searching for LOs, hence rich set of metadata are required without which one of the main benefits of reusable LOs would be lost (Barritt et al., 2004).

The most useful standards are SCORM and IMS which work with standard bodies such as the Aviation Industry Computer-Based Training Committee, and IEEE to integrate their specifications into a cohesive, usable, holistic model, and to define key interrelationships between the standards (Jones, 2002). The SCORM 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 (ADL, 2006). SCORM defines assets as the basic learn-

ing content, SCO as a collection of one or more assets and content aggregation as a content structure that can be used to aggregate learning resources to a cohesive unit of instruction such as subject, chapter and topic. SCORM content may be packaged to represent a course, lesson, and module or may simply be a collection of related objects.

The IMS packaging specifications is used for content packaging. Content packaging may correspond to the reuse of existing learning resources in courseware authoring and delivery stages where resources are re-purposed and assembled, from different sources such as digital repositories (Low, 2002). One of the key benefits of IMS content packaging is that various support materials for a piece of content are bundled together, ensuring that they are no breakages in the content flow (Wilson et al., 2002). Metadata can be used on the materials to ease the searching mechanism of content from the storage medium. The IMS package enables content from one learning environment to be exported to another, while retaining information describing the media in the IMS package and how it is structured. Reasons for content packaging include (Chew, 2001);

- Much e-Learning content is now being created in the form of LOs, which need to be assembled in order to form a coherent e-Learning course
- e-Learning content needs to be stored in digital repositories so that it can be made accessible to many students and across many dispersed areas
- There is a need to address the reusability of the course materials

Special editors like ReLOAD are used in the process of content packaging which creates a zipped file with XML bindings to the resources and activities. A zipped file formed is called a package interchange file which can be stored in a content repository and referenced by any LMS which supports SCORM standards like Moodle, ATutor etc., or can be directly uploaded to the LMS.

2.4.5   Learning Objects Repositories

A repository is a collection of LOs (or metadata describing LOs) that is managed by technology; it allows users to find, retrieve, publish or submit them via a network. The e-Learning repository allows small building blocks (e-Learning objects) to be tagged for storage and subsequent retrieval, facilitating the flexible reuse 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).

2.5   e-LEARNING CONTENT DELIVERY APPROACHES

Various approaches can be used to make LOs available over the web. The simplest approach is to generate web pages containing these resources and make the web pages available through a website for the course. The other approach is to use a fully-fledged Content Management System (CMS) such as a Learning Content Management Sys-

tem. Other approaches may include CD-ROM, print-based material, presentation slides etc (Singh, 2003).

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

2.5.1   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) and where communication, collaboration and learning can occur at different times and in different places, and users can select when they wish to communicate. Based on the developed techniques of networking, asynchronous learning can consist online and offline learning (Fang et al., 2006).

2.5.1.1   Offline Learning

Computer-Aided Instruction is a typical method of offline learning (Huang et al., 1998). In general, its content, text, graphs, pictures, audio and video are stored on a CD-ROM. Recent production of the DVD-ROM is capable to storing seven times the capacity of a CD-ROM. Therefore, these two kinds of disks provide storage for offline learning. In general, interactive response in the offline state is faster than online state. Once the content has been stored, editing is not allowed. Hence, it is suitable for constructing well developed core courses that are fundamental to the curriculum.

2.5.1.2   Online Learning

The content of online learning is built by the hypermedia technique, whereby it is stored on the network computer server. Students can study or review the content from the website at any time. Online learning is affected much if the content is dynamic with huge amount of data and slow transmission speed of the internet. The content can be renewed at any time, and so it always remains up-to-date (Fang et al., 2006).

2.5.2   Synchronous Mode

Synchronous learning generally occurs in real-time with highly interactive and structurally dynamic characteristics, and is led by an instructor (Singh, 2003). It allows people to interact with each other at the same time in different places, and imitates a classroom. This means that classes take place in real-time and connect instructors and students via audio or video conferencing. 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). Although it has several advantages, steady and wide bandwidth network configuration is absolutely essential

(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).

2.5.3   Blended Learning

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 which can be a mix of various event-based activities, such as F2F classrooms, asynchronous, and synchronous learning. A mixture of F2F and e-Learning is known as hybrid or blended e-Learning (Buzzetto-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). This mode meets the needs of a larger numbers of students and teachers, and seems to be a key component of the more successful uses of ICT (Smith, 2001).

Past patterns suggest that the likely future will 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.

2.6   MULTIMEDIA LEARNING RESOURCES

The rapid development of computer and Internet technologies has caused e-Learning to become an important learning method. One of the key characteristics of e-Learning is its ability to integrate different media, such as text, picture, audio, animation and video to create multimedia instructional materials, promoting an interest in reading and the willingness of the learner (Gillani et al., 1997; Vichuda et al., 2001). Multimedia technologies can be used to produce stimulating and interactive learning environments and to create e-Learning systems which support multiple learning styles as they present a wide range of graphical, textual and aural resources.

Research has proved that humans have several forms of intelligence and individual learning styles are largely dependent on this diversity. A learner's dominant sensory system (visual, auditory or kinaesthetic) also plays a major role in determining his or her natural learning style. If the teaching style employed closely matches the learner's preferred style, learning becomes more natural and easier, consequently reducing learning time and improving results. Studies that focused on the effectiveness of this type of education have proved that multimedia learning resources can enhance motivation, attention, comprehension and recall (Collin, 1987).

Technology provides the opportunity to present knowledge in diverse media formats, including textual, audio and visual ones, which is generally called "multimedia" (Brown, 1997a). Interactive components must be developed to introduce content,

engage students and provide assessment information (Glenn, 2003). However, the ability to engage students with e-Learning resources is not automatic. A careful subject design of the subject and a command of the technology are required for a learning environment to be successful.

2.7   e-LEARNING TECHNOLOGIES

e-Learning technologies encompass a broad range of applications of technology and refer to using ICT to support the process of learning, to support communication in educational settings, to evaluate learning activities, to manage resources and create educational materials. Today, computer and Internet technologies are more integrated with professional, academic and personal lives. These technologies are opening up ways for courses, seminars, discussion forums and other approaches to learning to be delivered online in an innovative and interactive. Different learning technologies and various tools are used in the e-Learning environments. The following subsections discuss the technologies most appropriate to the research context.

2.7.1   Web Based Software

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

At present, a wide variety of learning content authoring tools, are available and a lot of them conform to one or more learning technology specifications. The vast majority of these tools can import various content types (texts, figures, charts, presentation, multimedia files, etc.) and produce web-compliant content that can be used in an e-Learning environment. The web-based software may include HTML, eXtensible Hypertext Markup Language (XHTML), eXtensible Markup Language (XML), JavaScript (JS), Hypertext Processor (PHP), Cascaded Style Sheets (CSS) etc. These allow the 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 to improve course quality and to enable learners to be able to monitor their progress (Avouris et al., 2003)

2.7.2   Open Source Software

Open source software refers to software programs that are distributed with the source code. They are now being used in the learning environments due to the advantages they provide over commercial software (Tong, 2004). The advantages of OSS include lower costs due to no licence fees, potential global technological support, more reliable, limit pirating, possible to learn, modify and localize from the source code etc. The open system encourages increased exchange of ideas that advances innovation, (Koohang et al., 2005).

General Public Licence is the most popular open source licence which stipulates that not only does the source licence need to be available, but also the program can be modified and redistributed, as long as that redistributed program is also governed by the same licence (Murrain, 2007). The Gnu's not unix project (http://www.gnu.org) defines free software as "a matter of users' freedom to run, copy, distribute, study, change and improve the software."

OSS plays an important role also in education, the use of open source platforms to manage users and learning materials in education is essential. Open source platforms can be used as one of the e-Learning content delivery methods. There are two main types of open source platforms, the LMSs and the CMSs. Examples of LMSs are Moodle, ATutor, Claroline etc. Examples of CMS are Drupal, Alfresco etc. Moodle has up to now being widely used in different learning environments and especially in the higher learning institutions.

2.7.2.1 The W/LAMP Environment

The Windows/Linux Apache MySQL PHP (W/LAMP) environment is a stack of software usually free and OSS. The W/LAMP environment is used to run dynamic websites or servers. It is normally comprised of Apache web server, MySQL Database, and PHP scripting language. The WAMP environment is based on the Windows operating system and the LAMP environment is based on the Linux operating system. The combination of these technologies is used primarily to define the web server infrastructure and the programming paradigm of developing software and to establish a software distribution package (Gerner et al., 2006). Examples of open source platforms which use the W/LAMP environment are Moodle, Claroline, and ATutor.

2.8   CONCLUSION

The literature review discussed in this chapter covered the theoretical and related contextual foundation for the development of e-Learning content. The literature regarding instructional design gave useful ideas on effective e-Learning content design. The ADDIE model as a foundation model for instruction design process was introduced, details of which are covered in chapter 3. The pedagogical approaches discussed influenced the choice of instructional strategies for e-Learning content design and development. The literature on e-Learning opened up discussions on various e-Learning

concepts for knowledge acquisition and its position in the process of researching for a viable solution to the problem at hand. The choice of delivery methods, software and hardware requirements are based on the discussion of e-Learning concepts. A description of literature review has been given to relate the theoretical issues to the context of study though not fully exploited. Some portions of the literature review specific to the chapters in concern are covered within the same chapters as the work progressed.

CHAPTER 3
RESEARCH METHODOLOGY

The research being a multidisciplinary research used courseware engineering methodology for e-Learning content development. CEM integrates the two main methodologies ID and SE together with user participation through interviews, focus groups, questionnaires and workshops. The research has also incorporated the concept of mode 2 knowledge production and the triple helix approach involving users/stakeholders in the development of the content.

3.1   TRIPLE HELIX AND MODE 2 KNOWLEDGE PRODUC-TION

3.1.1   Triple Helix Approach

Three main stakeholders were involved in this project, namely the university (UDSM), the Government (MoEVT) and the secondary schools. These three main actors constitute what is called Triple helix collaboration (Etzkowitz et. al. 2000). The triple helix approach can establish the basis for new forms of collaboration and interdisciplinary knowledge production, which enable a university to become directly involved in social and economic development (Saad et al., 2008).When the three actors work together on new tasks, it is possible to obtain an enhanced outcome in the form of relevant innovative products and solutions, which are sustainable.

3.1.2   Mode 2 Knowledge Production

Mode 2 knowledge production operates within the context of application (and implication) in that tackling problems is not confined to an academic disciplinary framework only but is transdisciplinary. It includes knowledge producers outside the university, involving the close interaction of many actors throughout the process of knowledge production with the ambition of becoming more socially accountable. Knowledge is always produced through continuous negotiation and will not be produced unless and until the interests of various actors are included, such as in the context of application. Mode 2 does more than assemble a diverse range of specialists to work in teams on problems in a complex application-oriented environment. In mode 1, problems are set and solved in a context governed basically by academic interests of a specific community (Gibbons et al., 1994). Mode 2 does not replace mode 1 but seeks to fill the knowledge production gaps in different spheres in society and, provide relevant and robust solutions to the problems identified.

3.1.3   Collaborative Activities with Stakeholders

The users' collaboration approach employed in this research reinforced the principles of ISD. Since the problem belongs to the people, there was a need to incorporate users in all phases of the ADDIE model in order to get first-hand information and also arrive at relevant solutions to the problems that the research was trying to address. The involvement of users had been instigated by the participatory action research methodology, mode 2 knowledge production and Triple helix approaches. All these approaches involve users actively and lead to a context-based solution to the problem.

Participatory action research requires the active collaboration of the researcher and client, thus stressing the importance of co-learning as a primary aspect of the research process (O'Brien, 1998). It requires that the research process be operated as an exploration with participants for gaining a better understanding of user needs and context (Salmon, 2002), thus promoting the building of a partnership between researchers and the people involved in the study (Freire, 2000). In mode 2 research the collaborative activities are organized in an interactive way with equal, close, informal and open relations between participants and the researchers (Gibbons et al., 1994), there is no clear division between participants and researchers, as all participate in the joint knowledge production. The triple helix approach makes an effort to establish an integrated research system that is responsive to social needs and capable of addressing targeted problem areas (Walsh, 2007).

A number of collaborative activities were conducted as explained below;

- In 2005/6, visits were conducted to the two schools at the pilot site in connection with the design and development of a student registration management information system. The activity involved the study and design of a manual student registration system for the pilot schools. This was done with

the purpose of establishing and building trust with the collaborators. We also had the opportunity to study the ICT environment at the pilot site, which opened the doors for the introduction of the ongoing e-Learning project.

- In September – October, 2007, we visited the two pilot schools and the MoEVT for the purpose of obtaining more information regarding the proposed e-Learning system for secondary schools in Tanzania i.e. the TanSSe-L system. Visits to schools involved getting permission from the Regional Administrative Secretary (RAS), District Administrative Officer and the Regional Education Officer (REO). By going through this exercise we had a chance to introduce and conduct discussions regarding the e-Learning project at regional (Pwani) and district (Kibaha) levels.
At this time, the progress of the e-Learning project was presented to Kibaha Secondary School (Wali Ul Asr Seminary was not ready for the presentation by then) and MoEVT. The aim was to introduce the project to the stakeholders, in order to get their views on the project and also to obtain more information and clarification from the users on issues which were not obvious to the researchers nor well covered in the literature and surveys. In these presentations, time was given for discussion on the presentation and later on guided discussions continued based on open-ended questions in the questionnaires for more clarification.

- In early November 2007, another collaborative activity was carried out at the UDSM with a team of lecturers from the then Faculty of Education (now School of Education). A discussion was held on the pedagogical principles that needed to be incorporated in learning materials, shared their expertise and experience concerning the pedagogy that was practicable for both F2F and distance learning modes 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 with the MoEVT and also making it known to the public. The seminar participants were representatives of the MoEVT and the two pilot schools, the college principal, deans of faculties at CoET, the research and publication coordinator at CoET, e-Learning project members, journalist, supervisors, PhD and MSc students involved in the project. The presentations for the seminar were made by 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.

Collaborative activities helped in getting the main stakeholders to participate in order to arrive at a viable and sustainable solution to the problem at hand. The application of the triple helix approach of drawing on the resources of academia, the Government (MoEVT) and the business sector (schools) was also necessary since all sectors must contribute to and agree on the proposed solution.

Valuable information in terms of readily available reports, documents and verbally communicated details was obtained from stakeholders through these collaborative activities. The information was in different areas including;

i.   Subject content structure
ii. Traditional pedagogical practices
iii. School identification, i.e. registration number and centre number
iv. School specialization/categories
v.   Students' mode of assessment and evaluation
vi. Type of National Examinations and their levels
vii. MoEVT ICT policy for basic education
viii. ICT for Secondary Education in Tanzania – The eSchool Programme-eSchool Forum for MoEVT (Draft Programme Document)
ix. Education Sector Development Programme (Programme document)
x.   Final SEDP (2004 – 2009) document of April 2004
xi. The presence of Education Resource Centres at district level in each region in Tanzania, which at least are equipped with ICT facilities. Therefore to start with they could be considered as resource centres for introducing the system further away from the pilot schools

3.2   COURSEWARE ENGINEERING METHODOLOGY

CEM integrated the two disciplines the ID and the SE in a systematic manner and optimized the best practices for content development. Ideally, ID models embody both educational (pedagogical) and psychological (learning) theories. In practice, these models guide the planning and development of instruction by providing important instructional factors and processes. Many of ID models deal with the instructional media but do not concrete procedures for carrying out the design of computer-based courseware. What has been learned from those ID models becomes inert when the designer actually faces the challenge of developing a courseware unit (Yang et al., 1995).

To realize the potential of e-Learning content and develop quality e-Learning material, a systematic software development approach is needed (Kay et al., 2005). When comparing the phases of ID and SE they are somewhat similar and related as they both provide structured processes for fundamental content development issues. Some of the designs which focus much on the technology, i.e. user interface and production aspects such as coding may be similar, as the tools and the medium may also be similar. However, education requires more attention to be given to the user or learner, so that learning outcomes are effectively and efficiently addressed (Bell, 1998). Courseware engineering may embody many of the developmental aspects of SE, but it is more specific to the development and implementation of educational software systems that support teaching and learning activities. In this context, courseware engineering is much more encompassing than software engineering, as it also includes all of the instructional theory and the practices, tools and methodologies required for developing and delivering quality e-Learning materials (Shaw, 2000).

It is worthy noting that early developmental stages of the analysis and design of instructional material are critical and much different than those found in software engineering. This is where a systematic approach to designing instructional materials to achieve specified learning objectives takes place (Kay et al., 2005). It involves identifying the appropriate learning methodologies and analyzing the subject matter and/or skills to be learned. However, the production, testing and maintenance stages are similar in both courseware and software engineering (Bell, 1998).

It is important to note that ID has its own unique processes and methodologies for solving problems, defining and refining goals. Embedding ID in CEM ensures that greater focus is placed on creating understandable and consistent behaviour within the entire instructional system. ID activity should centre on making predictions about the learning process and decisions concerning instructional activities within the whole system, rather than attempting to manipulate learners (Goodyear, 1993).

There is no one foolproof method of producing good courseware and no true path to the perfect product (Riley, 1995). In particular, content development is a software engineering work that needs to follow the steps of software production such as the SE lifecycle. The development process must be complete; to cover the whole life cycle which involves the typical phases of the SE process, thus requirement analysis and specification, design, implementation, testing and delivery (Bruege et al., 2000).

To be effective, the courseware development needs to be tailored to suit the particular learning tasks planned. In order to do this, the learning process itself must first be analysed and understood. Learning is a complex process involving a large range of activities which could be active, passive, creative, reactive, directed, and exploratory (Hammond, 1992).

Furthermore, academic learning should also be seen as the process of producing knowledge and developing reflexive awareness, where the individual is an active processor of knowledge information. This type of learning occurs through interaction with rich learning environments, and results from engaging in authentic activities, and from social interaction and negotiation (Nunes et al., 1996).

3.2.1   Instructional Design Methodology with User Participation

ISD ensures the quality of the instruction (Dick et al., 2005). It is the defined process used to determine where there is a training need to develop targeted learning to meet that need, and to evaluate whether that need has been met (Cot, 2004). It is also used to guide the design of learning materials in a systematic manner, identifies the outcomes of the instruction and establishes how instructional effectiveness will be evaluated.
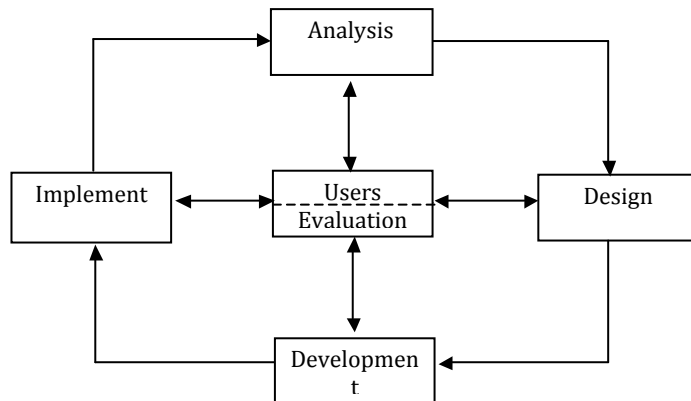
Figure 3.1: ADDIE Instructional Design Model with User Participation

The choice of an ID model to follow to build effective instruction is frequently diffi-cult, since there are many different models based on a variety of contexts. These might not have been relevant to our context, and so a generic ISD model was used. Most ID models are variants of the ADDIE model. ISD is the backbone of the development of the e-Learning content. It ensures that learning does not occur in a haphazard man-ner. This approach provides a step-by-step system for the evaluation of students' needs analysis, the design and development of training materials, and the evaluation of the effectiveness of the training intervention (Cot, 2004).

In this research, the generic ADDIE model was modified to integrate users in all of its phases, as shown in figure 3.1. In this way it was possible to capture users' needs and experiences and develop the content to suit the intended users.

3.2.2 Software Engineering Methodology

The SE methodology was needed in this research in order to give guidance to the development of a software product (e-Learning package) which is the outcome of this research. The two concepts of SE methodology used in this research are discussed in the following subsections.

3.2.2.1 Software Development Life Cycle

Many technological challenges that occur during development of the e-Learning con-tent cannot be handled properly using ID, function modelling and the design of user interfaces. The code generation and testing phases are properly taken into considera-tion by the SE methodology. e-Learning content made with different media need SE for their development. This makes development of e-Learning content essentially a SE challenge (Brown, 1997b), hence make use of software development life cycle (SDLC).

The current linear and sequential models that predominate are the least able to cope with emerging constructivist theories. This is primarily due to the lack of evaluation

and feedback throughout the development cycle. Iterative models that encourage continual user feedback and evaluation offer a pedagogical perspective for software development that is in line with the student-centred (constructivist) perspective (Kennedy, 1998).

3.2.2.2 Object-Oriented Modelling

The nature of e-Learning content makes object-oriented modeling (OOM) an essential prerequisite in the design process for the determination of the courseware functional requirements. Such an approach leads to courseware design specifications (Hadjerrouit, 2007). The principles of OOM allow for efficient manipulation of e-Learning information.

The research used the LO modelling approach based upon the concept of LO in designing the e-Learning content. The use of the term object is borrowed from the object-oriented paradigm of computer science. The fundamental idea behind object-orientation relates to the small-sized pieces of learning materials that can be reused many times in different contexts (Wiley, 2000).

Moreover, the use of objects is well suited to the design of e-Learning content, because objects provide perspectives and modes of representation. Object-oriented design is considered to have implications for the future of learning materials and instructional technologies, as well as for the immediate use of existing educational resources (Youm et al., 2005).

Learning materials in the form of LOs need the concept of object-oriented SE approach to model e-Learning content. A modeling language is needed to describe the object-oriented models, thus building visual models (Maciaszek, 2003, Stevens et al., 2006). The Unified Modeling Language (UML) was used in this research to build visual models.

UML is a standardized general purpose modelling language in the field of SE. It includes a set of graphical notation techniques to create abstract models of specific systems (OMG, 2003). UML uses five views that describe the system from distinctly different perspectives, and each view is defined by a set of diagrams, i.e. Design view, process view, component view, deployment view and use case view (Chitnis et. al., 2007).

In this research, the user model view and design model view (structural views) were employed for modelling e-Learning courseware and functional requirements.

(i)   Use case diagrams: Have been used to identify the primary elements and processes that form the system, actors and use case. A good technique for increasing the understanding of requirements is the creation of use cases which show actors interactions with the system. One of the biggest challenges in course ware development is building the right system that meets users' needs. Use case modelling is one of the most widely used analysis techniques

for object oriented development (Uden, 2002). Use case modelling in CEM helps with three of the most difficult aspects of courseware devel opment: capturing requirements, planning iterations of development and validating systems (Jacobson et al., 1992)

(ii)   Class diagrams: Defines a detailed design of the system, and describe the internal structure with its attributes and relationships. A number of rela tions can be modelled using the structural model view: 1..1 (one-to-one), 1..* (one-to-many), 1-0..* (one-to-none or one-to-many), 1-1..* (one-to-one or one-to-many). The "*" represents the range: 0..many.

3.3   THE ADOPTED COURSEWARE ENGINEERING METHODOLOGY

The CEM adopted by research integrated phases from ID and SE in a systematic way. Both ID and SE methodologies have most phases in common. For quality design, the development and delivery of e-Learning content, the modified ADDIE model as the ID model, incorporating users in all of its phases, and the SE used SDLC.

The development of e-Learning material needs more than one discipline, and so two were used, education and technology. The ADDIE model dealt with the educational discipline and the SE dealt with technological discipline. The ID methodology ensures that the pedagogical approach to instruction was achieved so that effective learning could take place (McGriff, 2000). The SDLC approach provides a more natural and complete definition of the development process of the software product, which is the e-Learning content, hence taking care of the technology that supports the learning. The two approaches were needed since ID principles alone would not have been enough to develop the process of e-Learning content, although they play an important role in the analysis and design of instructional content.
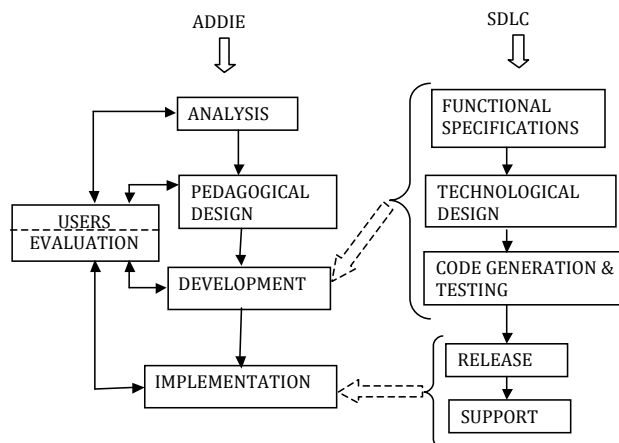
Figure 3.2 Adopted Courseware Engineering Methodology

The SE is a complete process involving typical phases such as requirements analysis and specifications, design, implementation, testing and delivery (Bruegge et al., 2003). Developing educational software has parallels with SE, and therefore, courseware engineering is rather like grafting the early stages of educational development onto stages of software development (Bostock, 2003). Figure 3.2 shows the CEM that was adopted for this research, the development phase in the ID incorporated early stages of the SDLC, and the implementation phase incorporated the last stages of the SDLC. Description of the phases in the adopted methodology is as follows;

3.3.1 Requirements Gathering and Analysis

The analysis phase is a necessary step ensuring the production of quality learning materials. It dealt with data collection and determination of requirements. It describes different data collected by the different means of data collection. It is the most important step as it is the basis of all subsequent phases. The collection of data is an important step in deciding what action needs to be taken. Several research tools commonly used in qualitative research can be used in this kind of research, which are data collection and analysis, participant observation recordings, questionnaire surveys, case studies, focus group discussions, and structured and unstructured interviews (Ferrance, 2000).

This research used two types of data collection techniques, the first being primary data collection, which involved observations, surveys, interviews, and group discussion. Secondary data collection involved perusing and using readily available reports, documents, and literature already collected by others. Multiple sources of data collection are used to better understand the scope of the problem, using at least three sources (triangulation) of data collection for the basis of actions (Ferrance, 2000).

Activities and samples of the methods that were used to collect data included the following:
  i.   Questionnaires (students, librarian, teachers, head teachers)
  ii.   Consultation with persons in the key positions (head teachers, RAS and REO)
  iii. Interviews (students, teachers and head teachers)
  iv.   Direct observation (students, teachers, lecture notes, library and laboratory conditions)
  v.   Focus group discussions (students and teachers)
  vi.   Use of available reports and studies (NECTA statistical performance re ports, MoEVT – BEST National Data)
  vii. e-Readiness for secondary schools in Tanzania (Survey I reports)
  viii Review of relevant literature

In order to design effective instruction, designers need to know the target audience, the content that is required and the context for which the instruction is being designed (who, what and why). Needs assessment is one of the major components of every instructional design model. During this phase the problem is defined, sources of the

problem are identified and the possible solution is determined (Özen, 2008). Needs assessment is usually the first step in order to make an effective change in the education environment, because it defines the gap between the current and the desired situation (Mc Ardle, 1998). The needs of users are assessed and the content and context are described. The structure of the existing learning content is determined and discussed. The main problems and their causes are also discussed in this phase. The requirements of the e-Learning content were determined based on users, education, and technology.

3.3.2   TanSSe-L Subject Design

The pedagogical structure of e-Learning content is determined by the typical structure determined in the analysis phase. Defined pedagogical principles are modelled and instructional strategies defined. The pilot subject design based on the LO approach was discussed, with LO design showing how the content should be structured and organized. The structure also gave details of the types of activities and exercises embedded in the learning content.

3.3.3   Creation of TanSSe-L Content

A successful development phase draws upon information collected in the analysis phase and the decisions made in the instructional design phase. The SDLC for content development was defined. The functional specification for the e-Learning content and the conceptual site design for accessing the material were also discussed. Determination and description of the tools used, the design and development of user interfaces, and the links and navigational aids for accessing e-Learning content at different levels were all discussed. Unit testing and unit integration and testing also took place in the development phase.

3.3.4   TanSSe-L Content Implementation

The implementation phase involved different content packaging options used in the research, configuration of the testing environment and CD-ROM content production. Prepare TanSSe-L content user guides for CD-ROM and TanSSe-L system delivery. The implementation phase also involved the demonstrating the TanSSe-L content at Dar es Salaam University College of Education and to the e-Learning project group.

3.3.5   Users' Collaboration and Evaluation

All phases of the methodology needed to be evaluated with users' collaboration. Formative evaluation normally done at the end of each phase was preferred to ensure better quality of the product and it fully covered the scope of this research, whereas sum-

mative evaluation of the TanSSe-L content is out of the scope of this research and is recommended for future work during TanSSe-L content deployment.

The analysis, design, development and implementation phases are covered in the subsequent chapters.

CHAPTER 4
REQUIREMENTS GATHERING AND ANALYSIS

This phase corresponds to the analysis phase in the ADDIE methodology, which resulted in the educational requirements to be incorporated in the e-Learning content. The data was collected from both primary and secondary sources (see section 3.1.3).

Two comprehensive surveys were conducted in different secondary schools in Tanzania. The e-readiness survey, which was the first survey conducted in 2004, involved visiting several secondary schools in rural and semi-rural areas of Tanzania. The aim of the survey was to determine the ICT status and its awareness in secondary schools in Tanzania.

Another survey was conducted in 2006/7 to get further understanding of the problems exposed by 2004 survey and the literature. The survey clearly pointed out some of the common problems facing many secondary schools in Tanzania, as explained in the summary of the problem in section 1.3.

4.1 e-READINESS SURVEY FOR SECONDARY SCHOOLS– SURVEY I

The main aim of the research was to use ICT tools to reduce the problems arising from the shortage of learning resources in the majority of secondary schools in Tanzania. The use of ICT tools needs some basic requirements of an ICT environment, such as the availability of computers, electric power and ICT personnel. The survey was conducted in 2004 whereby a total of 40 secondary schools in 14 districts were surveyed.

Some of the findings from the data collected are described in the e-readiness survey in the following sections.

4.1.1 Telecommunication Services

Landline telephones are available in most schools, as well as business places and government offices which are in the vicinity of school compounds but they are used mainly for voice communication. Most of the secondary schools visited in the towns have landline connections operated by Tanzania Telecommunications Company Limited which is a Public Switched Telephone Network operator. The main mobile telephone companies that have been providing services in most towns for quite some time now are Vodacom, Tigo and Zain (previously Celtel).

4.1.2 Schools Details

School details covered information concerning, 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.

4.1.2.1 School Accessibility

Data obtained showed that many schools can be reached by road with the exception of a few schools which are not easily accessible due to the bad conditions of the roads. Also, most schools can be contacted via postal addresses and/or by telephone/fax services.

4.1.2.2 Physical Facilities

This gave the information regarding the physical structures of schools (offices, classrooms, laboratories, libraries, and dormitories for boarding schools), and their ICT facilities (number of computers, audio/visual teaching aids etc.).

Generally most schools had enough classrooms, but not enough or well equipped laboratories for science subjects, and they did not have well stocked libraries and in some cases no libraries at all. Many schools had computer labs with either one or two computers or no computers at all, although there were at least there was a room set aside for housing 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 whether they had any.

4.1.2.3 Staff Profile

The staff profile gave information regarding the staff, their qualifications, employment status (full or part-time), computer literacy, gender balance, performance evaluation scheme, professional/academic development programme, and salary scheme.

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

4.1.2.4 School Profile

This covered information regarding school ownership, school registration number, donor projects if any, school's subject combinations Physics Chemistry Mathematics, Physics Chemistry Biology, Economics Geography Mathematics etc, school educational level (O-Level/A-Level) and type of school (co-education, girls', boys', day/boarding).

4.1.2.5 School Finances

School finances greatly depend on the type of school i.e. Government, or non-government owned (see section 1.1.3 (v)). Government schools are financed by the government whereas non-government schools depend on school fees and any other income-generation projects to maintain them. School fees for day government schools were TZS 40,000/ (≈USD 40), and for boarding government schools they were TZS 70,000/= (≈USD 70). School fees on average for private day schools were TZS 150,000/= (≈USD 150) and for boarding private schools they were TZS 300,000/= (≈USD 300), however, school fees for private schools are not uniform and vary from one school to another. All rates quoted for 2004 and for O-Level secondary schools

4.1.2.6 Students' Performance

Table 4.1 shows a sample of students' performance in CSEE for some selected schools for the period from 2001 to 2003, the number of students given under each division.

Table 4.1: Sampled CSEE Performance for the Period 2001 - 2003															
	YEAR														
	2001					2002					2003				
	DIVISION					DIVISION					DIVISION				
Sch	I	II	III	IV	0	I	II	III	IV	0	I	II	III	IV	0
1.	1	5	29	45	8	2	10	23	40	0	2	11	29	36	1
2.	1	1	3	30	17	1	2	3	27	13	0	2	11	29	12
3.	45	17	17	14	0	64	16	18	06	0	35	7	13	6	0
4.	10	16	42	70	21	8	14	47	73	15	13	16	53	81	14
5.	3	16	48	97	15	9	21	59	111	1	14	17	67	103	4
6.	0	0	1	6	12	0	0	0	10	1	0	1	1	13	12
Source: Survey I Reports															

Key:

Sch.: Description of Secondary School
- 1.: Iringa Girls is a Government, boarding, girls' secondary school (Iringa region)
- 2.: Kilwa is a Government, day, co-education secondary school (Lindi region)
- 3.: Kibaha is a Government, boarding, boys'secondary school (Pwani region)
- 4.: Bagamoyo is a Government, day and boarding, co-education secondary
- school (Pwani region)
- 5.: Forest Hill is a private, day, co-education, secondary school (Morogoro
- region)
- 6.: Dindimo is a non-Government (owned by a religious organization) day and
- boarding, co-education secondary school (Kilimanjaro region)

Not all the visited schools provided the requested information for the whole period, and so only available data was collected. The sample of schools selected differed in the ownership, kind and belonged to different regions as shown in the key information for table 4.1. The data collected for performance showed the number of students who passed in each division i.e. (I, II, III, IV and 0). From table 4.1, most of the students except those in Kibaha secondary school obtained Divisions III, IV and 0. The selection of students to join form V depends on good performance as explained in section 1.1.4.

4.1.2.7 Power and ICT Infrastructure

Electric power in most schools is mainly provided by Tanzania Electric Supply Company (TANESCO), but some schools not connected to the National grid have generators. Out of 40 schools surveyed, 31 schools were connected to the National grid, 3 schools had generators, 3 schools had no electricity at all and 3 schools made no comment.

The ICT status gave information on the existence of computer labs, number of available computers, 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 in schools varies remarkably. The range varies from a minimum of not possessing even a single computer to a maximum of 72. The majority of schools had less than 4 computers, and a few secondary schools had a considerable amount, such as, Kigurunyembe 72, Machame Girls' 35, Nia Njema 32 and Kaole 30 computers. Most of the PCs were in good working condition. In many schools, computers were mainly used for administrative purposes and in a few schools for computer literacy training (Summary of Survey I reports, 2004).

4.1.2.8 Means of Communication and Record Keeping

On average, 90% of the schools indicated that internal communication is paper based. For schools without a telephone, 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%, used mainly for administration, record keeping and publication. For schools which do not have computers, communication is close to 100% paper based.

4.1.3 Surrounding Community

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

A pilot site was established from the data collected in the e-Readiness survey. Among all schools surveyed, two schools, Kibaha secondary and Wali-Ul-Asr girls'semnary in Kibaha district, Pwani region, were selected to form the pilot site. A summary of the specific information obtained from the two schools obtained from the e-readiness survey is presented in table 4.2.

4.1.4   The Kibaha Pilot Site

Table 4.2: Pilot Schools Comparative Information		
Variable	Wali-Ul-Asr Girls' Seminary	Kibaha Secondary School
Basic ICT Infra-structure Computers Computer Lab Local Area Network Power	20pcs available Available Available in the administration TANESCO	4pcs available Available None 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 (No comments were made on Qualifications)
Accessibility	Excellent by tarmac road 30-40 Minutes from UDSM	Excellent by tarmac road 30-40 Minutes form UDSM
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 (3km) Regional Headquarters	Wali-Ul-Asr girls' seminary (3km) Tumbi secondary school (3km) Kiluvya secondary school(10km) Pwani secondary school (5km) Kibaha Education Centre Regional Headquarters
Form IV Performance in 2003	Div I – 0 Div II – 1 Div III – 10 Div IV – 27 Div 0 – 1 School rank: 114 out of 754	Div I – 35 Div II – 7 Div III – 13 Div IV – 6 Div 0 – 0 School rank: 20 out of 754
Source: Summary of Survey I Report		

Apart from the interest shown by the two schools in participating in the e-Learning research, several other reasons were considered when selecting the pilot site which included;

i.   Performance of the two schools in CSEE for 2003 showed that Kibaha Secondary school performed better than Wali-Ul-Asr girls' seminary. Using ICT could improve the performance of Wali-Ul-Asr girls' seminary

ii. The variation in ICT infrastructure between the two schools, with Wali-Ul-Asr having better facilities than Kibaha secondary school, means there is a possibility of sharing resources between the advantaged schools and disadvantaged schools

iii. An active neighbouring community (Kibaha education centre, Tumbi Hospital, Government offices – regional headquarters, nearby secondary and primary schools), this would accelerate the use of ICT into the community

iv. The district and schools are within easy reach from UDSM or the city centre, by tarmac road about 30 - 40 minutes from UDSM. Kibaha is 40km from Dar es Salaam. This eased the collaboration between the researcher and the schools

v.   The availability of the electricity via the national grid seemed to be stable and reliable

vi. The presence of Internet connectivity via leased line from Kibaha to the schools and the possibility of having a fibre cable

The summary of the Survey I report gave a comparison of the performance in CSEE of the two schools for 2003 only, since before that, Wali-Ul-Asr girls' seminary did not have the form four candidates. At the time of conducting this research, data for the performance in CSEE of the two schools for 2004 – 2009 were obtained, as shown in table 4.3. The performance clearly shows that Kibaha secondary school still performs better than Wali-Ul-Asr seminary. Most of the students at Kibaha secondary school obtained divisions I – III, while those from Wali-Ul-Asr seminary ended up with division IV.

Table 4.3. :Comparative CSEE Performance for Pilot Schools in the Period 2004 – 2009										
	Wal-Ul-Asr Seminary					Kibaha Secondary				
	Division					Division				
Year	I	II	III	IV	0	I	II	III	IV	0
2004	2	2	22	52	2	31	16	11	2	0
2005	1	5	20	52	2	61	15	12	10	0
2006	0	2	7	77	11	37	10	19	22	2
2007	4	2	20	73	4	55	22	20	5	0
2008	0	0	8	47	13	31	24	21	20	1
2009	2	4	11	52	8	32	15	21	20	0
Source: NECTA Website (2004 – 2009)										

The e-readiness survey conducted in rural and semi-rural secondary schools in Tanzania revealed that many schools which have taken initiatives to engage in ICT activities by starting computer laboratories. However, the utilization of these ICT facilities for e-Learning did not take place because of lack of Internet connectivity, lack of computers and insufficient ICT personnel.

4.2   RESEARCH PROBLEMS IN DEPTH – SURVEY II

The fundamental requirements for education institutions are the adequate provision of appropriate instructional and learning materials for use by teachers and students, and the provision of sufficient qualified teachers in all subject areas.

Survey II was conducted in different secondary schools within four regions, Arusha, Ruvuma, Mbeya, and Dodoma. At least 6 schools both O- and A- level were visited in each region. Half of the visited schools were Government (pure Government and community) owned schools and half were privately owned. Private ownership includes religious institutions, non-governmental organizations and wealthy individuals.

Five types of questionnaires were used for data collection, namely for Head Teachers, Teachers, Students, Librarians and MoEVT officials (shown in appendix B). The contents of the questionnaire was design to get information about teaching and learning activities, the status of books and reference materials, teaching methodologies, ICT awareness, students' performance, teachers' qualifications, and subjects with a shortage of teachers. In some cases, interviews were conducted with students and teachers using open-ended questions. The questionnaire for the MoEVT officials focused more on obtaining information about the National ICT policy, MoEVT ICT policy and the integration of ICT in schools (See attached appendix A for sample letters).

Table 4.4: Respondents and Activities Carried Out with Stakeholders in Survey II						
	Head Teachers	Teachers	Students	Librarian	MoEVT Officials	RAS and/or REO
Total Questionnaires	30	150	150	30	-	-
No. of Respondent	22	88	114	11	-	-
Interview	Yes	No	No	Yes	No	No
Focus Group Discussion	Yes	Yes	Yes	No	Yes	No
Consultation	Yes	No	No	No	Yes	Yes

Table 4.4 shows the number of respondents and a summary of the activities carried out with stakeholders in survey II, consultation with the RAS and/or the REO was necessary as discussed in section 3.1.3.

The questionnaires were filled out by the respondents themselves after group discussions, interviews or consultation. Group discussions for students and teachers were carried out together. Interviews with the headmaster and the librarian in each school were also carried out before the questionnaires were filled out. In some cases headmasters were also involved in the discussion groups. In almost all the schools, the librarians are normal teachers. A summary of data regarding the shortage of resources according to the questionnaire responses is shown in figure 4.1, which gives average percentages of the interviewed schools which responded positively to the shortage of resources, hence roughly portrays the real situation in schools.

4.2.1   Inadequacy of Learning and Reference Materials

The MoEVT is in charge of providing a capitation grant to Government secondary schools for the purchase of the required educational materials. Government schools are expected to purchase educational materials according to the guidelines for the procurement of educational materials and the official list approved by the MoEVT. Teachers are also expected to improvise teaching and learning materials using locally available materials in situations where educational materials cannot be procured (MoEC, 2004b).

	Arusha	Mbeya	Ruvuma	Dodoma
▪ Mathematics and Science Teachers	70%	60%	70%	80%
▪ Other subject Teachers	50%	30%	80%	60%
▫ Books	70%	80%	80%	95%
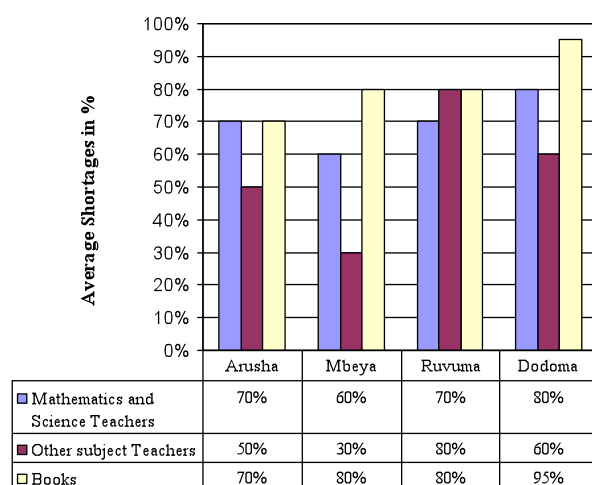
Figure 4.1: Average Resource Shortages in Percentage

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 use by teachers and students, but they can also organize collections of multiple copies of textbooks for borrowing when purchasing them is not possible. But all this depends on the Government (library establishment and maintenance), which lacks sufficient funds to run the schools; with the result that the majority of schools have no libraries at all. Where there is one, it is often a collection of a few shelves of outdated and worn-out materials, inadequately staffed and thus marginal to the teaching and learning process.

Many parents in Tanzania fall into the category of low to medium income people, with an average salary of TZS 130,000/= (≈ USD 100) per month, in the case of those who work and live in urban areas, but the monthly income of parents living in rural areas is comparatively low. As of 2008, the minimum wage of Tanzanians is TZS 100,000/= (≈ USD 77) per month (The Citizen, 2008). Purchasing books and other learning materials is very difficult and even supporting their children to continue with schooling is sometimes a problem, for instance, meeting the cost of school uniforms, stationery items and school fees.

Figure 4.1 shows that the average percentage of shortage of books in the surveyed secondary schools varies from 70% in the schools in Arusha region to 95% in the schools in Dodoma region. This shows that the condition of book scarcity had not improved at the time this research was being conducted. School libraries are ill furnished and in many schools there are no libraries at all. Students depended on the availability of books in regional libraries. The averages are based on the responses from head teachers, teachers and students.

Results from different respondents regarding the shortage of books are summarised as follows:

- *Head Teachers*

Most of the head teachers reported that there is an acute shortage of books in their schools. They normally prepare notes for their students, request parents to buy books and advise students to share the available books.

- *Teachers*

Teachers reported the number of books in most of their schools was inadequate. They use their own books, borrow books teachers at other schools and/or librarians, prepare notes and gather materials from other schools for their students. They also use regional libraries for references and recommend students to use books from regional libraries.

- *Students*

Students also reported that there was a shortage of books in their schools. Few students who came from wealthier families managed to buy books and pamphlets from bookshops. Most students share the few available books, borrow books from others, photocopy notes or portions of books, go to regional libraries, and get notes through discussion with school mates from other schools and some of the students have nowhere to go.

- *Librarians*

67% of the schools with librarians who participated in the survey reported that there was inadequacy of books in their schools. 22% of the schools had enough books and 11% of the schools reported that there were no books at all.

4.2.2   Shortage of Teachers

Teachers for O-Level secondary schools should have the minimum academic qualification of either a Diploma in Education or a Degree in Education and A-Level teachers should have a Degree in Education. Where necessary Form 6 leavers and graduates without teacher training course but possess a teaching license may be employed (MoEC, 2004b). According to the Ministry's policy, in O-Level secondary schools diploma teachers are supposed to teach form I and form II and degree teachers to teach form III and form IV (MoEC, 1995).

The recommended maximum teaching load for secondary schools teachers at O – Level is 30 periods per week, an average 6 periods a day. The number of streams per class varies from a minimum of one to a maximum of four, where the class limit is 40 pupils (MoEC, 2004b). The recommended number of teachers varies depending on the number of streams, subjects and the number of periods per week. For instance the

subject of mathematics has a maximum of 24 periods per week hence 6 periods per form (form I – form IV) for a one-stream school, and so the recommended number of teachers is 1, 2 teachers for a two-stream school, 3 teachers for a three- stream school and 4 teachers for a four-stream school. In the case of science subjects, the total number of periods per week is 14 (3 periods – form I, 3 periods – form II, 4 periods – form III and 4 periods – form IV), and the recommended number of teachers is 1 teacher for both one and two stream schools, and 2 teachers for both three and four-stream schools (MoEC, 2004b).

Figure 4.1 shows that the average percentage of the surveyed secondary schools with a shortage of science and mathematics teachers lies between 60% of schools in Mbeya region to 80% of schools in Dodoma region. The average percentage of surveyed secondary schools with shortage of all subject teachers varies from 30% of schools in Mbeya region to 80% of schools in Ruvuma region. The data show that the shortage of science teachers on the average is greater than the shortage of all other subject teachers. The shortage of teachers is also associated with the inadequacy of qualified teachers since some of them due to poor working conditions tend to look for schools in urban areas or alternative highly paid jobs (see section 1.2). The implementations of PEDP, SEDP and low increase of teachers also contributed to a greater extent to the shortage of teachers.

The summarised responses regarding the shortage of teaching staff gave a clear picture that many schools face that problem. The situation as regards mathematics, science and commercial subjects is reported to be critical. The approach so far in trying to reduce this problem has been to combine several methods including the use of part-time teachers, borrowing qualified teachers from other schools, recruiting temporary teachers from neighbouring schools, employing form VI students who are on leave and recruiting retired teachers.

4.2.3 Students' Performance

The problems mentioned in sections 4.2.1 and 4.2.2 account to a great extent to the students' poor performance in the National form IV examinations. The failure rate in mathematics for the period 1994 – 2002 was 73%, which among other reasons, was also due to the shortage of textbooks and reference materials (Mazigo, 2003).

Table 4.5 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 rates given in table 4.5 clearly indicate that there is a need to consider alternative methods to learning and teaching to reduce the problems faced by secondary schools in Tanzania. The need to this can be viewed as an opportunity for e-Learning solution to emerge. Introducing an open source e-Learning environment and the related resources could be an immediate solution to be looked into which could go some way to minimizing the mentioned problems.

Table 4.5: Average Failure Rate in CSEE 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   NEEDS ASSESSMENT

In order to arrive at the best contextual solution for the problems of secondary schools that are addressed by this research the needs assessment was carried out for the solution to suit the main stakeholders. The needs assessment covered aspects of the subject structure (mathematics), users, computer literacy, teaching and learning, the use of ICT in teaching and education, practical constraints for ICT integration in secondary schools, e-Learning environment, and summarised responses of stakeholders related to problems are also explained.

4.3.1   Subject Structure – The Pilot Site Example

Referring to the problem statement, the research gave priority to the subject of mathematics since students have performed poorly in it in the CSEE for more than 10 years (see table 4.5) and it is one of the compulsory subjects which students must obtain a credit in the CSEE. Therefore the research selected the form III mathematics as a pilot subject.

A good understanding of the subject notes that are required to be used for designing e-Learning resources is a prerequisite for the process of content development. The subject notes were obtained from teachers at the pilot site and the Basic Mathematics Form Three book recommended by TIE. The mathematics syllabus used to guide what is to be taught and the extent of the coverage was also obtained from TIE.

The notes included static multimedia forms such as text, equations, graphs, figures, etc. The organization of the content is a hierarchical structure in nature. Figure 4.2 shows the existing subject structure for chapter 1 of basic secondary mathematics form III. The rest of the chapters have a similar structure. In figure 4.2 "Qns" stands for questions.

Form III basic mathematics comprised a total of 10 chapters

- each chapter had more than one topic and one end of chapter exercise, i.e.
  each revision exercise had more than one question
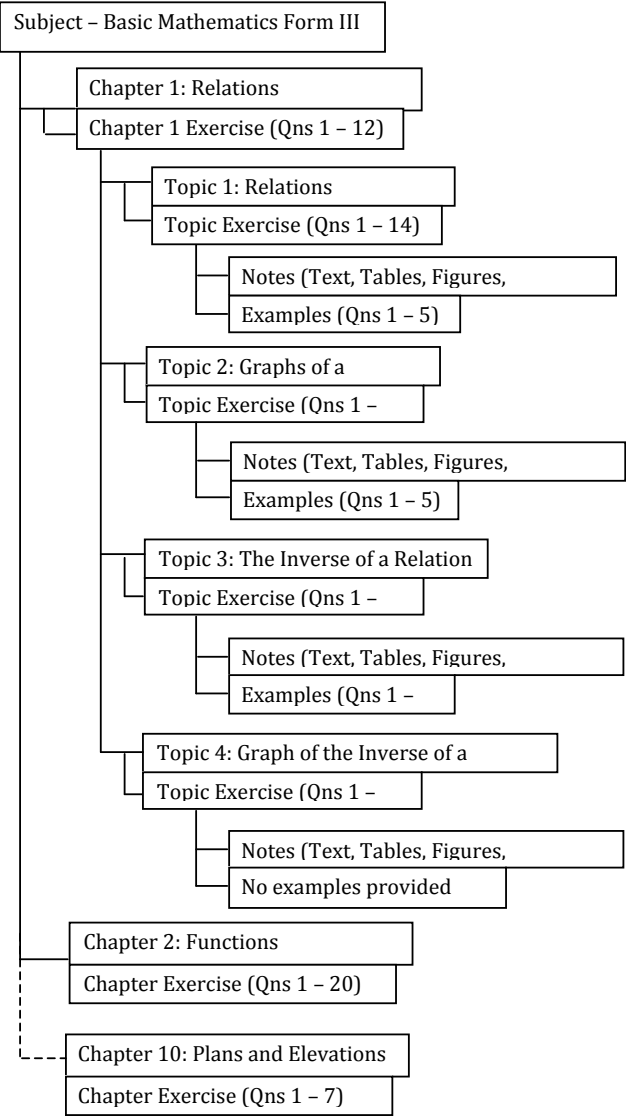
Figure 4.2: Basic Mathematics Form III Chapter 1 Typical Existing Subject Structure

- each topic had more than one paragraph of notes, worked examples and one
  exercise at the end, with the topic exercise containing more than one exercise
  question

An example of a typical Chapter 1 composition:

- Chapter title: Relations and one end of chapter exercise

- Four topics titled; Relations, Graph of a Relation, The Inverse of a Relation, Graphs of Inverse of a Relation. Topics 1 – 3 each contained notes, concept definitions, worked examples and one exercise. Topic 4 contained notes and one exercise, but no examples were given in this section

- The lecture notes included text, equations, tables and drawings. The drawings and tables are included to emphasise the concept

It was noted that the notes from teachers and the book did not specify the learning objectives which would be very useful information for students to know what skills they would acquire after completing a certain learning material. The content obtained was purely for traditional F2F delivery mode, mostly used by teachers in the class, with chalk and talk as the means of transmitting knowledge to students.

The syllabus for basic mathematics for secondary schools provided guidance in the formulation of learning objectives which were required for the design of e-Learning content. It was also noted that the available notes for the subject under consideration were relevant, though missed illustrations/elaborations in some parts.

The available resources were not motivating enough to be used in the e-Learning environment, and so they needed modification and some areas strengthened to suit the new e-Learning environment introduced. Traditionally, subjects are designed with teacher-led learning in view, which is the transmission of knowledge from the teacher (expert) to a passive leaner (novice). This research, focused on a learner-centred (constructivist) pedagogical approach to work in parallel with the teacher-led pedagogy.

4.3.2 Users' Profile

Identification of users and their characteristic is important information for the development of e-Learning materials. Data from surveys identified two main types of users who would interact with the e-Learning material. The targeted users are students and teachers from secondary schools. From the questionnaires the results show that students' ages ranged is from 12 – 18 years for O-level and 16 – 25 years for A-level. Teachers' ages ranged from 20 to 65years. Teachers had different educational qualifications ranging from just form VI to Masters' degree level with different specializations in arts, science or commerce. Teachers' work experience varied from under 5 years to 45 years of service.

4.3.3 Computer Literacy

Computer illiteracy is one of the main stumbling blocks preventing users from accessing e-Learning materials. The results from the questionnaire showed that almost half

of the teachers interviewed had poor computer skills, about 31.8% had good computer skills, 11.4% had very good computer skills and only 6.8% had excellent computer skills. The data showed that, of those teachers who managed to acquire computer skills, many had a certificate of attendance and the few who had a Bachelors degree had bee given the chance to undergo computer training in their course of study. Regarding computer literacy for students, more than half of the students were computer illiterate as 58% fell in the grade of 'poor', 25% have a grade of 'good', 12% were graded in 'very good' and 5% graded themselves as 'excellent'. The variations in students' computer literacy depended greatly on their background whether they had been given the opportunity to undergo basic computer training or whether they had access to computers before. Other than those, the rest of the students had not had the opportunity of accessing computers before.

4.3.4 Current Teaching and Learning Environment

According to participants' responses, teachers prepare notes in handwritten format and use the blackboard and chalk to transmit the notes to students. In 2009, the subject delivery mode for secondary schools in Tanzania was still the conventional way of chalk and board, which was confirmed by the questionnaire results, which showed similar responses from all participants to the question "Lecture delivery mode?" the reply was "Chalk and Talk". Up to the time of conducting this research, none of the subject content was in electronic format. This may be due to the lack of computers and other multimedia tools in secondary schools and to some extent the ICT illiteracy of the teaching staff. In general, subject content digitization has not yet started in many schools.

The responses from students regarding where improvement is needed in the current mode of teaching, were based on the following given choices for students to respond to Content delivery/ assignment/ time management/ feedback/ laboratory, the question allowed students to select more than one option. For individual choices, the results showed that 44% of the responses chose 'content delivery', 54% chose 'laboratory', 60% chose 'time management', 55% chose 'assignment', 54% chose 'feedback' and about 31% chose all options. From the results it can be concluded that a number of students would like modifications in almost all the options given for improvements.

Users come from a background of traditional classroom learning. It was noted that the level of education of both teachers and students is enough to follow the e-Learning content when introduced. The language of instruction used is English hence the e-Learning content was also developed in English. Due to the problems of scarcity of learning materials and because e-Learning content is new to users, the participants responses showed a positive attitude towards the whole idea of learning using computers.

4.3.5   The use of ICT in Teaching and Education

Regarding the use of ICT in teaching/education, the responses from the question-naire showed that most of the respondents 'strongly agreed' (students 45.6%, teachers 37.5%, and head teachers 54.5%). Respondents who chose 'agree' comprised 36% of students, 38.6% of teachers and, 22.7% of head teachers. Some of the students (3.5%) chose 'disagree' arguing that its use would result in making students and teachers not active enough regarding working hard and taking up their responsibilities. 14.9% of students, 23.9% of teachers and 22.7% of head teachers chose 'neutral' regarding this question. Further individual group comments regarding the use of ICT in teaching/education are as follows:

4.3.5.1 Head Teachers' Responses

The use of ICT in education will help students to expand their knowledge and moti-vate them to learning and improve their performance. ICT is crucial and since it is the modern way of keeping information, it should be provided to all students and staff. ICT facilitates efficient teaching and learning, simplifies work, saves time and provides storage of information. With ICT it is easy to access any needed information from a distance, hence reducing to some extent the problems caused by shortage of resources. ICT is essential at all levels of education and it should start at primary school level and continue to the university level. One of the respondents disagreed with the use of ICT in education and commented that "ICT is good, however it might destroy African culture".

4.3.5.2 Teachers' Responses

ICT is really good, it gives teachers access to a lot of important information, and widens their skills as professional teachers and so it be used effectively. ICT is good if all the required facilities are in place and all students and teachers have access to it, and avoid educational discrimination. ICT saves time, reduces difficulties in teaching, simplifies the transfer of knowledge and can be used in areas where there is a shortage of fully qualified teachers, and inadequate and inappropriate teaching and learning materials. However, teachers and students should be well prepared on the use of ICT in education, and if possible manuals for the use of ICT should also be translated in Swahili and all prospective users should be trained. It is crucial to involve ICT in education, providing that educational institutions are properly provided with the ap-propriate ICT and power infrastructure. It might be thought very expensive at the beginning but once ICT is in use the expense of buying books and other teaching and learning materials would be minimized. ICT is very important for the education sys-tem but it is yet to take off in most of our schools, especially in rural areas and students in Tanzania still need the teacher's physical appearance because of their level of ability. Some families have very low income and cannot afford to buy books for their children or pay school fees for the elite schools which might have favourable conditions for ICT to be used there. Enough time is required for the adoption of ICT in our education system and to ensure its sustainability.

4.3.5.3 Students Responses

Most of the students agreed with the use of ICT in education, commenting that ICT will help them to obtain learning materials easily, thereby improving their academic performance. With ICT it is possible to learn at a distance, and to store educational materials which cannot be easily lost or wear out as is the case with books. The use of ICT in education will bring improvement to the quality of our education if used appropriately. In some schools where there are few teachers and an inadequate supply of books, the use of ICT will help students to perform well in their final exams. To stimulate the use of computers in education there should be enough computers, and if possible each student should have one computer.

However good ICT in education may be, some of the students were uncertain on its availability due to the problems that many schools are facing, i.e. lack of computers, no internet connectivity, charges for Internet services and the strict use of it (academically) as some students may misuse the service. Students should be taught how to use of ICT and the Internet for academic purposes in order to prevent them from being led astray by misleading information. They should be warned against getting involved in undesirable situations like watching pornographic movies, which might lead to undesirable behaviours like spread of sexually transmitted diseases. Some of the students disagreed with the use of ICT in secondary schools, and commented that its proper use is at diploma and university level, they are afraid if used at lower levels of education it may either leave students brains idle, destroy their culture or make them lazy, because instead of using their brains they will depend on the computer.

4.3.6 Practical Constraints for ICT Integration in Secondary Schools

There are several practical constraints regarding ICT implementation in the real school setting. These constraints include lack of resources such as computers, software, teachers with computer skills, training to integrate ICT into the curriculum, reliable internet connectivity and electricity. Moreover, owing to these conditions, the use of ICT in Tanzanian secondary schools has to be planned and implemented in phases, while improving the conditions of limited ICT and power infrastructure. Constraints given here are based on the responses from the questionnaire

4.3.6.1 Internet Connectivity

Responses from the participants showed that 70.8% of the schools do not have internet connectivity, 20.8% have internet connectivity and 8.4% of the schools did not respond. Activities reported by the schools which use the internet include searching for teaching materials, viewing NECTA results and accessing emails.

4.3.6.2 Lack of Resources

Many schools reported that they lack resources. On average 50% of the schools participated in the survey had an acute shortage of computers. Participants' responses showed

that number of computers varies a lot from one school to another and from schools in one region to those in another. Not more than 4 schools in each region have total 1 – 5 computers, some schools had 1 only. 2 schools reported having 5 – 15 computers, and 5 schools had 30 – 50 computers. About 45.8% of schools reported that they lacked ICT personnel, though some teachers have attended basic computer courses but to the level of certificate of attendance only, and still many of teachers are computer illiterate. On average, 25% of schools did not have electricity, 12.5% of schools reported other problems like lack of computer technicians, lack of a computer room and furniture (chairs and tables), and lack of printers and 12% of the schools did not respond.

4.3.7   School Performance

The status of resources is one of the factors which contribute to the academic performance of the school. Various efforts have been made by schools collectively and/or individually to try to improve school performance. Responses from the head teachers and teachers regarding school performance are presented below.

4.3.7.1 Head Teachers' Responses

Head teachers should make sure that every period is taught, conduct annual evaluations through staff meetings and ask teachers to *use good teaching methods*. Emphasize private studies, arrange for *remedial classes*, advise students to study hard insist on group discussions and give more exercises and tests. Teachers should encourage and give rewards to the best students and teachers, and negative feedback like warning letters to students who perform poorly as a means of making them take responsibility for their studies. Some of the head teachers reported they made sure that their schools have *enough teaching resources*, though this is possible only in private schools where the owner has the power to recruit/hire teachers independently. For Government and community schools this may not be possible since their requirements have to be met by the MoEVT budget.

4.3.7.2 Teachers' Responses

Many teachers reported that they work hard at teaching, covering the syllabus and always giving students questions for discussion in order to keep them busy and focused on academics. Other comments were that they make use of *participatory methods*, ensure students' discipline while teaching, encourage students to *work in groups* and share available materials. Some teachers commented on the use of the *student-centred* teaching methodology. Most of the teachers advised on providing *many exercises* and going through past papers, establishing subject clubs, and encouraging themselves and students to *make use of the Internet*. The school must have *fully equipped laboratory for science subjects*. Teachers have to plan teaching and learning activities in relation to the objectives, act on the plan accordingly and provide of updated materials.

4.3.8   Assisting Weak Students

The performance of the school is determined by many factors. Apart from improving the availability of resources, another factor is reducing or eliminating the number of weak students in schools. Following are the responses from participants regarding efforts to assist weak students;

4.3.8.1 Head Teachers' Responses

Weak students are helped by counselling, remedial classes after working hours and during holidays, and revision of the topics already covered. To make students work collaboratively, provision of tests, assignments, homework, group discussion are frequently given and for some days in a week academic clubs meet for discussion. Weak students are emphasized to attend tuition and look for learning materials in the regional library. Some of the head teachers reported that, due to having double sessions in their schools, they did not have room for extra classes but at least they help weak students at weekends, though this is not often done. One of the techniques used by teachers is to mix weak students with active ones in group discussions.

4.3.8.2 Teachers Responses

Students are advised to be serious in their studies and feel free to ask questions when they fail to understand any concepts in the learning process. Some teachers deal with them individually by counselling, talking to them trying to identify their weaknesses and giving them advice on how to overcome their problems and encouraging them not to despair. Students are advised to attend remedial classes to give more time to their studies and seek assistance from their teachers and fellow students. Teachers encourage and motivate students to study hard, do many exercises and assignments, and attempt past paper questions in group discussion where they mix with intelligent students. Efforts are also made to approach parents on consultation days when they are advised to spend time with their children and prepare them psychologically to make an effort in their studies.

4.4 e-LEARNING CONTENT GENERAL REQUIREMENTS

Determining e-Learning content requirements was needed to give guide concerning the most important features to be considered during the design phase; and to ensure the quality of the e-Learning content through verification and validation activities (Montilva, et al. 2002). The main goal of the research was to use ICT tools to increase access to learning resources and to have pedagogically sound learning materials. Increased access to learning and teaching materials which are pedagogically designed (quality aspect) is one way of enhancing the effectiveness of teaching (Edwards et al., 1997).

The requirements determination captures and defines them as natural language statements (Maciaszek, 2003). In view of the above discussion, e-Learning content requirements were determined based on three perspectives; pedagogical, technological, and users' perspectives which have an influence on the development of e-Learning content. Data from the surveys, literature and collaborative activities led to the determination of these requirements which were:

- The subject matter was mathematics form III. The subject of mathematics was chosen due to the increased failure rate in CSEE every year, the lack of resources for teaching and learning, and it is one among the subjects students must pass in the CSEE otherwise affects the overall performance at CSEE level.

- The e-Learning content targeted two types of users in secondary schools, students and teachers. Specifically the TanSSe-L content targeted students at the level of form III and teachers/content developers. Teachers/content developer must be experts in mathematics.

- The e-Learning content should be in modular format. This is in line with the object oriented paradigm for the formation of LOs which are chunks of learning materials easier to design, develop and manage (Lujara, 2007b)

- Transmissive/Instructivist pedagogy (teacher-led) continues for students to acquire basic knowledge of the subject matter. Courseware developed in teacher led mode may also be used for remedial or revision

- Constructivist pedagogy (student-centred) is emphasized to introduce collaborative learning for students to increase students-students and student-content interaction. Establishment of new learning approach of student-centred is aiming at students achieving their goals more quickly

- Web-based technologies, open source and freeware software should be used for content development due to limited funds as proprietary packages are very expensive (Lujara, 2007a)

- Despite bandwidth limitations multimedia and animated content should be used where possible to increase students' motivation and interaction with the learning material

- Deployment of different types of assessment, assignments and feedback to assess and motivate students

- Blended mode of delivery using TanSSe-L system, CD-ROM delivery and F2F delivery was proposed. Students can conduct self-paced learning at their own time and can access their learning material (Brown, 1997a) via Internet/ Intranet or from the CDs/DVDs (off line).

4.5   CONCLUSION

The joint collaboration of all actors would lead to contextual solutions to a societal problem. Making use of more than one method of data collection and collaboration with users and actors proved to be a successful way of covering most of the users' requirements. Data collection was an interactive process, not a one-off exercise extracting information from people. There was 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 with its delivery to in order to support the learning activity.

Given that e-Learning is new to Tanzanian secondary schools, the participation of teachers and students in schools was limited to discussions and comments on e-Learning material and suggestions provided by the researchers. However, the input and interest from the pilot schools has been crucial to the research project and were taken into account to fulfill the requirements.

Findings from the two surveys enlightened the researcher on the true condition of the common problems that are faced by many secondary schools in Tanzania. Although the surveys covered a relatively small number of schools they illustrated the problems existing broadly across Tanzanian secondary schools. Through the surveys, it was easier to establish the pilot site, know about the status of existing ICT infrastructure in different schools, ICT awareness of students and teachers, the availability of telecommunication services, and the situation of the surrounding community. The knowledge gained from all this sources of information helped in establishing the feasibility of the research.

The gap between the actual situation and the desired situation has been identified, as well as how to reduce the gap by using ICT tools. Learners' characteristics, content, technology and context constraints have also been discussed. The study of materials collected from teachers and the recommended book led to the realization of the current content structure. The aim was to get the current content structure as a basis for determining the structure for the e-Learning environment as discussed in the next chapter.

CHAPTER 5
DESIGN OF PEDAGOGICALLY SOUND TanSSe-L CONTENT BASED ON LOs APPROACH

Designing online or web-based courses requires a very different approach to course development from that of a traditional course. In relation to e-Learning content requirements, it was revealed that both educational and technological aspects have an influence on the end product (see section 4.4), in this case the e-Learning content. The educational aspects of e-Learning content design incorporated pedagogy and LO approaches. The LO approach has also been used in structuring the learning content into manageable small chunks of material, which can easily be aggregated or disaggregated and easily handled in an e-Learning environment. However, it is also important to recognize that instructional design is constrained by the delivery technology and by the authoring tools available. The technologies significantly affect the educational approaches which can be used, which is why concern for technological design. Technology can also integrate suitable pedagogical approaches for e-Learning resources.

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).

5.1   FORMALIZED SUBJECT STRUCTURE

The formalized subject structure in existence is shown in figure 5.1. The structure is derived from the learning materials obtained from the pilot site and the mathematics book 3 as discussed in section 4.3.1. The structure was viewed in respect of the LOs, and so different levels were obtained which are all represented using LOs.

The existing subject materials were found to be bulky notes that consolidated different types of materials into big chunks of topics. Moreover, the structure was designed for the traditional classroom setting and so some improvement or modifications were necessary in order to be used for e-Learning environment. The research focused on incorporating LOs and pedagogy concepts in designing the e-Learning content.

The current structure of the learning materials provided for the mathematics is comprised of a number of chapters, with each chapter consisting of several topics, and each topic comprising notes, example(s) and exercise(s). Subject structuring followed a top-down approach, starting from top the level 1 (subject level) going down to basic learning elements (level 5). The basic learning elements were considered to be like text, figures, equations etc.
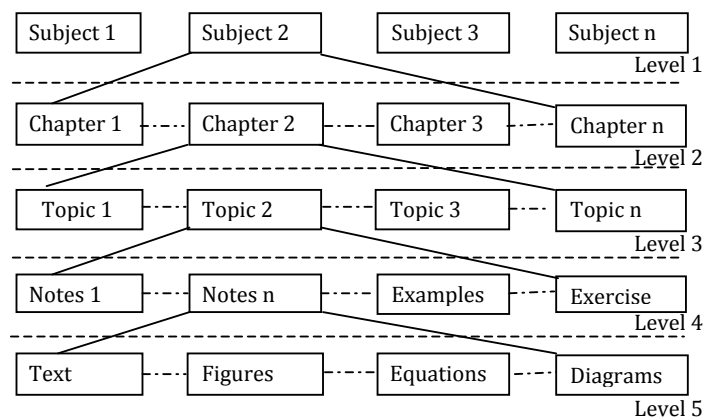
Figure 5.1: Formalized Subject Structure

From the concept of the LOs each level is built or aggregated from the composition of one or more lower levels. Levels 1 to 5 in figure 5.1 represent the following:

- Level 1 – Subject Level   • Level 4 – Notes Level
- Level 2 – Chapter's Level   • Level 5 – Basic learning elements
- Level 3 – Topics Level

5.1.1   Teaching and Learning Strategies in Practice

Generally, teaching and learning strategies vary from one topic to another, depending on the subject, topic, the extent of the content covered in that topic and the learning

environment. In mathematics form III, the strategies which are used in F2F teaching mentioned here (list not exhaustive) include teachers to explaining, demonstrating, deriving, showing, proving, preparing the how to… guidelines, leading students in discussions, brainstorming on various concepts, illustrations etc., while students on the other hand do exercises individually or in groups, show, explain, draw, calculate, make use of formulas, present group work, and participate in discussions (MoEC, 2005). These instructional strategies provided a guide to look for better ways to incorporate them in the e-Learning environment.

5.2 PILOT SUBJECT LEARNING OBJECTS DESIGN

The design of the pilot subject was based on the results of the analysis of the current subject structure, incorporating pedagogical and LO concepts. The LO concept was used to structure the learning materials into objects at different levels identified in the current subject structure. An LO may thus be simple, consisting of one independent object, or it may be compound comprised of two or more independent LOs that are linked together (Boyle, 2003). LOs can also be grouped into larger collections of content to create units of learning.
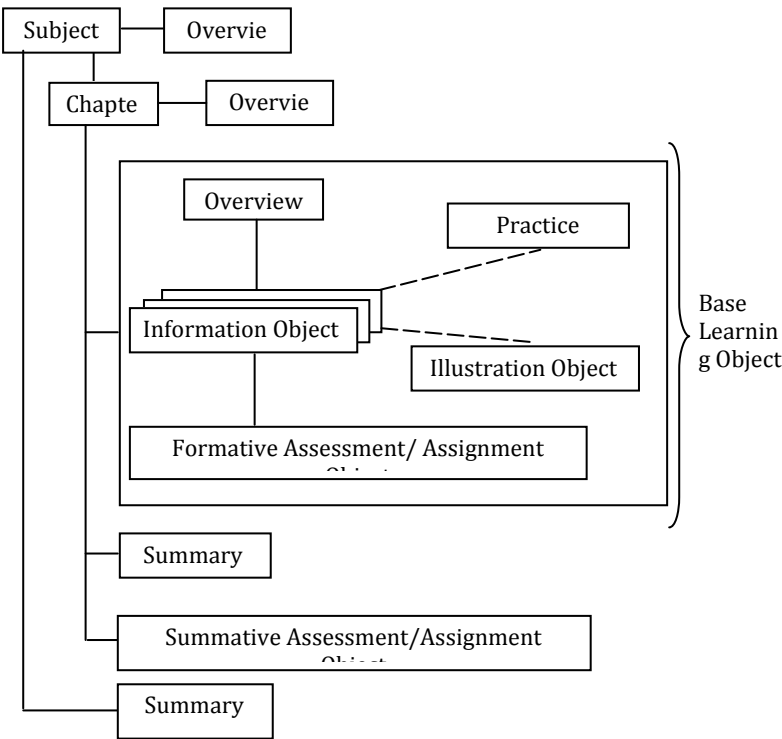
Figure 5.2: Subject Structure Based on LO Concept

The subject has been designed to accommodate two containers – subject and chapter and four major objects – overview, information, assessment/assignment and summary. The LO granularity suitable for our secondary schools environment was identified to be at the topic level which has been referred to as 'base learning object'. The base learning object is formed with learning materials like assets, overview, information and assessment/assignment objects. The overview object has been defined at topic, chapter and subject levels and the summary object has been defined at the chapter and subject levels. Similarly, the assessment/assignment objects have been defined at chapter and topic levels. The summary object has been defined at both chapter and subject levels. The structure of the subject is as shown in Figure 5.2.

5.2.1 Subject Container

This is the main container covering the overview and summary objects at the subject level. The subject overview object is composed of metadata to define the subject and some attributes to briefly inform learners about what they should expect to learn from the subject depending on the context of learning. The attributes which are enclosed in the subject container are as follows;

- *Subject name*: Gives the name of the respective subject

- *Subject form level:* Uniquely identifies the subject form level

- *Subject syllabus:* Gives general and class competences and objectives informing students on abilities they are going to gain at the end of the subject

- *Indicative content:* Gives a list of contents in this case chapter titles and subject summary enclosed in a subject container.

- *Summary Object:* Summary object used at the subject level is termed as subject summary. In this case it gives details of recommended references, extra exercises and mathematical tools. The list is not exhaustive can be more or less than what is given here depending on the learning context.

5.2.2 Chapter Container

The chapter container is enclosed in the subject container in terms of indicative content (at subject level). It gives an overview, indicative content, assessment/assignment objects and the summary object at the chapter level. The overview gives details of the chapter metadata and the indicative content gives details of the topics included in the chapter. The assessment/assignment object gives details regarding assessment/assignment at the chapter level. The summary object gives the summary at chapter level. Attributes of the chapter container are as described below:

- *Chapter number:* Uniquely identifies the chapter. Each chapter is identified by its chapter number

- *Chapter title:* Gives the title of the respective chapter

- *Chapter objectives:* (Optional) Give the objectives of a certain chapter, it is optional and can be declared at the topic levels also

- *Indicative content:* Content enclosed at the chapter level which include base learning objects (topics), assessment/assignment object and the summary object

- *Assessment/Assignment object:* Gives summative self-assessment/assignment (revision exercise) to be done in groups at the end of each chapter

- *Summary object:* It gives all the important concepts and formulas in summary form of all topics involved in a respective chapter

Depending on how the material is used and where it is stored, the metadata can have more fields than is declared in this case. Apart from defining the material, metadata also helps to easily identify the material in a storage medium and facilitate its accessibility.

5.2.3   Design of Base Learning Object (Topic)

Due to the wide range of definitions of a learning object, the research has termed the fundamental LO as the 'base learning object' which is composed of three main objects; namely: the overview, the information and assessment/assignment objects. Depending on the learning conditions, the base LO may also be associated with other LOs such as practice object and illustration object for enhancing the learning material.

5.2.3.1 Topic Overview Object

The overview object offers information about the topic metadata, learning objectives, and the indicative content in terms of the information objects. The overview object with its attributes is as shown in figure 5.3.

A description of the attributes of the overview object in the base learning object is as follows;

Topic number: Uniquely identifies the topic. Each topic is identified by its corresponding topic number

Topic title: Gives the title of the topic

Topic objective(s): (Optional) Give(s) objectives of a certain topic, it is optional since objectives can also be declared at chapter level

Indicative content: Is associated with the IO which is the main part of the base LO, it represents a set of selected information at appropriate granularities and it is what students are expected to learn in order to fulfil the subject's objectives.
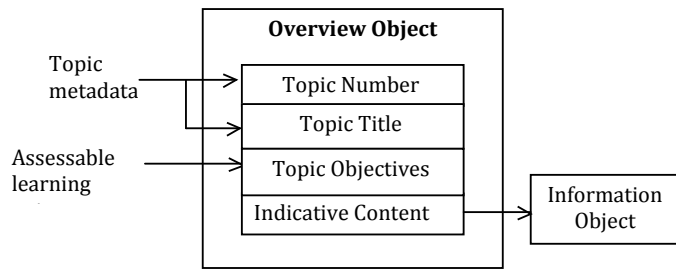
Figure 5.3: Topic Overview Object

5.2.3.2 Topic Information Object

The IO has been designed to contain the core content of the base LO. Its attributes include the introduction, concept/facts, worked examples and illustrations. The structure of the IO is shown in figure 5.4. Some of the attributes in the IO are domain specific to the situation and context while others are domain independent. Attributes which are considered being domain-independent are highly shareable and reusable, e.g. the purpose and description content objects in figure 5.4. An example of domain independent objects may be the purpose of learning mathematics form III, or the purpose of learning a certain chapter in mathematics form III.

The content objects that are considered to be domain-specific contain general information, which outlines the scope of the topic e.g. the illustrations (practice object) may differ as one moves from one domain to another, depending on the contextual situation of the domains under consideration, and hence they cannot be reused in different domains. An illustration object should perform personalised learning functions, which allow students to engage in interaction and become self-directed while learning.
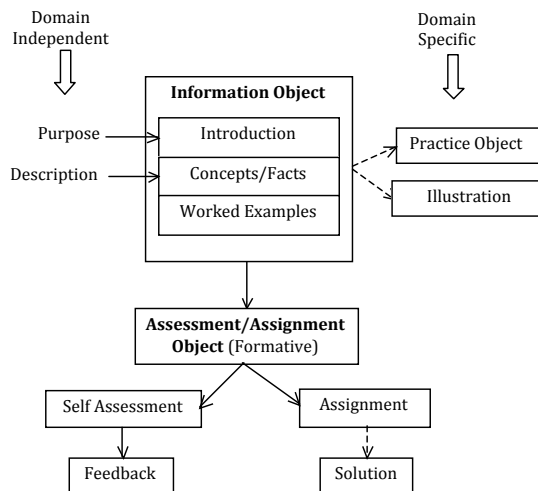
Figure 5.4: Information Object and Assessment/Assignment Object

Figure 5.4 shows the IO associated with formative assessment/assignment object and illustration and practice objects. Each object is designed to be self-contained and can be used independently of the base LO. The LOs designed in this manner are said to possess a reusability property meaning that they can be used in multiple-contexts for multiple purposes.

The practice object is optional depending on the requirements of the subject context, and can be included in the learning material or not (Sun et al., 2004). It puts emphasis on some hard concepts or worked examples to help students increase their understanding of the concepts or examples. The practice object can either be in the form of illustrations or step-by-step instructions. In this research, the practice objects have been applied to some hard concepts or to worked examples partially or in full

The assessment/assignment object is aimed at improving the performance of an individual student or students in a group, depending on the instructions given. The assessment settings encourage students and teachers to have regular discussions on exploring multiple ways of getting solutions to the given questions. The assessment/assignment object engages students with the learning content, hence providing them with a way to achieve learning objectives or outcomes. The assessment/assignment object is also used as a mechanism to obtain feedback on learners' performance. The assessment/assignment given at the topic level are formative and are given at the end of each topic.

The assessment object in the form of self assessment comprised of multiple choices, gap filling, matched pairs or true-false type of questions. They provide prompt feedback on correct or wrong answer with graded points. Self-assessments are aimed at increasing student-student and student-content interactions.

The assignment object aims at enhancing students' performance in small group settings, which improves collaboration among students and motivates them to work together in group discussions, and solve problems. Formative assignments provide access to topic exercises where students work offline to solve the given assignment through discussion. Assignments increase student-student, student-teacher and student-content interactions. Assignments can be done in groups or individually. Provision of solutions to assignments is optional, in this case solutions are provided to guide students how to solve the given problems.

5.2.3.3 Designed Summary Object

The summary object has been designed to be placed at the end of the chapter and at the end of the subject. At the chapter level the summary object is comprised of a review attribute which in this case gives a collection of important concepts and formulas from each topic in a respective chapter for students to have a quick revision and reference.
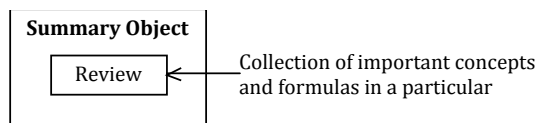
Figure 5.5: Summary Object at Chapter Level

At the subject level, the summary object comprises of reference, extra exercises and mathematical tools attributes as shown in figure 5.6. The reference attribute has been designed to provide a list of reference to books or other learning resources in relation to the subject. The extra exercises attribute gives a collection of past papers and their solutions in a portable document format (pdf) in relation to the subject. Past papers are provided to help students to extend their knowledge for deeper learning, by solving more exercises apart from the ones provided at chapter or topic levels.

The summary object can have more or less attributes than defined in this case it depends on the context of learning, the availability of resources/facilities and the type of subject.
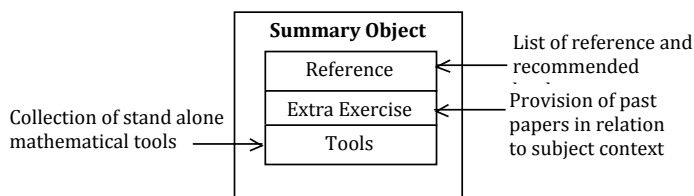
Figure 5.6: Summary Object at Subject Level

5.3 PEDAGOGICAL DESIGN CONSIDERATIONS

Pedagogy promotes students' learning and produces learning materials with a high degree of interactivity. Sound learning materials can only be achieved if pedagogical design considerations are incorporated into them. Pedagogical considerations should help designers to construct e-Learning material and associated activities in a way that will incorporate and bring to life the sound principles of pedagogy. A lot of research on the learning process has provided evidence for this stance that learning does not only come from providing knowledge, but that it is the activities of learners in the learning environment, like solving problems, interacting with real devices, interacting with their social and work situation, which account for learning (Koper, 2001).

The pedagogical models facilitate the teaching and learning of learning materials and must support different modes of interaction. The research has implemented students-content, students-students, and teacher-students kinds of interactions. The pedagogical models that have been designed are a result of the pedagogical requirements determined in chapter 4, which are teacher-led pedagogy and student-centred pedagogy. The design of pedagogical models involved objective definition, learning content composition, assessment/assignment definition and instructional strategy definition.

Pedagogy for the e-Learning environment must capture most of the learning resources and activities done in the traditional mode. To support the pedagogical models the concept of Gagne's nine events of learning instructions not necessarily covering all the events or the order of events was incorporated in structuring the learning content as given below;

- Make clear learning objectives for each chapter/topic

- Focus on goal oriented and activity based learning

- Inclusion of extra drills and practices

- Material presentation in the order of difficulty which directs progress in the learning process

- Provision of self assessment exercises and the right type of feedback for students' self assessment

- Provision of extra references from the recommended materials

- Enforce collaboration among students-students and between students and teachers by providing group assessments/assignments. Assignments are best for promoting interactivity when conducted offline

5.3.1   Transmissive (Teacher-Led) Pedagogical Model

In the teacher-led pedagogical model, the objective definition for instructions is to provide the knowledge to be acquired which can also be used for remedial purposes. The model provides a collection of learning materials in the form of base LOs and other learning objects (e.g. illustrations) which will impart knowledge to students. Figure 5.7 shows a transmissive pedagogical model.
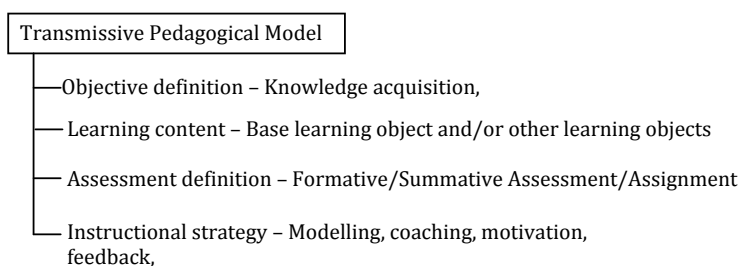
Figure 5.7: Transmissive Pedagogical Model

The assessment definition can be assessment/assignment formative or summative depending and where it is placed. The assignment is done in offline mode either by individual students or in groups depending on the instructions given. Solutions to the assignments are also provided to help students learn how to solve problems incase of any difficulties.

The instructional strategies which accompanied this model are;

- *Modelling:-* Modelling implements an approach to educational support which is problem-oriented and guided by the teacher. In this way students acquire expertise in problem solving.

- *Coaching:-* This refers to the way in which a teacher supports students' efforts to solve some tasks. In this case emphasis is on the students work. This kind of support develops during an activity and entails a high degree of interaction between the students and the teacher.

- *Drill and practice:-* Extra assignments are designed to engage students more in the learning content

- *Motivation:-* Assessment, assignments and animated contents were constructed to increase motivation to students

- *Feedback:-* Assessments have been designed with proper feedback to motivate students to perform better

The transmissive pedagogical model has been designed to provide all the necessary material students that may be needed in order to understand the subject matter. The learning material was divided into smaller chunks, including worked examples and step-by-step illustrations and delivered in an intuitive way for students to easily follow when reading for themselves. Drill and practice is emphasized since it is a method of instruction characterized by systematic repetition of concepts, examples, and problems, designed to help users remember isolated facts or concepts and recall them quickly. The model integrated interactivities between student-content, student-student and teacher-student. In most cases students will be reading either individually or in small groups with or without teacher's assistance.

Transmissive pedagogy resulted in instructions which aimed at imparting basic knowledge and skills to students. The approach was used to provide learners with an anchor before they go deeper to acquiring more knowledge. A basic understanding of the material in question provides the learner with a guiding compass for further travel (Mergel, 1998). At the stage of gaining introductory learning, classical instructional design is suitable because it is predetermined and sequential. The stage of introductory learning is considered in the conceptualization phase of the learning cycle, which focuses on the acquisition of knowledge (Hadjerrouit, 2007).

Moreover transmissive instructions in this research have been designed to serve the purpose of increasing students' access to basic notes, which is a problem in many secondary schools in Tanzania. Transmissive instructions create an environment where students can proceed with learning (remedial or revision) without the presence of an instructor or teacher and they can also be used where the learning environment is F2F. The subject content chosen was designed to be interesting, stimulating and productive and to encourage students' intellectual growth. Students are encouraged to assume ownership of their learning process by interacting with e-Learning materials as supporting or supplementary material for revision, or when doing assignments or attending remedial classes to enhance their learning.

5.3.2   Constructivist (Student-Centred) Pedagogical Model

The constructivist model emphasizes that students should work in a collaborative manner to build the knowledge. It is designed in the form of problems or educational activities based on the knowledge already acquired by students.

The assessments types in this mode are formative assignment, summative assignments and extra exercises. Assignments and extra exercises are designed to be taken in offline mode, which encourages students to tackle the assignment by discussion and collaboration, hence improving their thinking capabilities especially for students who are slow learners or have difficulties in understanding the concepts. The constructivist pedagogical model is shown in figure 5.8. Solutions are provided to clear students' doubts incase facing problems when solving the assignments.

```
┌─────────────────────────────┐
│ Constructivist Pedagogical  │
└─────────────────────────────┘
    ├──Objective definition – Strengthen Knowledge, Remedial
    ├──Assessment definition – Formative/Summative
    │  assignments
    └──Instructional Strategy – Problem based, collaborative and
```
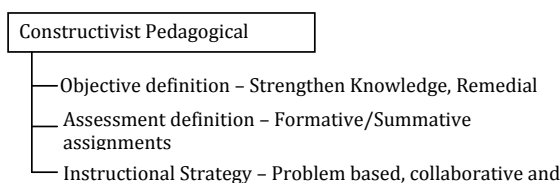
Figure 5.8: Constructivist Pedagogical Model

Like in the transmissive pedagogical model, the constructivist pedagogical model also emphasizes student-content, student-student and student-teacher interactions. Instructional strategies that accompanied the constructivist pedagogical model are:

- *Problem solving: -* Through authentic activities which engage students in a realistic and meaningful task that is relevant to students' interests and goals. Different multimedia can be used in the development of authentic activities

- *Collaboration and discussion –.* This is a collection of activities that emphasize joint construction of knowledge, joint negotiations, student interaction with teachers and learning resources. The goal is to collaborate and share different viewpoints and ideas on problem solving and knowledge reinforcing activities. This encourages interaction between and among two or more students

Constructivist instructions have been developed based on the constructivist pedagogical model, which aimed at making students learn to appreciate multiple views on the task given and showing them how to reconcile those differences so as to arrive at a solution that is acceptable. The scope of group activities needs to be proportional to the topic level and students' background (prior knowledge), i.e. assignments or assessments must be designed to require students to apply the knowledge they have gained. Students learn more effectively if they are active rather than passive during the learning process. Learning by doing is generally more effective than learning by listening or reading (Wood, 1994). The main characteristic of constructivist instruction is the engagement of students in collaborative work, where close interaction and exchange among students enriches the learning process. The close collaboration of students and the instructor also plays an important role in group dynamics (Danchak et al., 2001; Yang et al., 2003).

In this research, the constructivist instruction has been employed to give students the opportunity to put into practice most of the theoretical concepts in the form of problem solving or discussion in order to enhance the knowledge imparted in the classroom, as well as in the form of assignments, and assessments which are done either individually or in groups.

Object	Attributes and/or Description
Subject	**Subject Name and Form Level:**- Uniquely Identifies the subject by name and form level **Syllabus:** Gives the general and class objectives and competences of the subject **Subject Composition:**- Describes what subject is comprised of **Indicative content**:- Includes chapters contents **Summary object (Subject Summary):**- Indicates extra exercise in the form of past papers, list of reference and recommended books/resources and tools
Chapter	**Chapter No. and Title:**- Uniquely identifies the chapter by number and its corresponding title **Learning Objectives:**- Indicates what students are supposed to learn at the end of the chapter **Indicative Content:**- Base learning object (topic content) and other learning objects **Assessment Objects:**-. Formative/Summative assessments, Formative/Summative assignment **Summary Object (Chapter Summary):** Gives a summary of important formulas and concepts
Base Learning Object	**Topic No. and Title:**- Uniquely identifies the topic by number and its corresponding title **Learning Objectives (Optional):**-Specifies what students are supposed to learn at the end of the topic **Information Object:**- Aggregation of one or more contents (concepts, worked examples, topic exercises, and practice) **Assessment Objects:**-. Formative assessments, Formative assignments
Information Object	Information Object is an aggregation of assets to form concepts/facts, worked examples, etc.
Assets	Assets are basic learning elements to be aggregated to form a higher order of learning materials, like information objects, base LOs and other LOs whenever needed. These can be images, figures, equations, graphs, texts, animations, audio/video clips
Practice Object	Practice object is optional, can be included in the learning material if required. e.g. Illustrations or step-by-step procedures
Assessment/ Assignment Object	Categorized into formative/summative self assessments and formative/summative assignments which can either be done individually or in groups depending on the instructions given. Self assessments are assessed by the system and assignments are provided with solutions. **Formative assessment/assignment:** appear at the end of topic, **while Summative assessment/assignment:** appear at the end of chapter
Summary Object	**Review, Reference, Extra Exercises, Tools:**- **Chapter Summary:** Composed of Review **Subject Summary:** Comprised of Reference, Extra Exercises, and Tools

Table 5.1: Summarized Modified Pilot Subject Learning Objects

5.3.3 The Hybrid Pedagogical Model Implemented with LOs

There is no single pedagogy that will fulfil all e-Learning content requirements, hence there is a potential of using more than one pedagogical model, and in practice a mixture of learning pedagogies has been used. From a learning point of view it is necessary to realize that some learning problems require prescriptive solutions whereas others are more suited to constructivist and collaborative learning (Karagiorgi et. al. 2005). Due to the scarcity of learning materials students need the increased access to the formal based learning materials in order to master the subject matter. Therefore a hybrid pedagogical model has been used in the development of e-Learning content which incorporated transmissive and constructivist pedagogies as explained above.

The hybrid subject pedagogical model integrated the designed learning object structure defined in section 5.2 which led to a modified pilot subject structure. The modified pilot subject structure is summarised in table 5.1 and the subject organization shown in figure 5.9. The modified structure maintained the five levels of objects which are subject, chapter, base learning object (topic), information object and assets. Where necessary the attributes for each level have been modified to combine the existing subject structure and the proposed subject object structures to suit the e-Learning environment.

In figure 5.9, link from one level to another is made through indicative contents. The overview object appears at subject, chapter and topic levels to clearly define the subject, chapter and topic. The summary object appears at the subject and chapter levels giving details of the summary at respective levels. The assessment/assignment object appears at the topic and chapter levels to give room for formative and summative assessments/ assignments respectively.

The IO is made from one or more assets, one or more IOs form the base LO, one or more base LO forms the chapter, and one or more chapter(s) form the subject, thus forming a 'one-to-many relationship' from one level to another starting from the lowest (asset) level. The letter 'n' indicates the nth term of a certain object level.

5.4 TYPICAL SAMPLE CHAPTER DESIGN BASED ON LOs

According to the basic mathematics syllabus for secondary schools in Tanzania, the subject of mathematics form III has a total of eight (8) chapters. The chapters are titled Relations, Functions, Statistics, Rates and Variations, Sequences and Series, Circles, The Earth as a Sphere and Accounts (MoEC, 2005).

The sample chapter under consideration was chapter 1 which has four (4) topics. Each topic was considered as the base LO, which is also composed of IOs and other LOs. Sample LOs were determined, and the structure for the whole of chapter 1 is discussed in section 5.4.1. The LOs were designed to comprise learning materials which fulfil the learning objectives as given in the Basic Mathematics Syllabus for Tanzanian Secondary Schools (MoEC, 2005).
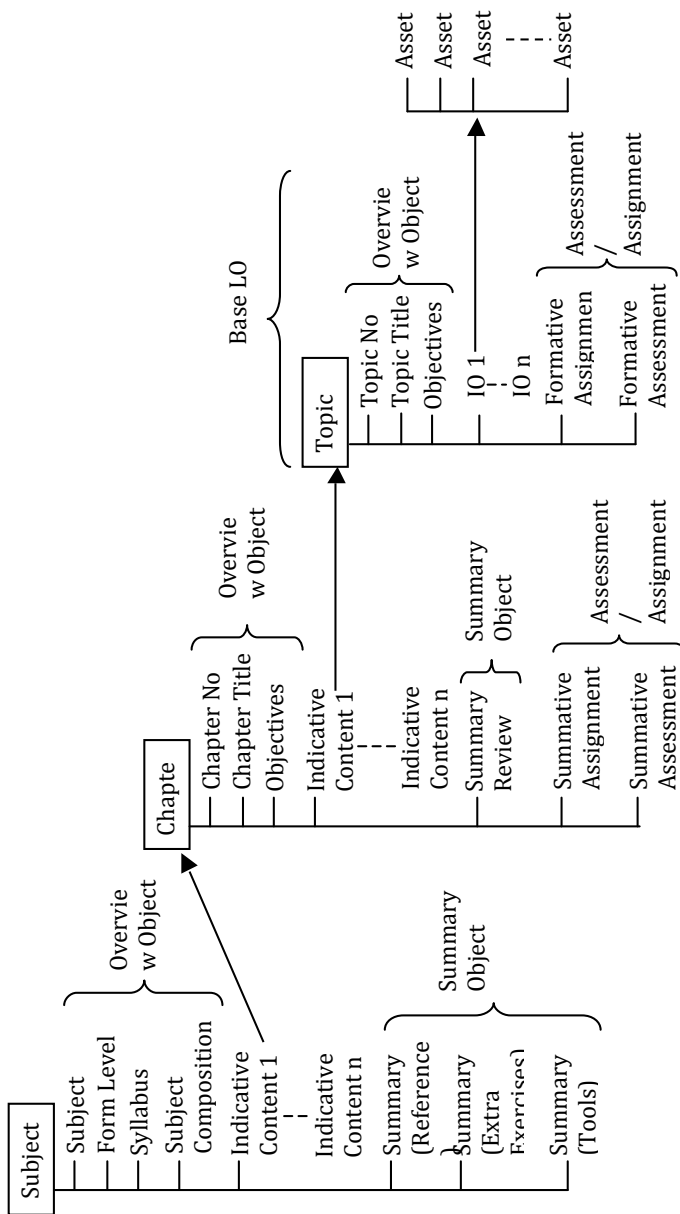
Figure 5.9: Organization of the Pilot Subject

Therefore, when students cover the learning material provided by the learning objects, they are expected to fulfil the stated learning objectives. Chapter naming is composed of chapter number and its title. Generally we can say *"Chapter No.: Chapter Title"*. Similarly topic naming is given by *"Topic No.: Topic Title"*. Section 5.4.1 gives details of sample base LO composition.

5.4.1   Mathematics Form III Chapter I Topic 1.1 Base LO

The design of e-Learning content in this research followed the LO approach. Topic 1 was considered as the base LO. Normally LOs do not have fixed sizes; the consideration given in this approach is that an aggregation of one or several IOs can be best used to suit a learning objective. This adds value to the content since IOs with different purposes can be aggregated to meet students' needs.

Table 5.2 gives an illustration of how a base LO can be determined from IOs and other LOs. For simplicity IOs, were formed based on the type of information or purpose i.e. definition, worked examples, illustrations etc. The base LOs were obtained as a result of breaking down the material of topic 1.1 in such a way that chunks of materials formed in the IOs have specific purposes. The base LO must fulfil all the objectives mentioned in the topic. Examples of IOs and other LOs which form the base LO for topic 1.1 are as follows;

IO1 – Concept – Gives an explanation of relation concepts

IO2 – Definition – Gives a definition of relations and some terminologies

IO3 – Illustration – Gives some illustration on the concepts in IO1

IO4 – Illustration – Audio/Video clip – Explains a concept

IO5 – Worked Examples – Show how to solve problems

LO1 – Formative Assignment – Exercise 1.1 – An exercise at the end of the topic

LO2 – Formative Assessment – Self assessment exercise at the end of the topic

An aggregation of IO1 – IO5, LO1 – LO2 and the overview object at the topic level form the base LO. Illustration objects (IO3/IO4) can be designed to have animation, multimedia or a neat meaningful drawing to accomplish the task it depends on what has to be illustrated. The assessment/assignment object formed by LO1 (Formative assignment) and LO2 (Formative assessment) can be done either by an individual student or in groups depending on the directives given. In this case assessment objects and practice objects can stand as independent learning objectives since they can be used alone to transfer knowledge to students.

Assets are raw elements for all objects. Table 5.2 shows assets of different media used in the formation of objects. IO1 is composed of text only, IO2 is composed of text and a table, IO3 is composed of text and a diagram, IO4 is composed of text, table, figure and equations, IO5 is composed of audio/video clip, LO1 is an exercise, and LO2 is a self assessment exercise. For the purpose of useful learning material, a topic has been

considered to be an aggregated base LO which satisfies all the learning objectives given in that particular topic. A sample base LO for mathematics form III topic 1 is shown in table 5.2. The overview object gives information regarding topic number, topic title and learning objectives.

Table 5.2: Sample Base LO for Mathematics Form III Chapter 1 Topic 1

Overview Object= Topic Metadata + Learning Objectives	
Metadata **Topic**: 1.1 **Title**: Relations	**Learning Objectives** 1. Define relations 2. Find the relations between two sets 3. Demonstrate the relations pictorially 4. State the domain and range of a relation
Aggregation of objects IO1 + IO2 + IO3 + IO4 +IO5 + LO1 + LO2	

IO1: Concept of Relations

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

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

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

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

IO2: Definition of Relation

A relation is a set of ordered pairs.
The set of all the first coordinates is the domain of the relation.
The set of all second coordinates is the range of the relation.

IO3: Illustration

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

IO4: Illustration - Audio/Video Clip

<u>Definition of a Relation</u> _   - A link to an audio/video clip illustrating the concept of relations representation

IO5: Worked Examples

EXAMPLE 1

Given the relation R={(x, y): y = 2x – 1, x =A}, where A = {1, 2, 3, 4, 5}
What is the range of R?

Solution:
Substituting values of x in the given equation for each value of x given in A, obtain its y values and tabulate as in the table below.

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

Rearranging the values of x and the corresponding values of y in a relation, we get;
R = {(1, 1), (2, 3), (3, 5), (4, 7), (5, 9)}

The pictorial representation is shown in the figure below.
The range of R = {1, 3, 5, 7, 9}

LO1: Exercise 1.1 – Formative Assignment Object

Write a rule for each of the following relations and list its domain and range:
1. $\{(1,3),(2,5),(0,1),(-2,-3),(10,21)\}$

2. $\{(-3,-3),(-5,5),(-6,6),(-10,10),(0,0)\}$

3. What is the range of the relation $\{(x, y), y = 3x - 4\}$, when the domain is $\{x : -2 \leq x \leq 4\}$

LO2 – Self Assessment 1.1 – Formative Assessment Object
Choose the correct answer for each multiple, true/false or gap fill question

1. A relation ………………...one element of one set to one or more elements of another set.
    A.   adds
    B.   associates
    C.   divides

The design of base LO is the centre of the design of the subject since the chapter and subject are just containers to enclose the base LO. The overview object for base LO is

composed of metadata information and learning objectives. Formulation of IOs and their number may not be the same in all topics it depends on the subject type and the content to be presented. A complete base LO should also have an overview object and formative assessment/assignment object.

5.5   STAKEHOLDERS' COLLABORATION

The discussion with participants (teachers in this case) resulted in obtaining the information regarding how teachers conduct classes, suggested areas which needed emphasis, and ways of illustrating and explaining difficult concepts. Moreover, teachers provided solutions for worked examples and questions for the formative/summative assessment and assignment objects. The information obtained was used in the development of e-Learning content to combine the transmissive and constructivist pedagogical approaches to provide the hybrid model.

Examples of the advice given by teachers and incorporated in content development;

- Use of figures (graphics) to represent a certain concept
- Use of different colours to draw pictorial representation of relations using different colours
- Incorporate animations where necessary to represent some concepts
- Draw functional graphs using real dimensions or use scale proportionality to get a clear picture etc.
- Where possible make use of audio instruction to emulate the presence of a teacher for the benefit of students who are aural learners

5.6   CONCLUSION

This chapter has dealt with the approach to the e-Learning content designed based on educational aspects where the idea of LOs and pedagogical concepts have been employed in the determination of appropriate pedagogy and suitable LO granularity for the e-Learning environment in relation to our context.

A number of existing approaches to e-Learning incorporate learning theories, though much of the development of e-Learning is still carried out without a true understanding of how learning theories can be aligned with pedagogical requirements. Pedagogical principles should exert a strong influence on the development and the use of e-Learning content which means that learning theories must reflect those principles and ensure that they are put into practice. The research adopted a blend of transmissive and constructivist approaches and placed emphasis on the interactivity between students-content, students-students, and student-teacher. Different instructional strategies have been employed to reinforce these interactivities.

The design was also based on the learning object concept where the content of the subject under consideration was broken down into smaller chunks, which provided meaningful learning. LOs are one of the most promising elements of e-Learning and may offer many advantages in terms flexibility, reusability and adaptability that are beneficial to both teaching and learning. Depending on the pedagogical approach used, LOs can encourage collaborative teaching and learning. The LO approach also gives a way to the choosing the technology for the development of e-Learning content since the production of LOs for e-Learning environment must have sound user interface design for usability.

The following chapter deals with e-Learning content development based on the educational requirements described in this chapter.

CHAPTER 6
AUTHORING TanSSe-L PILOT SUBJECT

The essence of e-Learning implementation lies with the representation of content which is the most important step in the e-Learning path. The development of content in a presentable form, which appeals to the learner, is a great challenge to content developers. Content authoring is preparing information so that it is well presented and accessible to individuals and groups in all the environments (Sharma et al., 2005). The development phase dealt with the authoring of e-Learning content.

e-Learning instructional material that is well designed can facilitate and promote very positive and deep learning experiences for end users. There are many issues surrounding the development and use of effective educational software systems that will produce these types of meaningful learning. By examining various attributes of common instructional material software products and their associated engineering concepts, tools and practices, we can better understand how to put engineering systems in place that will increase efficiency, effectiveness and accuracy and reduce time delivery ratios (Shaw, 2000).

The courseware engineering methodology has been used in this research as described in sections 3.2 and 3.3. SDLC was used in the development phase to guide the development of the pilot e-Learning material. The steps that were taken in the e-Learning content development for the pilot subject are shown below.

- Technical requirement specifications
- Courseware site architectural design model
- Courseware authoring
- Design and development of user interfaces, links and navigational aids
- Testing and Evaluation

6.1 TECHNICAL REQUIREMENTS SPECIFICATIONS

6.1.1 Functional Requirements

Functional requirements describe what the system should do, behaviours which can be determined by modelling. Modelling was done using UML which included definition and specification of sets of operations (use cases) that the courseware must provide to users, teachers or content administrator and students. The sets of operations can be divided into teaching operations and learning operations (Montliva, 2002). In this research sets of operations were divided into teaching and learning functions and the following requirements were determined:

The content provider functions denoted by "CF" were considered as the content administrator/teacher interactions with the courseware, and the learning functions denoted by "LF" were considered as students interactions with the courseware. The functional requirements are shown in table 6.1.

Functions were modelled with use case diagrams at a high level of abstraction. Figure 6.1, shows the functional requirements for students with students' use case diagram.

Table 6.1: Defined e-Learning Pilot Subject Functional Requirements	
Function No.	Function Description
Students Interactions	
LF1	Allows students to read subject composition
LF2	Allows students to read syllabus
LF3	Allows students to read subject content
LF4	Allows students to read chapter learning objectives
LF5	Allows students to read topic content (topic learning objectives, notes, worked examples, illustrations)
LF6	Allows students to perform formative assessment with feedback
LF7	Allows students to perform formative assignment with solutions
LF8	Allows students to read chapter summary
LF9	Allows students to perform summative assessment with feedback
LF10	Allows students to perform summative assignment with solutions
LF11	Allow students to read subject summary(reference, extra exercises, tools)
Content Administrator/Teacher Interactions	
CF1	Allows teachers/content administrator to provide/read subject composition
CF2	Allows teachers/content administrator to provide/read syllabus
CF3	Allows teachers/content administrator to provide/read subject content
CF4	Allows teachers/content administrator to provide/read chapter learning objectives
CF5	Allows teachers/content administrator to provide/read topic content (topic learning objectives, notes, worked examples, illustrations)
CF6	Allows teachers/content administrator to provide/do formative assessment with feedback
CF7	Allows teachers/content administrator to provide/do formative assignment with solutions
CF8	Allows teachers/content administrator to provide/read chapter summary
CF9	Allows teachers/content administrator to provide/do summative assessment with feedback
CF10	Allows teachers/content administrator to provide/do summative assignment with solutions
CF11	Allows teachers/content administrator to provide/read subject summary(reference, extra exercises, tools)

A typical scenario for the set of operations for students is: students read introductory content such as subject composition, syllabus, subject content and chapter learning objectives. Students can also read learning materials at topic level composed of learning objectives, notes, illustrations, and worked examples and perform formative assessment which is provided with prompt feedback and/or formative assignment which is provided with solutions. In formative assessments/assignments students can discuss

how to reach to the solutions alone or with teacher's guidance. Students can also perform summative assessments/assignments which are given at the end of the chapter. Summative assessments are provided with prompt feedback and summative assignments are also provided with solutions. Students are also able to read chapter summary which gives the review of the chapter concepts and subject summary which in this case have comprised of list of recommended references, extra exercises in the form of past papers and solutions and mathematical tools such as a graphing tool.
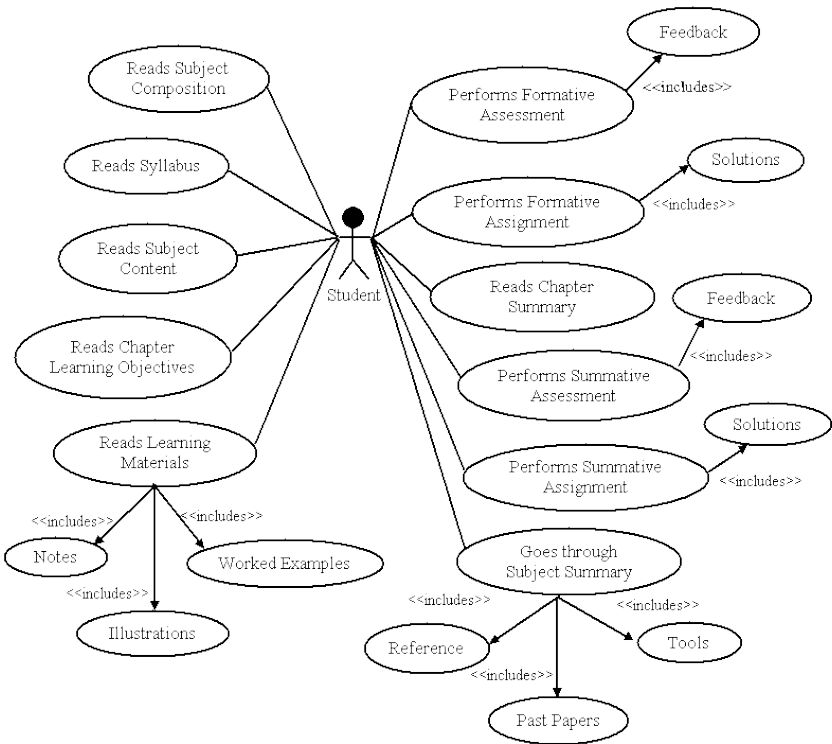
Figure 6.1: Student Use Case Diagram

Most secondary schools in Tanzania use the same syllabus, and for consistency of the e-Learning content for the pilot subject, it is proposed that only the approved content would be used in content development in real implementation. Therefore to start with, teachers were not going to author their own content, but instead use the approved content developed for secondary schools. However, to get used to the TanSSe-L system teachers were encouraged to develop learning content and exercises which could be used in the vicinity of their schools/classes. Table 6.1 shows the expected Content Administrator/Teacher interactions with the TanSSe-L content. A typical scenario for teachers or content administrator will mostly be to provide/do learning content and activities, to provide feedback for the assessments or solutions for assignments and extra exercises. Content Administrator/Teacher can also provide/view subject composition, syllabus, subject content and chapter learning objectives. The use case diagram for Content Administrator/Teacher interactions is shown in figure 6.2
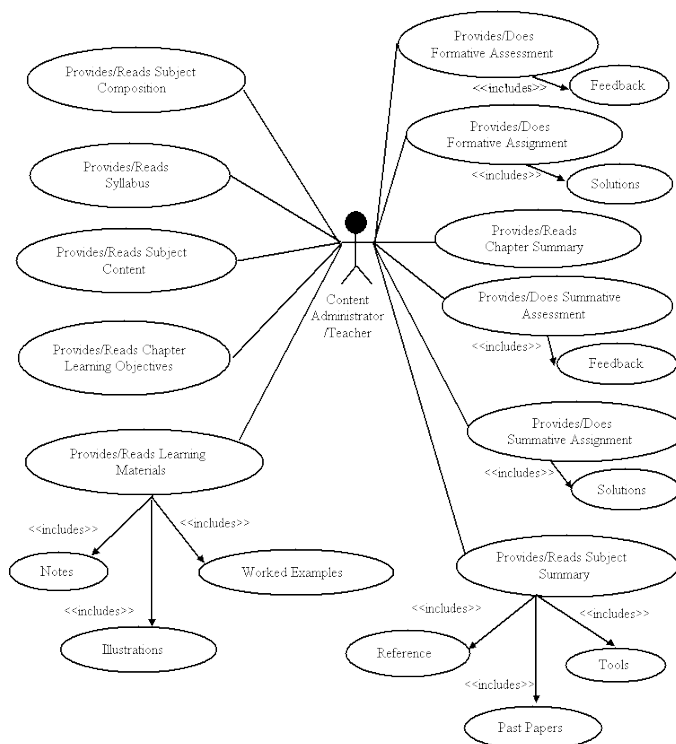
Figure 6.2: Content Administrator/Teacher Use Case Diagram

6.1.2 Non Functional Requirements

Non functional requirements are global constraints on a software system, often known as software qualities. Non functional requirements defines how a system is supposed to be hence should include but not limited to performance, usability, reliability, interoperability, scalability and security (Stellman, 2008). Following is a description of non-functional requirements in relation to this research

(i)   Availability

TanSSe-L content be operational and available for use. This is considered because some systems are designed with expected downtime for activities like database upgrades and backups. The TanSSe-L content is supposed to be in full operation which is very possible with CD-ROMs content. CD-ROM content can be run in offline mode which does not require the use of Internet to be accessed hence free from bandwidth and Internet failures problems.

(ii)   Usability

Ease of use requirements addresses the factors that constitute the capacity of the software to be understood, learned and used by its intended users. The TanSSe-L content has to be designed with simple user interfaces for users to easily follow the contents.

(iii)   Flexibility/Scalability

It is possible to extend or increase the functionality of the software after it is deployed.

(iv)   Portability/Interoperability

This specifies the ease with the software to be installed on different platforms and on the platform it is expected to run. In this case the CD-Content is designed as a stand-alone content hence it is cross-platform, can be delivered using client computers and with little modifications can be made available in TanSSe-L platform or any other platform.

(v)   Reliability

The capability of the software to maintain its performance over time, CD-ROM content is very reliable, once the content is burnt on a CD-ROM can be used as long as desired if the CD is well maintained.

6.2   COURSEWARE SITE ARCHITECTURAL DESIGN MODEL

One of the requirements of the e-Learning content was to develop web-based content. Therefore, there was a need to determine pilot subject site architecture to provide access to the learning content. The design of e-Learning content is usually hierarchical, with the top page as the home page which gives access to the learning content. The courseware site architectural conceptual model captures the main objects of pilot subject. The model is essential for gaining an understanding of the purpose, general characteristics and structure of the courseware (Montilva et al., 2002).

The pilot subject site shown in figure 6.3 has been modelled using class diagram modeling. The site is composed of different pages and sections of pages which are interlinked and their associations indicated. Associations between pages (learning content) are either only one represented by 1, one or many represented by 1:n and none or many represented by 0:n. Example of an association of only one is between the subject page and any of the following composition/ syllabus/ content pages, this is such that a subject page can have only one of those mentioned pages. An example of 1:n association is between subject content page and chapter page, whereby one subject content page can have one or more chapter pages. An example of a 0:n association can be seen between the topic and its contents like illustration in the form of animation/audio/video, in this case the topic can have none or more illustrations of this nature it depends on what is to be illustrated.

The courseware site is a virtual learning environment that can be viewed from the instructional, technological, structural and functional perspectives (Montilva et al., 2002). A courseware site looked at the instructional perspective can be seen as an instructional and communication medium that provides an environment that facilitates the teaching-learning process of web-based e-Learning content. Hence it must support different kinds of interactions which are teacher-content, teacher-students, students-

content and students-students. Instructionally, figure 6.3 reveals communications between pages as users can move through the courseware via different pages developed.

From the technological perspective, a courseware site is seen as a collection of inter-linked web pages stored in a web server or any other storage medium and accessed by students using a web browser. The host page of the courseware site must always be invoked in order to access the learning content. Figure 6.3 also represents a collection of various web pages/sections which are logically connected to form a meaningful learning.

The structural perspective focuses on the learning materials which are components of the subject and their relationships. The structure of the subject is represented to support different interactions among students, teachers and the learning content. Figure 6.3 shows that the learning material is organized into a set of one or more content unit pages, each divided into several sections, with the purpose of communicating teaching about a given concept, topic or chapter to students.

The functional perspective of a courseware site architectural design model concentrated on the behaviour of a site which considers operations that are available to the content developer/teacher and students as given in table 6.1. Therefore figure 6.3 also supports all the functionalities as stipulated in table 6.1.

6.3   COURSEWARE AUTHORING ISSUES

Owing to the nature of the e-Learning content, it is best represented if combines different types of multimedia content such as texts, graphics, animations, audio and video. This is followed by the production of the study material associated with the learning resources and activities (Hadjerrouit, 2007). Sections 6.3.1 – 6.3.3 discuss some authoring issues in respect of this research.

e-Learning Pilot Subject

is_composed_by

1 — Subject Composition Subject

1 — Subject Contents Subject

1 — Subject Syllabus Subject

1 — Subject Summary Subject

1: n

1: n

Chapter Page Chapter

References

Extra

Tools

Learning — 1

1: n — Topic Page Topic

1: n — Summative Assessment

1: n — Summative Assignment

1 — Chapter Summary - Review

1 — Topic

1: n — Notes, Examples, Illustrations

0: n — Illustration –

1: n — Formative

1: n — Formative

Key:

◇ Composition

▭ Page/Section

▭ (dashed) Optional

1 One

1: n One or More

0: n Zero or More

Figure 6.3: Pilot Subject Site Architectural Design Model

6.3.1 Common Image Formats

Pictures and graphics can be used to illustrate and enrich web pages. Digital images consume a large amount of memory when they are stored without using a data compression technique, and so a number of digital encoding formats were used in order

to reduce transmission times and file sizes. Moreover, some images formats are not compatible with browsers (VTT Information Service, 2007). The common images formats are:

- *JPEG* (Joint Photographic Experts Group) – One of the most common image formats, primarily used for photographs. It is a lossy type of format, which removes information from the image each time it is decompressed and recompressed. With JPEG format the amount of compression can be adjusted when saving a jpeg image and so the final output quality can be controlled. JPEG formats are popular since they compress the image into a small file size and retain excellent image quality.

- *GIF* (Graphical Interchange Format) – Another popular format, especially on the web, is a lossless format ideal for graphics. GIFs can either be static or animated, used mostly for non-photographic types of images.

- *BMP* (Bitmap) – This is the standard window image format. It is lossless and works well for pictures or graphics. It is uncompressed file format, hence takes up lots of disk space.

- *PNG* (Portable Network Graphic) is a lossless image format and does not support animation. For the same image, a PNG file can generally end up being twice the size of a JPG and three times larger than GIF. Some older version browsers do not render them correctly.

- *TIFF* (Tagged Image Format File) – is lossless format that can use file compression and results in larger file size that a jpeg of the same image, hence not recommended for the web.

The research mostly used GIF format, due to its advantages for web-based content as compared to other saving formats.

6.3.2 W3C Recommendations on Web Page Design and Development

To avoid undesirable behaviours when viewing the web pages, the pages must be designed following the W3C recommendations (Foss, 2004). Therefore this research abided by those recommendations.

(i)   Valid Code (Standard Compliance)

The page must be validated by W3C validation service to check if the codes used are valid. The page validation shows most of the errors that have been coded and, give suggestions on how to resolve them.

(ii)   Accessible Code

The <title> element should contain a description of the specific page. The header tags <h1> to <h6> if used should be described. Use ALT text for all images and SUMMARY for tables. A table summary is much like the alt text for the images. The tool

tip-style comments should be used in the TITLE for images (and other elements) and CAPTION for tables. Use high contrast colours to accommodate other visual impairments.

(iii)   Semantically Correct Code

Semantics deals with the relationships between signs and symbols and the meaning they represent. The XHTML markup should explain the document itself and not how it looks. The <title> element should describe the specific page, rather than using the same title for the whole site. The heading elements <h1> to <h6> should be used to "chunk" the document into meaningful pieces. Lists are a great way to group related information and CSS can be used to change its look later if desired.

In the case of images, ALT is used to explain the image to someone who cannot see it, and TITLE is used for tool tips for those who can. Tables help to establish the relationship between pieces of information. SUMMARY can be used to explain the table to those who cannot see it and CAPTION to explain it to those who can. <thead>, <tfoot> and <tbody> help explain parts of the table and provide good CSS for styling. Semantically correct code provides a solid platform for use on alternative devices.

(iv)   Separation of Content and Presentation

It is advised that the XHTML document should contain no presentation markup, i.e. a description of how it looks. All the presentation should be in the CSS document and referenced from the XHTML document. Java Script brings some animation to the XHTML document. The JS file should also be referenced.

In this research, all XHTML documents were designed to contain content and referenced to external CSS for the presentation markup. For consistent presentation, all XHTML files were referenced to the same CSS file.

6.3.3   Software Packages Used

The contents to be used in the development of e-Learning material must be in digital form, independent of the developing environment. The analysis in chapter 4 revealed that the existing content was in traditional format (hand written and some hard copies), hence it needed to be digitized in order to be used effectively in the e-Learning environment. Because of the type of content to be used for e-Learning, and the availability of resources at the time of conducting this research, some software packages were identified for the digitization and authoring of the e-Learning content.

In content authoring there are many tasks to do, so many kinds of content to manipulate and so many distribution and display technologies to support that it is unreasonable to expect a single tool to cover everything. The interface for content development between the author and the content is the content authoring tool (Sharma et al., 2005).

A number of proprietary and open source or freeware tools for content authoring exist in the market. Due to the high license costs of proprietary software packages, the

research used the available proprietary software and downloaded some freeware and open source packages/tools for content development. Since the common categories of authoring tools use some basic software applications like web technologies, power point presentations and flash-based environments, this justified for this research opting for web technologies and open source software for content development.

The following is a description of the authoring tools used in the process of content authoring:

(i)   *Adobe Dreamweaver CS4*

Adobe Dreamweaver Creative Suit (CS) 4 was the main authoring tool used in this research. The package present an integrated web-authoring environment which incorporated an editing environment in What You See Is What You Get (WYSIWYG) editor, XHTML, CSS and JS design working windows, the WYSIWYG editor was used for the creation of static learning resources. Dreamweaver is provided with code and design views, so that it is easy to edit the document in whichever mode one is conversant with, either the code view where only the codes are seen, or the split mode where both views are seen. Most of the web pages were developed using the dreamweaver environment, images, graphics and other multimedia elements were easily included in the XHTML pages. The use of Adobe CS4 Dreamweaver helped in cutting down development time by simplifying some of the content development processes. Macromedia Dreamweaver has different formats for saving its files depending on which program had been used to create the file, i.e. HTML, and HTM for X/HTML pages, CSS for style sheet documents and JS for Java Script documents.

(ii)   *Adobe Flash CS4 and ActionScript*

Adobe Flash CS4 is an efficient tool for creating animations and interactive elements for e-Learning content. ActionScript is a scripting language used by Flash application. Several software products, systems and devices are able to display Flash content, including adobe flash player which is available free for most common web browsers. Flash saving formats are FLA for flash documents and Shockwave Flash (SWF) for shockwave documents or flash movies.

(iii)   *Hot Potatoes Software Package*

The Hot Potatoes v6.5 suite is a set of six (JQuiz, JCloze, JMatch, JCross, JMix and JMasher) authoring tools which permit the development of several types of interactive Web-based exercises. Hot Potatoes handled the creation of self-assessment exercises. Depending on which program of Hot Potatoes is used, the Hot Potato file can be saved in many different file formats, including the web format HTM. Therefore, it was easy to include exercises created by the Hot Potatoes software package as HTM files into the e-Learning content. It is advised to save the Hot Potatoes documents in two file formats, i.e. the default format corresponding to the program used and the HTM format for publishing. The default saving format gives room for any modification if required. Among the six exercise tools available in the Hot Potato package this research used, three tools as shown below:

- *JQuiz* - creates multiple-choice, short-answer, and hybrid questions
- *Jmatch* - creates matching exercises and
- *Jcloze* - creates fill-in-the-blank exercises

(iv)   MathType

MathType v6.5 is an equation editor used to create mathematical equations. It was used in this research to author almost all types of mathematical equations in the e-Learning content. Mathtype has different file saving formats, including GIF, TIFF and WMF and works with many applications.

(v)   Graph Software Package

The Graph v4.3 package is an open source application used under Gnu's Not Unix General Public Licence. The application was used to draw mathematical graphs in a coordinate system. The program was very useful for this research since it simplified the work of drawing graphs of functions, visualized functions and pasting them into the e-Learning content in the development. The graph application possesses different file formats such as PNG, JPEG, metafile and PDF. The default saving format for graphs is GRF format which gives access to any modifications/additions to the graph. In case of missing information (some limitations found in the graph package), Paint Microsoft package was used to add more information to the graphs.

(vi)   Paint v5.1

Paint is a drawing tool used to create simple or elaborate drawings. It is a distribution of Microsoft Office and was used in this research to add graphical information missing in the original graphs drawn by the Graph tool. Paint produces either black and white or coloured drawings and can be saved in BMP, JPEG, GIF, TIFF and PNG file formats.

(vii)   SmartDraw

SmartDraw v5.5 is a drag-and-drop drawing program. It was used to draw some mathematical diagrams and give added emphasis to some illustrations included in the e-Learning content. The MathType equation editor is also imbedded in SmartDraw which made it easy to add equations to the diagram where necessary. SmartDraw has different file saving formats including GIF, TIFF, WMF and JPG. SDR (SmartDraw) is the default saving format.

(viii)   CamStudio 2.0

CamStudio version 2.0 is an OSS tool for recording screen activities in audio and video and plays them back. The video files created by CamStudio are saved in the standard Audio Video Interleave (AVI) format, which is used widely in many Windows applications that support video. Screen captures saved in AVI format can be easily embedded in HTML documents. The AVI format is suitable for playback on a slow device like CDROMs.

6.4 ASSETS DIGITIZATION

Having identified which software packages to use for content digitization, the first items to be digitized were assets, these were equations, images (figures, graphs) and flash documents. This helped to speed up the work when authoring of the e-Learning content started. Text documentation was straight written in HTML pages using the WYISWYG editor in the Dreamweaver environment.

Different folders were opened for meaningful saving purposes, one folder for equations e.g. ". .\equations" and one folder for figures/graphs e.g. ". .\images". All digitized figures, equations and graphs were saved using the GIF format due to its light weight which may suit well to the existing limited bandwidth as larger image files require more time to download and also need broad internet bandwidth. It was necessary to look for software packages which had different saving file formats GIF included.

The Flash CS4 software package was used for the creation of illustrations and animations. The files were saved in .FLA extension (default format) and also saved in .SWF extension file format for viewing purposes. The SWF files were also embedded in HTML separate pages to allow users who do not have shockwave application to view the animations. All flash files were also saved in one folder e.g. ". .\flash".

Self assessment exercises were authored using the Hot Potatoes package and saved in a separate folder e.g. ". .\hotpotatoes". The documents were saved in their default formats, depending on which program had been used to create assessment, and were also saved in HTM format to be easily imbedded in the e-Learning content.

Assets digitization was a necessary process since the formation of all objects depends on the aggregation of assets and it also simplifies the authoring work. Although all the assets were ready when the authoring work started, in actual practice some images and text portions required further modifications or rearrangement to fit in properly when inserted into the main web pages.

Two modes of authoring the e-Learning pilot subject are discussed in this research. The stand-alone content mode (section 6.5) and the platform authored content mode (section 6.6). Assets digitized at this stage can be used and reused in the composition of learning content in both stand alone and platform authored content modes.

6.5 AUTHORING STAND-ALONE TanSSe-L CONTENT

The Stand-alone TanSSe-L content was created using the identified software packages and authoring tools. The stand-alone content is interoperable and can be reused in different contexts, delivered via a variety of delivery mediums including learning management systems such as TanSSe-L and CD/DVD ROM. The stand-alone content contained static and interactive learning materials. All the content was developed and stored in a development folder.

6.5.1   Development Folder

The developed TanSSe-L content was saved in one folder named bamf3 in a hard disk. Each chapter with all its corresponding information was saved in a respective chapter folder which is a subfolder in the development folder. The development folder can be considered as a subject container as defined in section 5.2.1, whereas the chapter folder can be considered as a chapter container (see section 5.2.2). Figure 6.4 shows the development folder bamf3 in drive D.
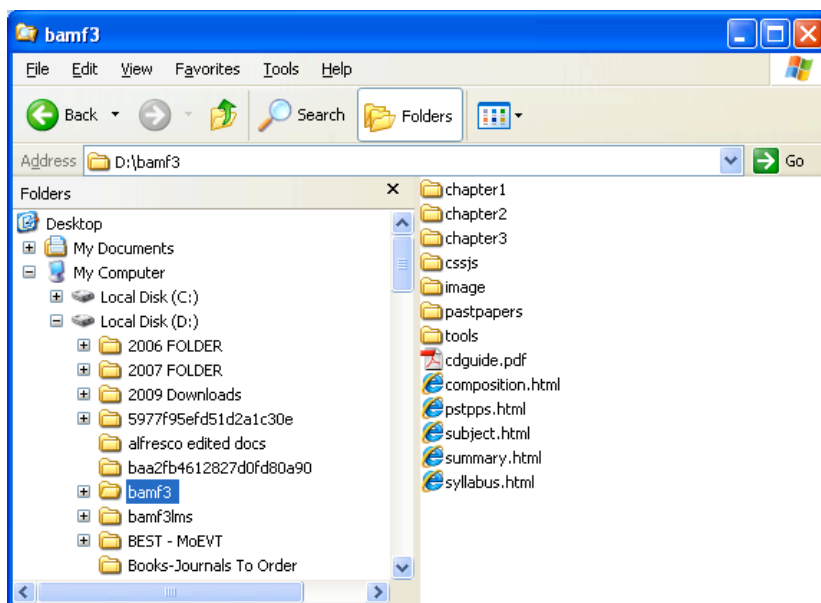
Figure 6.4: Stand Alone TanSSe-L Content Development Folder bamf3

In figure 6.4, the left panel shows drive D in the hard disk containing different folders including the development folder bamf3, which is highlighted with a coloured background. The right panel shows sub folders and web pages belong to the selected folder bamf3 from the left panel. The selected folder contains subfolders for all chapters developed which belonged to the respective subject. The subfolders are named chapter1, chapter2, and chapter3. Other subfolders which are contained in bamf3 are cssjs for stylesheets and java scripts files, pastpaters for past papers files, and tools for stand alone mathematical tools. Apart from the subfolders, the development folder also contains other documents such as web pages corresponding to subject composition, syllabus, subject, summary and pstpps and a user guide file in pdf format.

6.5.2   Static Learning Materials

Static learning materials included basic learning materials, static illustration objects, assignments, solutions and extra exercises.

Most of the basic learning content that is assets, information objects, learning objects, topic exercises, revision exercises, review summary object, subject metadata, chapter metadata and topic metadata was authored using the Adobe Dreamweaver CS4 following the LO structure defined in chapter 5.
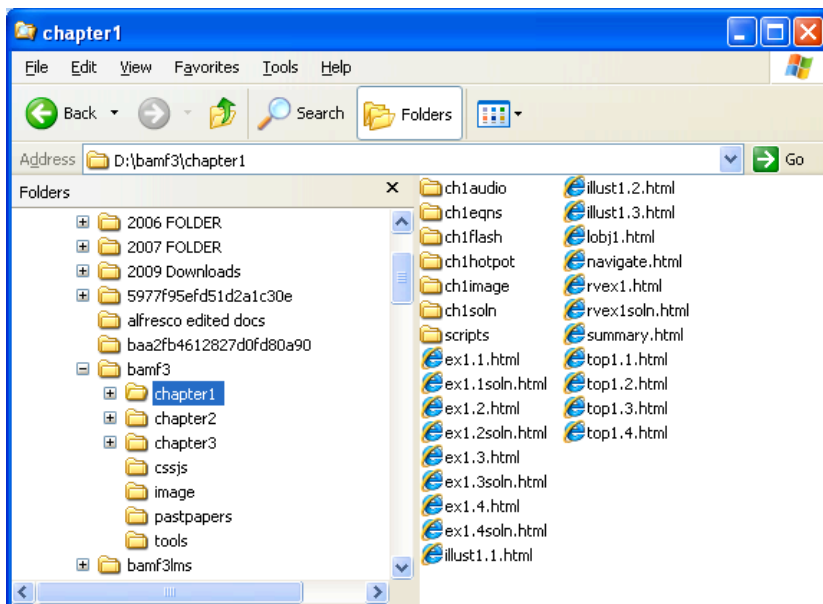
Figure 6.5: Chapter 1 Folder and its Contents

All LOs were saved in different folders according to where they belonged e.g. LOs belonging to chapter 1 were saved in the folder named chapter 1. Figure 6.5 shows the selected chapter1 folder on the left panel and its contents on the right panel. Chapter 1 folder contained folders for equations, images, flash documents, hotpot documents, solutions, and the corresponding subject web pages for topics, illustrations, learning objectives, summary and navigation. Figures, equations and images were inserted into their respective places on the web page from their respective folders. Figure 6.6 shows a screenshot of a portion of basic learning material. It gives the topic description (topic number and name), learning objectives at topic level, worked examples.

Math Form III Chapter 1 Topic 1 - Windows Internet Explorer

D:\bamf3\chapter1\top1.1.html

Yahoo! Search

File   Edit   View   Favorites   Tools   Help

Math Form III Chapter 1 Topic 1

Page ▾   Tools ▾

TOPIC 1.1: MEANING OF A RELATION

Learning Objectives

At the end of this topic students are expected to be able to:

- Define relations
- Find relations between two sets
- Demonstrate relations pictorially
- State domain and range of a relation

Worked Examples | Chapter Contents

Often people talk of things which have some relationships. Examples are; Musa is a husband of Mariam, Juma is a brother of John, $y = x$. The words 'a husband of ', 'a brother of' and the symbol '=' in the above three sentences are relations. Some statements such as 'Juma is tall', 'I am hungry', are not relations. These statements do not indicate any connections between two or more things.

A relation associates an element of one set with one or more elements of another set. An element 'a' from one set which associates another element b from another set is written in an imposed order as (a,b) and is called an ordered pair. It is often convenient to display information in some information like the one shown in table 1.1a.

View Illustration - Practice on Pictorial Representation

Table 1.1a: Students' list with their Corresponding Test Marks

Test Marks	Students
83	Alex, Mary
87	Sara
92	Ellen, Tom, Sue
98	Maria, Tina

Worked Examples

Example 1

What is the range of the mapping $x \rightarrow 2x + 1$ for the domain $\{0,1,2,-1\}$.

Solution

Substituting the values of x in the given equation and tabulate values as shown in table 1.1d

Table 1.1d

x	0	1	2	-1
$2x + 1$	1	3	5	-1

Therefore, range = $\{1,3,5,-1\}$

Figure 6.6: A Portion of the Basic Learning Material

In figure 6.6 the basic learning material is a composition of text, a table illustrating some concepts (in this case the 'Relation' concept), a highlighted sentence emphasizes an important concept, link to a practice object, and a portion of worked examples.

6.5.2.2   Static Illustration Objects

Static illustration materials were authored using Smart Draw software package and inserted into the basic learning material in their respective places. These were saved in either the equation folder or the image folder depending on what they illustrated. An example of a static illustration object is as shown in figure 6.7.
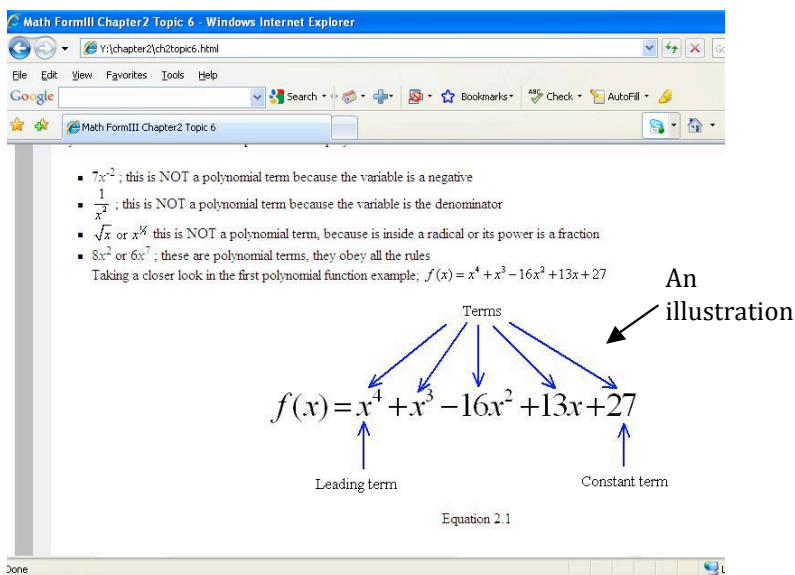
Figure 6.7: Static Illustration Object

6.5.2.3 Formative/Summative Assignments

The assignments come into two forms, formative and summative assignments depending on where the assignment is placed. Formative assignment placed at the end of a topic represented a topic exercise. Figure 6.8 shows a screenshot of a portion of formative assignment.
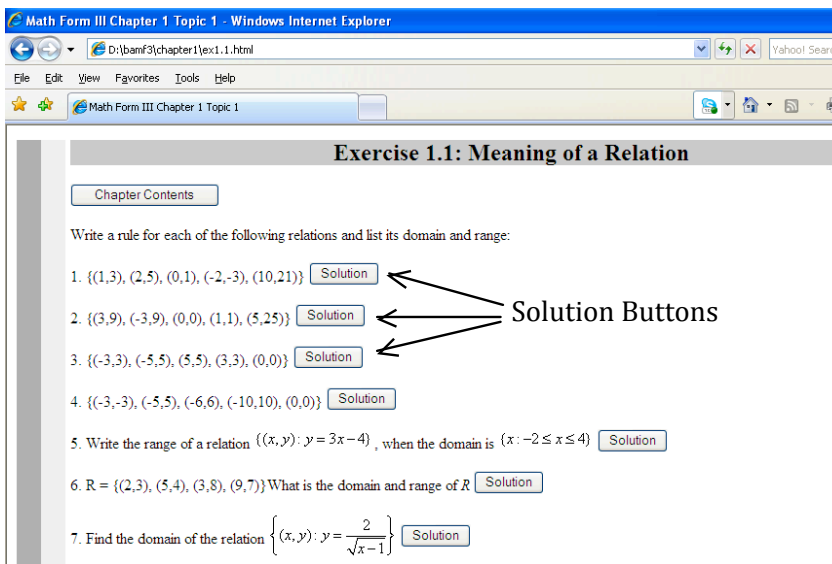
Figure 6.8: A Portion of Formative Assignment

Summative assignment given at the end of the chapter represented end of chapter assignment. Figure 6.9 shows a portion of a summative assignment. In both formative and summative assignments a solution button is also provided alongside each question to facilitate a link to a particular solution. In summative assignments links are provided to go to a particular formative assignment and also to a corresponding topic where need be.
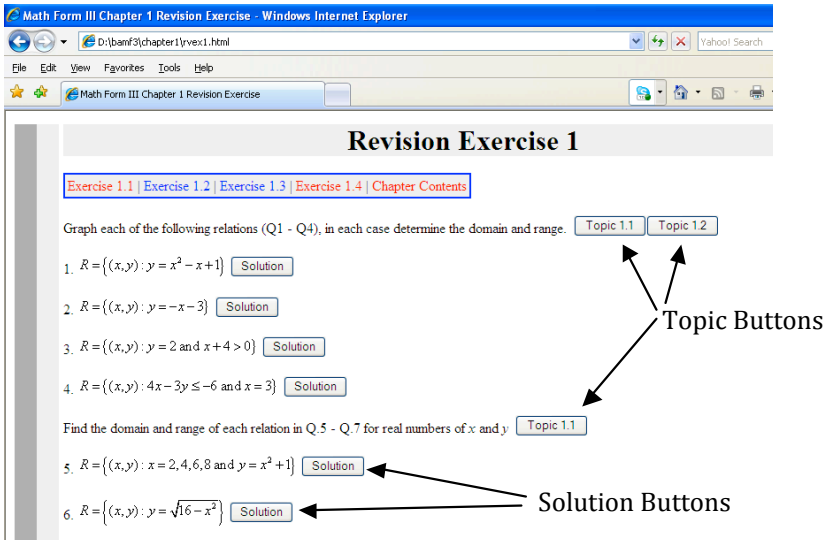
Figure 6.9: A Portion of Summative Assignment

6.5.2.4 Solutions to Formative/Summative Assignments

Solutions page to formative/summative assignment is part of the static learning content which can be reached from the assignment or from the chapter page. The solutions button in the assignments links a certain question to a particular solution related to that question.

Figure 6.10 shows a portion of formative assignment solutions page. When a solution tab is clicked in figure 6.8 a solutions page opens up which provide solutions to the questions being worked on. In this case, at each solution a link 'Exercise 1.1' button is provided to take users back to the questions' page.

Figure 6.11 shows a portion of summative assignment solutions page. Revision Exercise Button is provided to take users back to the assignment page. There are also topic buttons to take users back to the topic content if reference to topic content is needed.

Figure 6.10: Formative Assignment Solution Page

Figure 6.11: Summative Assignment Solution Page

6.5.3   Interactive Learning Materials

Interactive learning materials included formative/summative assessment objects and animated illustration objects. These are meant to provide activity-based objects for students to practice and master the subject matter.
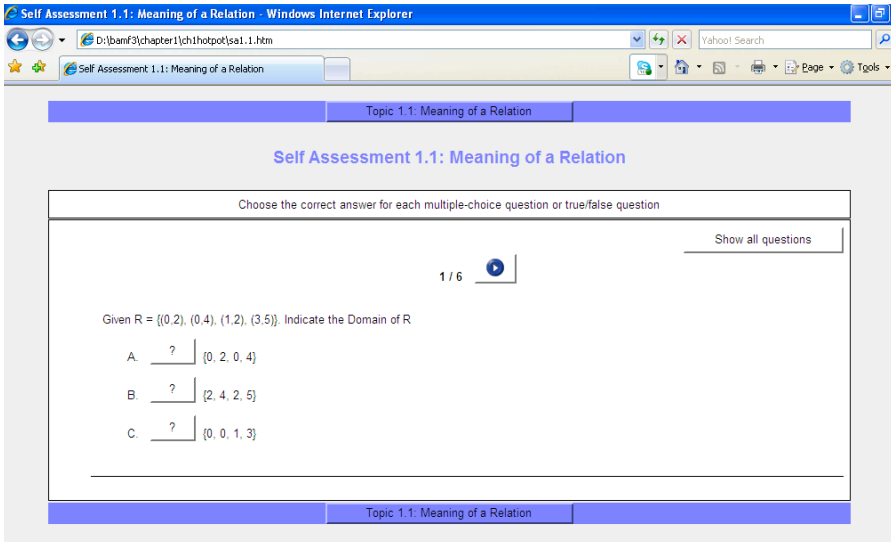
Figure 6.12: A Portion of Formative Assessment Object
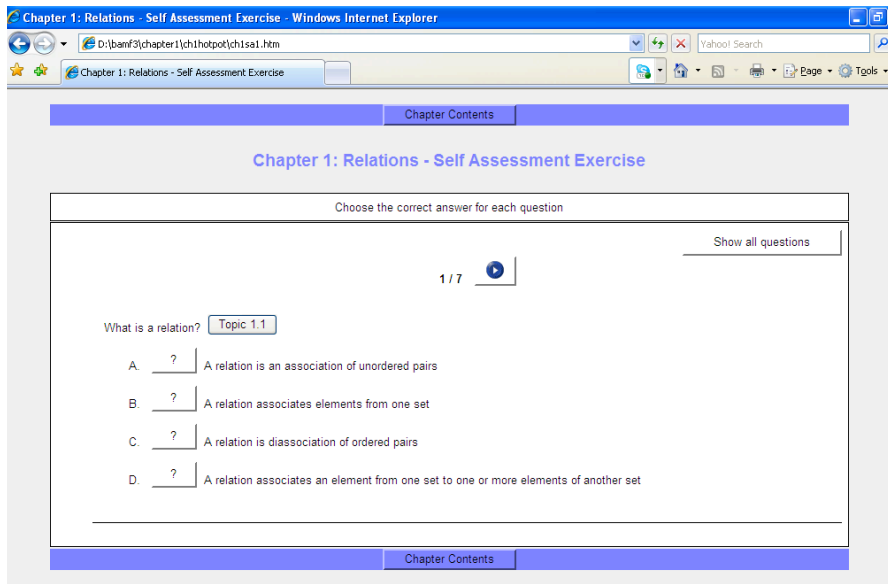
Figure 6.13: A Portion of Summative Assessment Object

6.5.3.1 Assessment Objects

Formative and summative assessments with prompt feedback were authored using the Hot Potatoes software package. The files for the assessment were separately saved in a folder named "hotpotatoes". An example of a formative assessment object is shown in figure 6.12.

Two view options are provided for the assessment object; either view questions one by one or view all questions. The multiple questions assessment has been designed to shuffle the order of questions and answers each time the page is loaded. In this case a link to topic 1.1 is provided to take users back to topic 1.1. Figure 6.13 shows a screenshot of summative assessment object. Button(s) to topic(s) for reference where necessary are provided beside each question. There is also two view options to view all questions or view questions one by one. A link to take users back to the chapter page is also provided. Assessment objects are titled accordingly to represent the topic they belong.

6.5.3.2 Animated Illustration Objects

Some of the animated illustration objects were authored using Adobe Flash CS4 software packages and saved into separate files in a Flash folder.
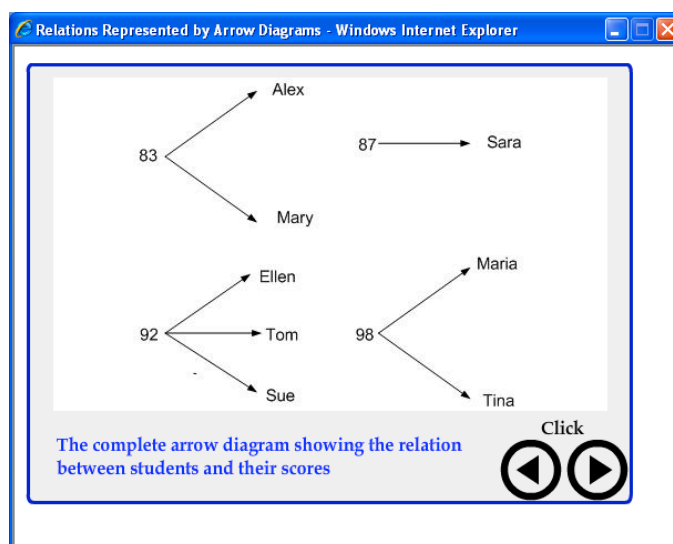
Figure 6.14: Sample of Animated Illustration Object

Animated illustrations were embedded in HTML files so that they can also be viewed by any web browsers. Each animated illustration is reached by a link from the main document where it belongs. Different controls were designed to animate an illustration. Figure 6.14 is a screenshot of animated illustration, illustrating a relation by arrow diagram. The animated illustration objects have been designed with some imbedded controls for students to activate the animation.

Animated audio and video illustrations were authored using camStudio screen capture package and saved in their respective folder. The audio/video clips were linked to the learning content using links with meaningful names. When the audio/video link is clicked it opens an audio/video clip in a pop up window. Figure 6.15 shows a screenshot of an audio/video clip played by windows medial player.
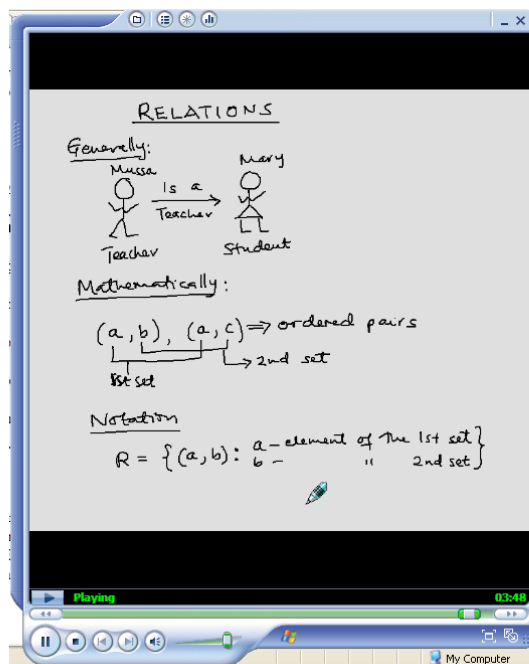
Figure 6.15: Sample of Animated Audio/Video Illustration Object

6.6   CREATING USER INTERFACES AND NAVIGATIONAL AIDS

The authored content described in section 6.5 formed either a web page or a section in a web page, resulting in the formation of various independent web pages and sections of web pages which needed to be interlinked to provide a coherent learning. Depending on the mode of delivery, for CD/DVD-ROM content delivery, design and development of user interfaces and navigational aids considered the top - bottom scenario. Navigational aids represent links and buttons which facilitate jumps within and outside the page in concern. In this case the home page is taken as the top page going further down to other pages as users navigate through the learning content.

On the other hand, if the delivery mode is through the TanSSe-L system or any other LMS, the structure of the home page should be in accordance to the readily available formats provided by the system. In the TanSSe-L system the arrangement of the home page has been designed to have one chapter per block and the navigational links follow what is provided by the navigation bar of the system, where necessary few links have been introduced to go back to the home page.

The user interfaces discussed in the following sections considered CD/DVD-ROM mode of delivery for the stand-alone e-Learning content. However, with little modifications user interfaces and navigational aids designed for CD/DVD-ROM mode of delivery can also be used for the LMS delivery if need be.

6.6.1   TanSSe-L CD/DVD-ROM Content Home Page

Figure 6.16 shows a designed structure for user interface and links for the TanSSe-L CD/DVD-ROM content home page. The Subject Composition page is shown in dotted line to indicate that it is not part of the home page.

The TanSSe-L content home page is the top most page which provides a passage to the CD/DVD-ROM contents. It has been designed with three links which are;

Enter which opens the door into the TanSSe-L content

Users' Guide link which opens a users' guide in a separate window and a

Quit which provides an exit from the TanSSe-L content
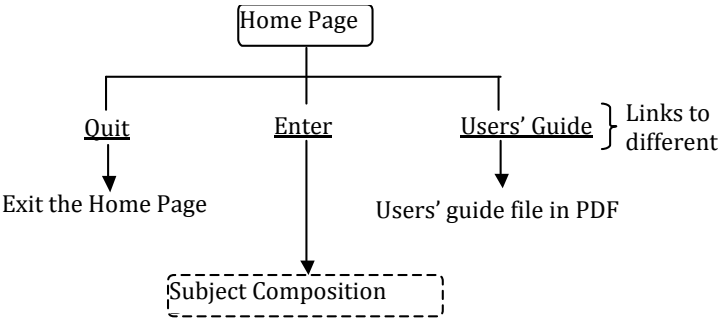
Figure 6.16: Logical Structure of TanSSe-L Home Page

A screenshot of the home page is shown in figure 6.17. The Home page has been designed to accommodate a welcoming note and three links Users' Guide, Enter and Quit to different destinations. The Home page also bears the subject identification title - Secondary Basic Mathematics Form Three and has been designed to display the contact address for any inquiries regarding the content.

6.6.2   Subject Composition and Syllabus Pages

Subject composition and Syllabus pages are intermediate pages placed between the Home page and the Subject content page. The Subject composition page is designed to be opened through the Enter link at the Home page. The Subject composition page is designed with a Syllabus button to open the Syllabus page. The Syllabus page is designed with a Subject content button to open the Subject contents page. The arrangement of these pages follows a top to bottom order aiming at self directing users on how to reach to the learning content. Figure 6.18 shows links structure for the intermediate pages.
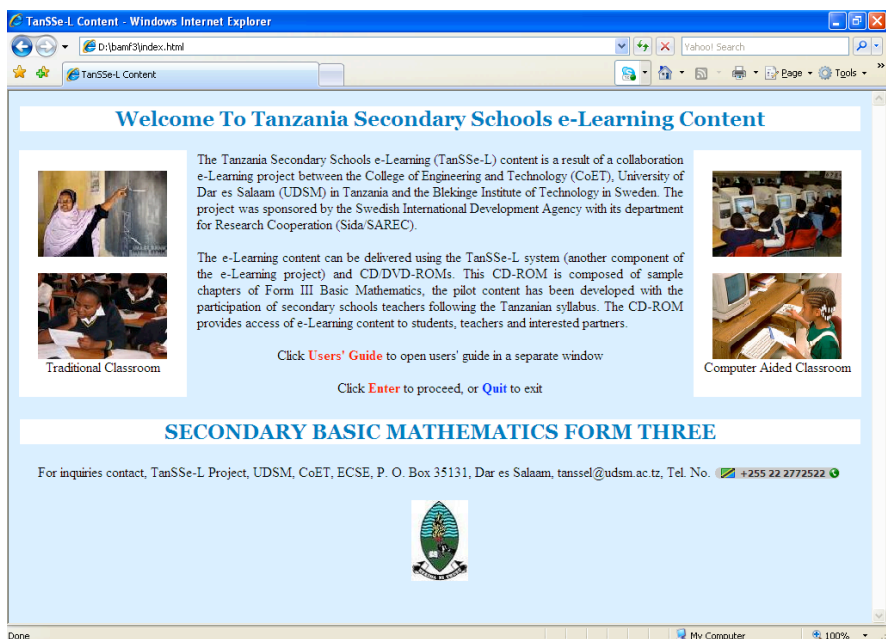
Figure 6.17: User Interface for Home Page
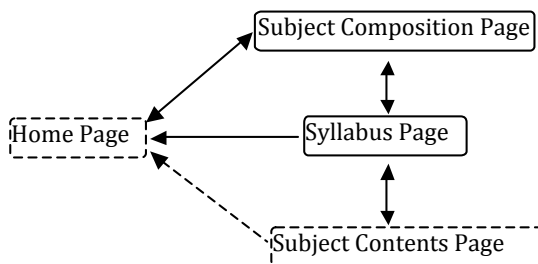
Figure 6.18: Links Structure for Intermediate Pages

Figure 6.19 shows the Subject composition page user interface which is composed of three buttons Home, Syllabus and Print. The Home button links back to the Home page. The Syllabus button facilitates a link to the Syllabus page and the Print button activates the printing functionality. The Subject composition page informs users on what the subject is composed of and also bears the subject identification title – Basic Mathematics Form III.
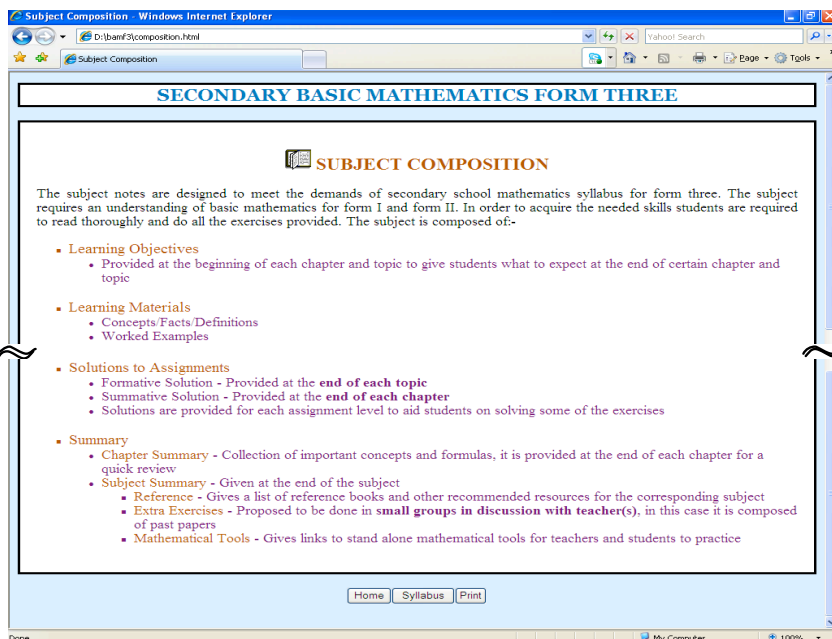
Figure 6.19: A portion of Subject Composition Page
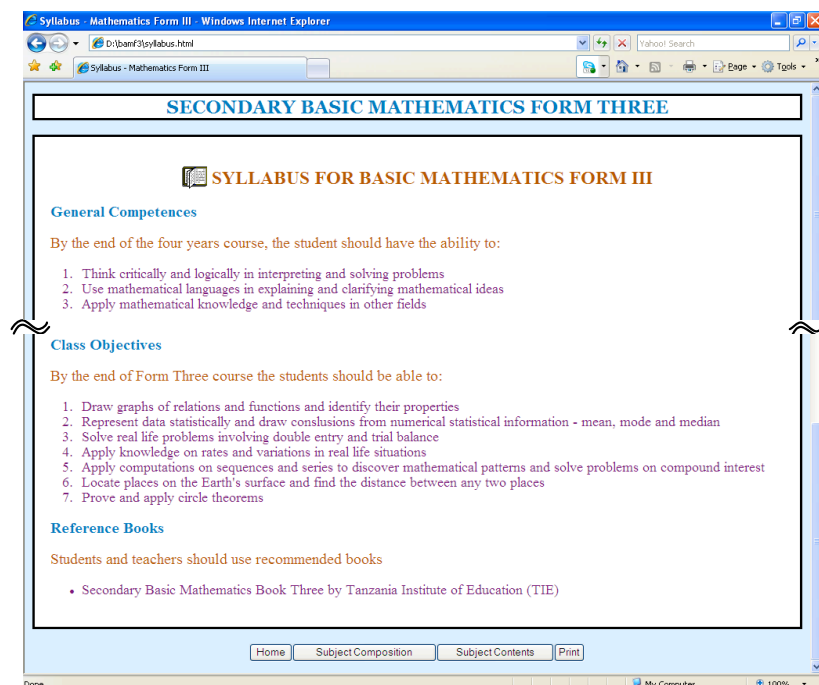
Figure 6.20: A Portion of Syllabus Page

Figure 6.20 shows the user interface for the Subject syllabus page, it is composed of Home, Subject composition, Subject contents and Print buttons. The Home button provides a link to the Home page. The Subject composition button takes users back to the Subject composition page. The Subject contents button facilitates a link to the Subject content page and the Print button facilitates the printing functionality. The page also bears the subject identification title – Basic Mathematics Form III.

6.6.3   Subject Content Page

The links structure at Subject content page is shown in figure 6.21, it is also considered as the subject container designed to accommodate links to different chapters and subject summary within the subject. Each link in the Subject contents page is designed to open in separate window.
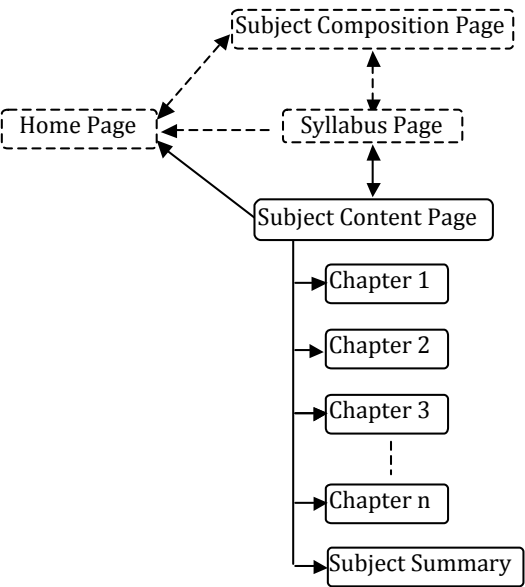
Figure 6.21: Links Structure at Subject Contents Page

The subject content page is also designed to have links to Syllabus page and Home page. In figure 6.21 the portion which is drawn with dotted lines is not part of the Subject content page but has been included to give a clear connection of the Subject content page from the Home page. Chapter n is considered to be the last one in the series of chapters in the respective subject.

The screenshot of the Subject content page is shown in figure 6.22. The Subject content page provides links to different chapters through chapter titles, and a link to Subject summary page. The Subject content page serves as a table of contents for all chapters and bears the subject identification – Basic Mathematics Form Three. The

Subject content user interface is designed with three buttons, Syllabus button to link to the Syllabus page, Home button to link to the Home page, and Print button to facilitate printing functionality.
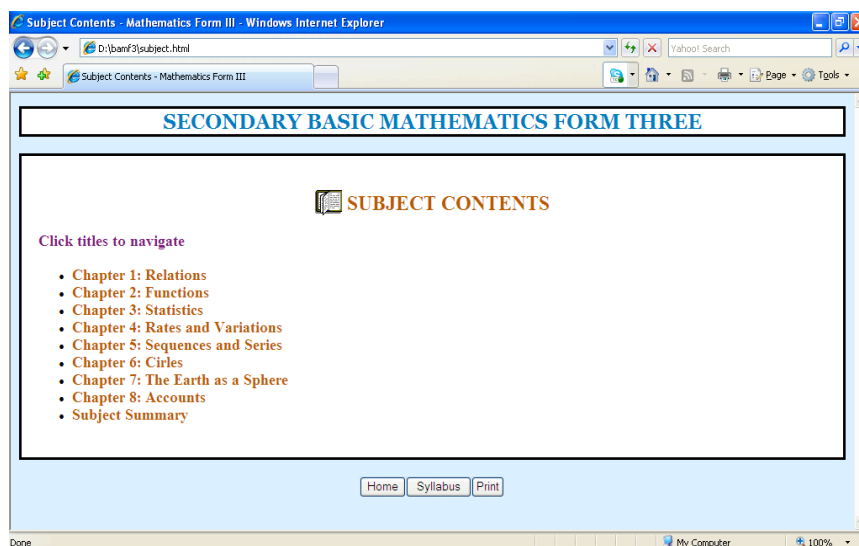
Figure 6.22: Subject Contents Page

6.6.4   Chapter Page

The link structure at Chapter page is shown in figure 6.23. The page is designed to accommodate links to all developed chapters, formative assessments, formative assignments, solutions to formative assignments and the subject summary. The nth letter stands for the last developed item at topic level, assessment or assignment. The portion of dotted line pages is not part of the chapter page.

The chapter page user interface is shown in figure 6.24. The interface is designed in such away that when the page is loaded on a web browser it displays the subject's full name, chapter definition (chapter number and chapter title) and the links to different pages. The user interface at the chapter level serves as a table of contents for all the contents that are accommodated in the respective chapter. The links are designed to open in separate windows.
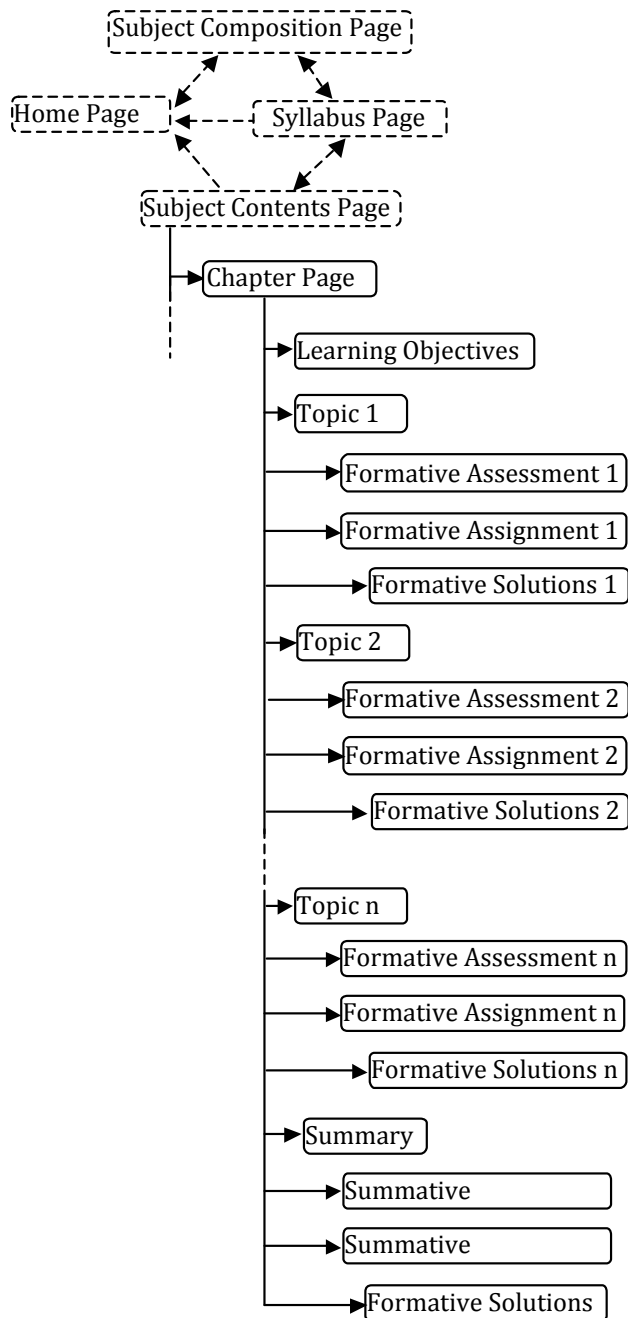
Figure 6.23: User Interface and Links Structure at Chapter Level
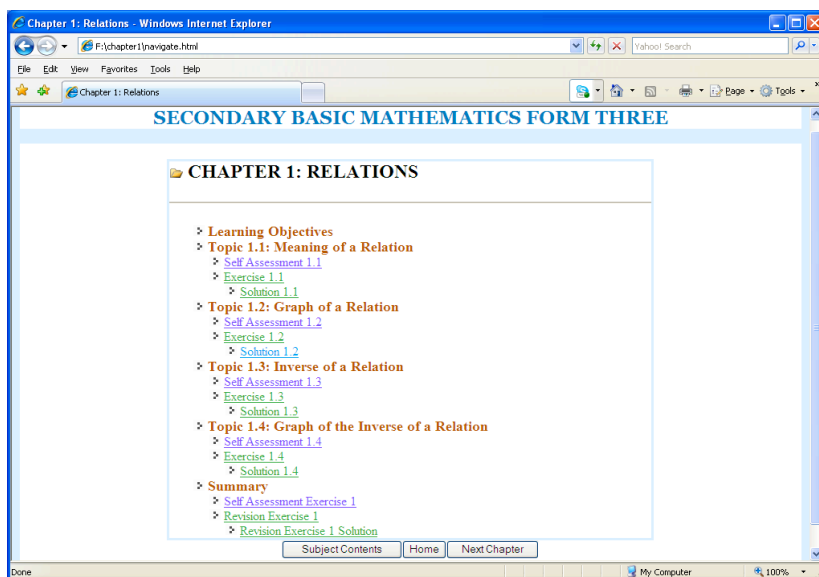
Figure 6.24: Chapter Page and Its contents

The Chapter page is designed with three buttons, Subject contents to take users back to the Subject content page, Home to take users to the Home page and the Next chapter button to open the next chapter page. In this particular case the next chapter is chapter 2. All chapter pages have similar design.

6.6.5   Topic Page

The user interface and navigational aids at topic level are designed to jump to the learning materials within and outside the topic. Figure 6.25 shows a screenshot of a portion of a topic page user interface, the topic page is identified by the topic number and the corresponding title. When the Topic page is opened it has been designed to display contents within the topic and related content outside the topic with the use of navigational aids. All topic pages have the same design, illustration links are optional and change depending the need. The following is the description of links/buttons in the Topic page when clicked;

- Link 'Worked Example' :- Jumps to the beginning of the worked examples within the topic

- Link 'Chapter Contents':- Opens Chapter contents page

- Link 'View Illustration:- Practice on Pictorial Representation' (Optional Link):- Opens an illustration in a separate window

- Link 'Domain and Range of a Relation' (Optional Link):- Opens an illustration audio/video clip in a separate window

- Button 'Top': Jumps to the beginning of the Topic page

- Button 'Self Assessment 1.1':- Opens formative assessment page i.e. Self Assessment 1.1
- Button 'Example 1.1':- Opens formative assignment page i.e. Example 1.1
- Button 'Topic 1.2':- Opens next topic page i.e. Topic 1.2
- Button 'Chapter Contents':- Opens the Chapter contents page
- Button 'Home':- Opens the Home page
- Button 'Print':- Facilitates the printing functionality

Figure 6.25: User Interface for Topic Page

6.6.6 Navigational Aids

Linking from one page to another or a jump within the page is made possible with the use of links and buttons which are clearly labeled to indicate the destination pages or places. Examples of meaningful link names used to aid navigation are "Worked Examples", "Chapter Contents", "Domain and Range of a Relation". Similarly some of the meaningful labels used for buttons are "Top", "Chapter Contents", "Print", and "Home".

6.6.7 Look and Feel

The content has been designed using different media types and colours. The emphasized content is identified by a different background colour. Links are designed with either a hover or underline behaviour as a mouse over action and designed to change colour when visited. Titles on the subject and chapter pages have been designed to change colour and/or become underlined with a mouse over action and when clicked. Sections in a topic are distinguished by coloured horizontal lines, and different coloured title backgrounds.

6.6.8 Extracted XHTML Structures used for Authoring LO

The following discussion is based on extracted XHTML structures used for authoring a sample LO of topic 1.1. The structures should be flexible to be adopted in CD/DVD-ROM and TanSSe-L delivery modes.

6.6.8.1 The <!DOCTYPE> Declaration

An XHTML document type (doctype) declaration is used to officially state which version and XHTML compatibility level is used for the web page. It should be the first line in an XHTML document and declared in every web page. The doctype declaration refers to a Document Type Definition (DTD) which specifies the rules for the markup language, so that the browsers can render the content correctly.. (HTML Reference, 2007). Sample of doctype declaration is shown in listing 6.1.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
```

Listing 6.1: The Doctype Declaration

6.6.8.2 Start and End of the XHTML document

The XHTML document starts with the root html tag <html xmlns=http://www.w3.org/1999/xhtml> and ends with the html tag </html>.

```
<html xmlns="http://www.w3.org/1999/xhtml">
..............................................................
..............................................................
..............................................................
</html>
```

Listing 6.2: The Root HTML Tag and its Closing Tag

The XHTML document must contain an xmlns attribute to associate it with XHTML namespace. Listing 6.2 shows the root html tag and its closing tag.

6.6.8.3   The Head and Body Sections

Within the root html tag and its end tag, the document is divided into two sections the head and the body, each enclosed in its start and end tags as shown in listing 6.3.

```
<html xmlns="http://www.w3.org/1999/xhtml">

    <head>
        ..........................................................
        ..........................................................
    </head>

    <body>
        ..........................................................
        ..........................................................
    </body>

</html>
```

Listing 6.3: Head and Body Sections of an X/HTML Document

6.6.8.4   Contents of the Head Tags

The <head> tag encloses other tags like <meta>, <title>, <link>, and <script>. XHTML files, along with any other text files, are saved using a particular character encoding. For the browser to display the web page content properly, it is always advised to explicitly declare the encoding used in the web page in the <meta> tag. XHTML requires that character encoding is declared if it is anything other than the default Unicode Transformation Format, UTF-8 or UTF-16 encodings. W3C highly recommends the use of UTF-8 whenever possible since it is multilingual and is the recommended character set on the internet. The <link> and <script> tags provide reference to a stylesheet file for content presentation and JS file for interactivity respectively. The <title> tag gives the title of the document. The head tag and its contents are shown in listing 6.4.

```
<head>
 <meta http-equiv="Content-Type" content="text/html; charset=iso-8859-
1" />
 <title>Math FormIII Chapter1 Topic 1</title>
 <link href="chapter.css" type="text/css" rel="stylesheet" />
 <script src="chapter.js" type="text/javascript"></script>
```

Listing 6.4: The Head Tags and Sample Contents

6.6.8.5   Body Tags and Sample Contents

The body tags enclose all the contents which are viewed by the user using a browser. Listing 6.5 – Listing 6.7, show different parts of the body as extracted from different view points.

- *The body – Topic Identification, Learning Objectives and Links*

Listing 6.5 shows some portions in a web page like Topic heading, a list of learning objectives and links. The heading given by the <h1>…</h1> tags is clearly described by the topic number and title. Learning objectives are given by unordered list <ul> tags. Links to a place inside the document and outside the document were formed by the … tags with “href” attribute referencing to “#work” for the internal link and to “navigate.html” for the external link to a mentioned destination. In this case, links are identified by meaningful names like, “Topic 1.2 Graph of a Relation”, so that when this link is clicked the content of the said topic must be displayed to the user.

```
<body>
………………………………
<div class="maindiv">
 <h1 class="h1topic">
   <span class="h1topic">
        <a name="top">TOPIC 1.1: MEANING OF A RELATION</a>
   </span>
 </h1>

<h4 class="objlink">Learning Objectives</h4>
   <p><strong>At the end of this topic students are expected to be able
to:</strong></p>
   <ul type="square" class="h1obj">
     <li>Define relations</li>
     <li>Find relations between two sets</li>
     <li>Demonstrate relations pictorially</li>
     <li>State domain and range of a relation</li>
   </ul>

<table class="menudiv" >
<tr>
      <td><a href="#work" class="link1" title="Worked Examples">Worked
        Examples  |</a></td>
      <td><a href="navigate.html" class="link1" title="Chapter
Contents">Chapter
        Contents</a></td>
</tr>
</table>
…………………………………………..
</div>
</body>
```

Listing 6.5: The body – Topic Identification and Top of the Page Links

Listing 6.5 also shows the use of other tags like <div>…..</div> for identifying a section which can be formatted accordingly to suit users needs. Paragraphs are denoted by <p>…</p>tags, table denoted by <table>…</table> tags, rows of the table are denoted by <tr>…</tr> and <td>…</td> tags for table columns.

- *The body – Images and Illustration Links*

Listing 6.6 show another section of the body with images and illustration links. An image is embedded by tag and "src" attribute to show the path of the image. Image attributes like ALT, TITLE must be filled with text to increase their accessibility. The image should be titled and numbered as in the example it shows "Figure 1.1a: Arrow Diagram Illustrating the Relation".

```
<body>

…………

<p class="pimage">
        <img src="ch1image/fig1-1.gif" width="482" height="341" alt="Relation
        in Arrow Diagram" class="image" title="Relation in Arrow Diagram"
        /><br />
                <br />
        Figure 1.1a: Arrow Diagram Illustrating the Relation</p>


<a href="ch1audio/relat3.avi" title="Relation Defined">
        <img src="../image/play.gif" alt="play" width="29" height="33"
        align="absmiddle" /> Definition of a Relation 
        <img src="../image/speaker.gif" alt="speaker" width="29" height="32"
        align="absmiddle" />
</a>

<p>
        <a href="illust1.1.html" class="illustrate" title="Arrow Diagram
        Representation"onclick="window.open('illust1.1.html','popup','width=60
        0,height=450,scrollbars=no,resizable=no,toolbar=no,directories=no,locati
        on=no,menubar=no,status=no,left=0,top=0'); return false">View
        Illustration - Arrow Diagram Representation</a>
</p>
……………
 </body>
```

Listing 6.6: The body – Paragraph, table and image

Listing 6.6 also shows how the link tag … with href attribute can be used to insert an illustration in the form of audio/video and also how to include an illustration object in Flash format in an XHTML page, the href tag locate the path of file.

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- *The body – Buttons at the bottom of the page*

Listing 6.7 shows a portion of bottom of a page containing one internal link and six external links, the links are through buttons with meaningful names. The internal link is named "Top" jumps to the beginning of the page when clicked. External links go to different windows or open different windows as indicates by the button name. Example windows opened by external links are self assessment - a formative assessment, formative exercise, previous/next topic, chapter page, Home page, and Print.

```
<body>
…………………..
…………………
<button class="link1" onclick="window.location.href='#top1.1'">Top</button>
<button class="link1"
onclick="window.location.href='ch1hotpot/sa1.1.htm'">Self Assessment
1.1</button>
<button class="link1" onclick="window.location.href='ex1.1.html'">Exercise
1.1</button>
<button class="link1" onclick="window.location.href='top1.2.html'" title="Graph
of a Relation" >Topic 1.2</button>
<button class="link1" onclick="window.location.href='navigate.html'"
title="Chapter Contents">Chapter Contents</button>
<button class="link1"
onclick="window.location.href='../index.html'">Home</button>
<button class="link1" onclick="window.print()">Print</button
………………
……………..
</body>
```

Listing 6.7: The body – Buttons at the bottom of the page

6.7   PLATFORM AUTHORED e-LEARNING CONTENT

Learning platforms like Moodle can use the content which has been authored within the platform itself and/or uploaded from other authoring environments, websites, and repositories. In the case of e-Learning project for secondary schools in Tanzania, the Moodle platform (TanSSe-L system) has been customized to facilitate the management of the learning content and users. The following sections cover an overview of the Moodle platform with respect to e-Learning content development (Rice, 2006).

6.7.1   Moodle Architecture and Philosophy

Moodle works best when it runs on a LAMP environment, but it can be run on any web server that supports PHP and a database. Moodle supports the social constructionist learning style which believes that people learn best when they interact with the learning material and other students using the learning material. However, Moodle does not impose on the developer to use this pedagogy for content development.

6.7.2 Moodle Content Authoring, Hosting and Delivery

Moodle has six (6) standard types of course formats which are Learning Activity Management System, SCORM, Social format, Topics, Weekly and Weekly (CSS/no tables). Moodle categorizes learning materials into two major groups which are resources and activity

- *Resources* – these are course materials that a student views or reads, and an item that a student views but doesn't interact with e.g. a text page or a web page.

- *Activity* – an item which students interact with like assignments and quizzes.

Moodle is capable of hosting and delivering learning material to the intended learners. Moodle provides WYSIWYG editor for content development. The editor uses XHTML 1.0 at the background to support XHTML content authoring and can be switched to code view if coding is necessary. The editor also provides an insert feature for inserting images if required.

Resources and activities authored outside Moodle can be uploaded to Moodle directly when creating a course. Moodle also facilitates linking to files outside Moodle, e.g. a link to a file in a repository or a link to a web page. On the activities side, Moodle provides templates for different types of questions like true-false, multiple choice, matching exercises and it is also possible to mix them in the same quiz, on to create a questions bank. Moodle has a flexibility of doing activities and assignments online or offline and answers uploaded to the system for grading.

6.8   TanSSe-L CONTENT TESTING

TanSSe-L content went through unit and units' integration testings for accessibility and effectiveness if complied with design's functionalities. Usability and utility are equally important since it matters if the contents are easy to work on but do not meet users' needs or the contents meet users' requirements but cannot be easily accessed due to inappropriate interface.

6.8.1   Unit Testing

TanSSe-L content is a collection of various web pages. The purpose of unit tests was to evaluate individual web pages if met design specifications. Tests on pages, links, navigation buttons, and animations were conducted in each topic of the first chapter and then on the complete chapter in order to have an effective and efficient content structure. Since the structure of all chapters had to be consistent, unit testing was necessary to identify and rectify mistakes encountered in the first chapter so that could not be repeated in the rest of the chapters.

The results of unit tests indicated the changes that needed to be made in codes to produce desired outputs. Unit tests also helped in rearranging different assets inside

the learning objects and checking the links and navigational aids for continuity. For a developer, it is so important that testing should be done frequently in the development phase in order to fix any bugs in the individual parts before integration, otherwise the tests become more complicated in the integrated system. Unit test represents the most practical design possible and is the basis for the quick production of any software product (Akpinar et. al., 2004).

Unit tests were conducted immediately when coding of different parts started. The tests were conducted in three environments which were the Dreamweaver development environment, the WAMP testing environment and the LAMP publishing environment. The tests carried out were content validation, links and navigation test, browser tests and e-Learning content general appearance. The following description gives details of the unit tests conducted.

6.8.1.1   e-Learning Content Validation

Validating the e-Learning content against known standards is advised in order to have a quality product. Once the doctype declaration has been declared at the top of the web page, the page can be validated using an XHTML validator to determine if the code used conforms to the rules outlined by the W3C. An XHTML validator, a free tool from the W3C was used to ensure that codes used for the e-Learning content conformed to the standards. The XHTML standards are guided by the W3C which develops interoperable technologies (specifications, guidelines, software and tools) so that the web page is used to its fullest potential. Validation is one of the effective means to check whether a web page has been built in accordance with web standards, and it eases maintenance (W3C, 2004-2009). In this research, the TanSSe-L content validation test was done using an XHTML validator. Examples of mistakes that were found and rectified were missing closing tags, missing ALT attributes, and use of deprecated tags like the <marqee>…</marqee> tag.

6.8.1.2   Navigational Aids Tests

Links and buttons were tested within and outside the topics for continuity and desired destinations. Link properties like link colour, link visited and link hover were also tested to see if they responded as programmed. Links and navigational aid labels were checked to see if they had meaningful names and navigated to the destined locations, positioning of links and navigational buttons were also looked upon. TanSSe-L content links and buttons tested okay though some were rearranged and/or renamed for better results.

6.8.1.3   Animated and Audio/Video Content Test

Animated content of some of the illustrations designed using the Flash software package, and self assessments exercises designed by the hot potatoes software package were tested to make sure if they were working properly, and if links to and from the animated content behaved as desired. Similarly, audio/video content clips were tested for proper functioning. It was noted that animated and audio/video content files must not be very large as they occupy a lot of memory and may consume time while accessing them.

6.8.1.4   Browser Tests

The e-Learning content was tested for two browsers, the Internet Explorer 7 and Mozilla Firefox 3.1. It was noted that both browsers responded well to the display of the learning contents. The tests were done for screen resolutions of 1024 x 768 pixels which rendered very good results, and for 800 x 600 pixels which resulted in a bit blurred output.

6.8.1.5   e-Learning Content Presentation

The general appearance of the content was tested in terms of the usage of colours, fonts, alignment of text, tables, figures, and equations and was modified if did not have the desired look and feel. The CSS and JS files were adjusted to get the desired appearance and some interactivity.

6.8.2   Units Integration Testing

At this point, the units (topics) which were tested in the unit tests were integrated and formed chapters. The test focused on functionality and usability of the e-Learning content at different levels, the LOs, chapter and Subject. All links and navigational aids were tested for continuity and desired destinations. User interfaces were also tested to ensure that they gave effective guidance on how to access the e-Learning content. These tests were conducted in the Dreamweaver development environment, the WAMP testing environment and the LAMP publishing environment. The units integration test is a very important step since all bugs due to integration are captured and fixed before releasing the prototype. Most of the bugs were cleared during unit testing, units integration testing also checked on pedagogical effectiveness of the TanSSe-L content and use cases if functioned as expected.

6.9   CONCLUSION

Developing e-Learning content is not an easy task. It involves skills from various disciplines, the ID and SE methodologies. It is important to be aware of the multiple ranges of skills required when choosing a methodology as there are many inherent complexities in the development of educational products.

The development methodology opted by this research was the one that combined educational discipline (instructional design), technological discipline (software engineering) with user participation. The ID guided the process and defined the instructional strategies, and SE aided LO authoring in response to the requirements from the analysis and design phases which were then streamlined into the design specific using object oriented modelling. Since e-Learning content is a software product, the use of SDLC in the development phase ensured that the development of e-Learning content covered all the steps needed to be taken for a quality product. Unit testing and units integration testing is one of the SE stages to ensure that all bugs are removed before the TanSSe-L content is taken to the users.

In developing contents the issue of delivery mode has to be taken into consideration. To avoid barriers posed by different delivery modes, web-based technologies have been used in this research for developing the TanSSe-L content. Web-based content can be delivered through CD/DVD-ROMs or an LMS and in this research through the TanSSe-L system. Web-based contents can also be packaged using IMS packaging specification for easier transfer into different LMSs for delivery. One of the advantages of using delivery medium like LMS which have also been discussed in this research, is the ability of teachers to develop and upload their own content if need be.

The CEM used is complete and emphasized quality assurance and its ability to integrate instructional and technical activities into a single methodology by combining in a systematic way the qualities of ID and SE. The use of the triple helix approach which involved the participation of stakeholders and the mode 2 knowledge production concept were important in taking on board users' concerns in the process TanSSe-L content authoring.

CHAPTER 7
TanSSe-L CONTENT IMPLEMENTATION

e-Learning content implementation is concerned with those tasks leading immediately to a fully operational system, which means placing the completed and tested system of hardware and software into the actual work environment of the users. The actual tasks performed during the implementation phase vary from project to project and there is no general consensus on this. Sometimes system testing is also considered part of the implementation process. Even acquisition of hardware, and software, and site preparation is considered to be under the umbrella of implementation.

The implementation phase was also concerned with e-Learning content delivery. As mentioned earlier, many methods are used to deliver e-Learning content. Web-based, CD-ROMs, LMSs, and television are some common delivery methods (Porter, 1997). e-Learning content can also be delivered using a combination of two or more delivery methods. Activities which were carried out in the implementation phase as regards this research are discussed below.

7.1   TanSSe-L CONTENT PACKAGING AND STORAGE

Content packaging and storage refers to the process of preparing e-Learning content for delivery. The starting point is always where the content was developed, in this case in the development folder (see section 6.5.1). Depending on the delivery mode used, there are different paths to take regarding packaging and storing. The TanSSe-L content from the development folder may be:-

- Saved on a client's computer and used directly with an internet browser
- Burnt on to a CD/DVD-ROM
- Zipped and uploaded to the TanSSe-L system
- Packaged using standard content packaging tools then upload to the LMS or alternative storage medium (repositories and CMSs)

The research used CD/DVD-ROMs and the TanSSe-L system modes of delivery. The description covers all options, except for content stored in the development folder which was explained during TanSSe-L content development.

7.1.1 CD/DVD-ROMs TanSSe-L Content Packaging and Production

There are number of reasons for using CD/DVD-ROMs for storage. It is a very convenient and cheap form of backing up the content material. CDs have multimedia capacity and they are platform independent. CD/DVD-ROMs offer much faster content uploading than Internet access and can be used in the absence of a network or server (Lating, 2009). CD/DVD-ROMs are one of the convenient means of transporting e-Learning content hence useful for rural schools. However, there is a significant disadvantage in using CD/DVD-ROMs to store content if the content needs frequent modifications. The cost of updates may be higher than the value of content housed in a centrally located web server (Mashinter et al., 1997).

Depending on the size (MB) of the content, e-Learning content can either be stored on the CD-ROM or DVD-ROM. DVDs have higher memory capacity than CDs. The storage capacity of the most common size of a CD-ROM is 700 MB, the range being 650MB – 850MB. The most common size of a DVD-ROM is 4.7 GB ($\approx$ six times the storage space of a CD-ROM). It should also be noted that DVD-Drives read both DVDs and CDs, but CD-Drives read only CDs.

CD-ROM TanSSe-L content packaging and storage involved arranging and integrating the learning material from the development folder. Some modifications of the web-based contents must be done to suit CD-ROM delivery (Microsoft Corporation, 2001). The changes included modifications in the doctype declaration for the home page (the index file), addition of an autorun.inf file, and inclusion of a startup.exe application program for making autorun CD-ROM. Logical connection of Home page, Subject composition page, Syllabus page, Subject content page and the rest of the learning content and some consideration was given to the relative links.

7.1.1.1 DOCTYPE Declaration of the Home Page

The home page designed and developed in section 6.6.1 must be saved with a name index.html to make it the first page to open when the CD-ROM is inserted in the C-ROM drive.

The DOCTYPE declaration designed for the web content has a reference to the Internet on the url http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd (see

Listing 7.1). To avoid the CD-ROM content referring to the internet, the DOCTYPE was changed as shown in listing 7.1.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" >
```

Listing 7.1: Doctype Declaration Excluding the Reference to the Internet

7.1.1.2 *Autorun.inf File*

The autorun.inf file is responsible for the auto-run functionality of the CD-ROM. This file must be added to the root of the CD-ROM before burning the content on to the CD-ROM.

In this research, the autorun.inf file created by the notepad program was added to the root of the development folder. The autorun.inf file was programmed to look for the setup.exe application program which internally looks for index.html file (Home page) when the CD-ROM is inserted in the CD-ROM drive. If in some cases the auto-run functionality is not required, then there is no need for the inclusion of the autorun.inf file and in this case users initially browse the CD-ROM content using the Windows explorer not the web browser looking for an index file.

7.1.1.3 *Logical Connection of Intermediate Pages*

Intermediate pages are those web pages which fare placed between the Home page and the learning content. These pages are Subject composition, Syllabus and Subject content (see sections 6.6.2 – 6.6.3). The logical connection between intermediate pages must be established so as to bridge the Home page and the learning content. This has been accomplished by the use of buttons linking from one page to another in a top-bottom approach. The Subject composition page in this research has replaced the normal use of the "Readme" file by providing some useful information regarding contents in the CD-ROM.

7.1.1.4 *Relative Links Consideration*

Links for the contents of the CD-ROM were made relative to the respective files, they contained only partial path and file name, there was no a link with "http://" or "servername/" or "drivename/" in the relative links. The use of relative links improves portability for web pages on the Internet, hard disk and on CD-ROMs. Listing 7.2 show some examples of relative links used in the research.

```
<a href = "topic1.html">Topic 1: RELATIONS</a> Example 1

<link   href="../cssjs/chapter.css"   type="text/css"   rel="stylesheet"   />
Example 2

<p  class="pimage"><a  href="../index.html"><img  src="../image/home.gif"
alt="home" /></a></p>   Example 3
```

Listing 7.2: Examples of Relative Links

With relative links it is easier to test the work offline straight from the hard drive and move the entire site from the local server (hard drive) to a CD, knowing that the site will still work. On the other hand, an absolute link defines a specific location of the web file or document including the protocol used, the name of the server to get it from and the directory it is located in as given in following example.

....

Absolute links are mostly used for accessing pages outside the home website (local site) or current directory, and relative links are used with pages created within the same home website. Relative links may need to be updated if the websites's structure is changed, for instance if a directory is renamed (Motive, 2000 – 2009).

7.1.1.5   Production of TanSSe-L Content CD-ROM

Content from the development folder can be copied to the CD/DVD-ROM using CD-burner software. The process of copying the contents to the CD/DVD-ROM is known as burning the CD/DVD -ROM. The CD-ROM must then be tested for auto-run and accessibility of its contents before producing more copies. If the CD-ROM tested okay then CD-ROM production can take place, otherwise another attempt of CD-ROM burning must be made. In this research, Nero burner software was used to burn the master CD-ROM and for the production of other copies after obtained a functional copy.

7.1.2   Package for TanSSe-L System Delivery

LMSs can use content from different sources, content stored in a computer hard disk or other removable disks, content directly authored within the system itself, content stored in repositories, content stored in CMSs and from other websites. Content responsible for the TanSSe-L system was developed and saved in the development folder bamf3lms. Figure 7.1 shows a screenshot of TanSSe-L content for TanSSe-L system delivery, the left panel shows the selected folder bamf3lms and the right panel shows contents of the selected folder bamf3lms. Some pages have been left out and modifications have been made to some of the pages in the development folder bamf3 and saved into development folder bamf3lms to suit the TanSSe-L system delivery.
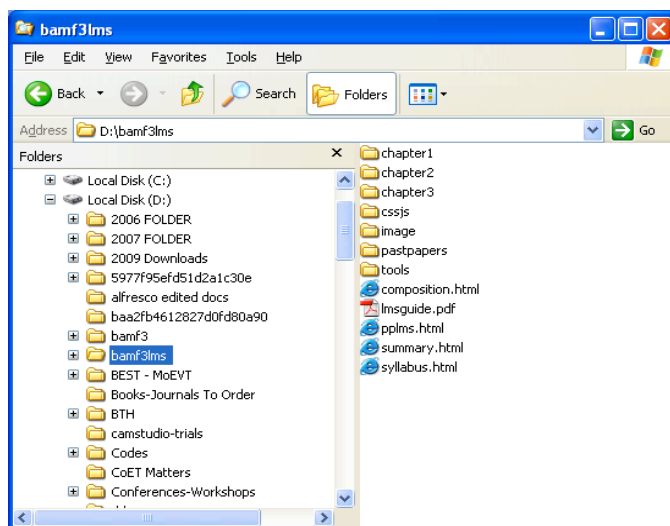
Figure 7.1: Content Development Folder for TanSSe-L System Delivery

The chapter pages, Index page and Subject content pages from the development folder bamf3 have not been considered for TanSSe-L content in the development folder bamf3lms since they were not needed for the TanSSe-L system delivery.

7.1.2.1   *TanSSe-L Content Modification for TanSSe-L System Delivery*

Most of the pages in development folder bamf3 were interconnected to create navigation through pages. In this case, navigational aids external to main pages were removed in order to be able to adopt the navigation provided by the TanSSe-L system.

Internal navigational aids provided by the buttons labeled "Top", "Worked Examples" and "Print" were not removed from the pages. The modified pages were Subject composition, Syllabus, Summary and pplms (for Extra exercises).
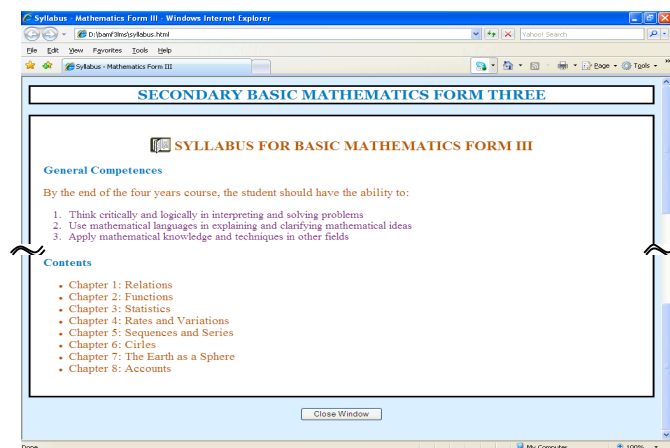
Figure 7.2: Modified Syllabus Page for TanSSe-L Delivery
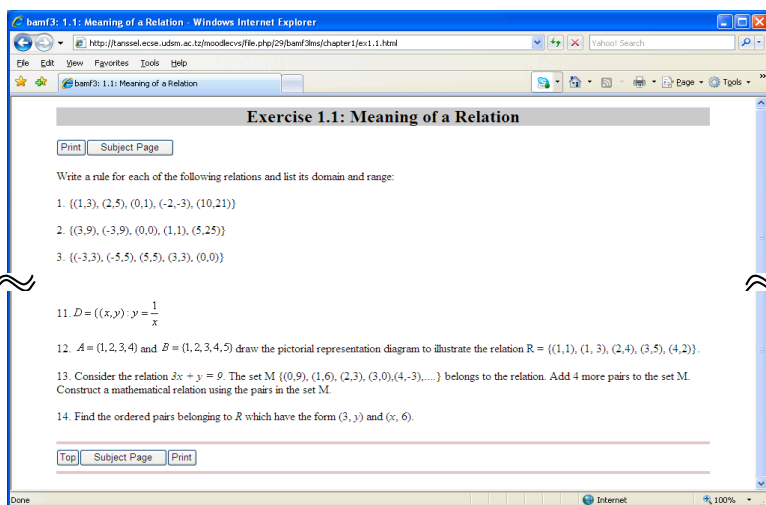
Figure 7.3: Modified Topic Page for TanSSe-L Delivery

A "Closed Window" button was introduced to the modified pages to facilitate a close window function when clicked. A syllabus page was further modified to accommodate a list of chapters for the TanSSe-L content. Figure 7.2 shows a screenshot of a modified Syllabus page.

Topic, format assignment/assessment, summative assignment/assessment, solutions to assignment pages were also modified by removing external links. A button labeled "Subject Page" was introduced into formative and summative assignments pages to facilitate navigation to the subject home page since these pages were designed to open on a separate window hence lose track of the TanSSe-L system navigation bar. Figure 7.3 shows a screenshot of a modified Topic page.

7.1.2.2 *Uploading TanSSe-L Content into TanSSe-L System*

The modified e-Learning content pages prepared for TanSSe-L delivery and stored in the development folder were zipped before uploaded to the TanSSe-L system. This was done in order to simplify the work of uploading files/folders in a bulky form from the development folder. If the TanSSe-L content had been just few web pages, the files could have been uploaded directly to the TanSSe-L system without being zipped. Figure 7.4 shows a screenshot of a subject page without any materials, a "Files" folder for storing the content is highlighted and "Turn editing on" button has been clicked.

The TanSSe-L system categorizes the learning contents into two groups which are resources and activities. Figure 7.4 shows that the subject page is divided into several blocks which are numbered 1, 2, 3 etc, each block has two combo boxes one for adding resource "Add a resource" combo box and one for adding an activity "Add an activity" combo box.
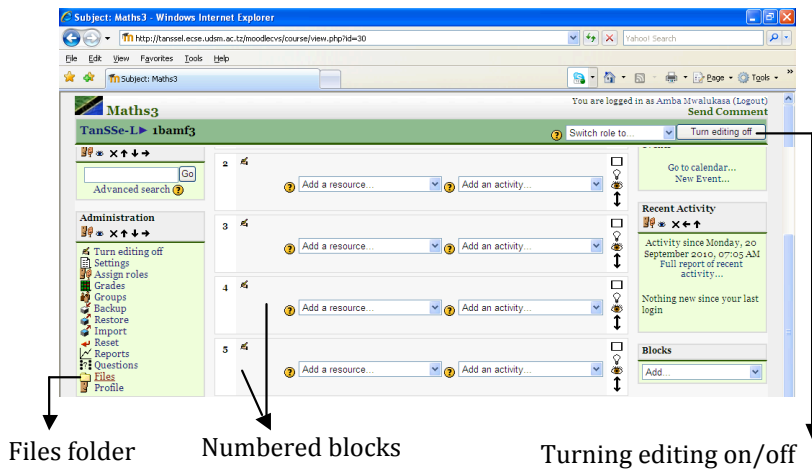
Figure 7.4: Sample of Subject Page without Learning Materials

Steps which were followed in the process of uploading TanSSe-L content to TanSSe-L system;

• Zip the development folder, for simplicity the zipped file name was the same as the name of the development folder (bamf3lms.zip)

• Login into the TanSSe-L system as an administrator, click the "Turning Editing On" button to be able to work with the system

• Add subject category and subject if are not present, else click the subject to open the subject page

• On the administration block of the subject, click "Files" folder and upload the zipped file

• Unzip the zipped file, a folder with the same name as the zipped file was created in the subject "Files" folder with all the contents of the zipped file

At this point all contents will be stored in the "Files" folder of the subject within the TanSSe-L system and can be easily accessed whenever required. Figure 7.5 shows a screenshot of the "Files" folder with its contents, the zipped file bamf3lms.zip uploaded from the development folder and the unzipped content in the folder bamf3lms.
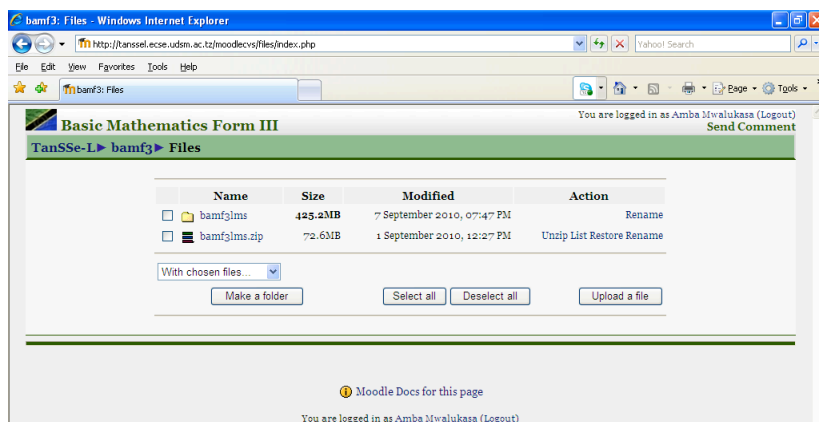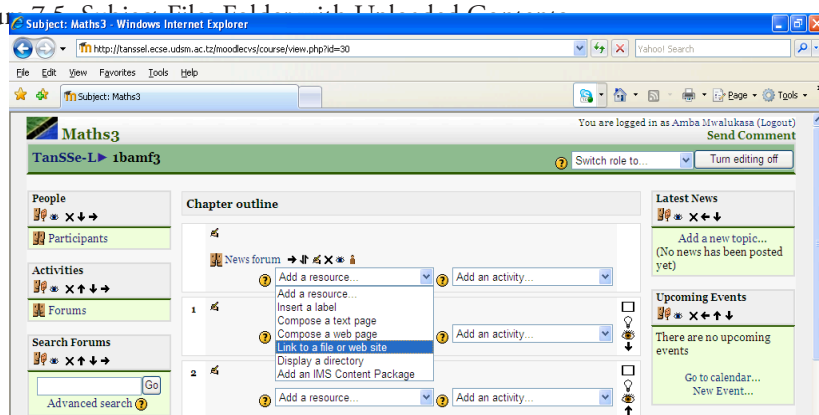
Figure 7.6: Adding a Resource to a Subject

The following are steps used to add a resource into the subject, figure 7.6 shows the use of Adding a Resource combo box.

- Login into the TanSSe-L system as an administrator, turn editing on, choose and click the subject to open the subject page
- Click Add a Resource – Choose any of the options given in the combo box depending on the type of a resource, in this particular case "link to a file or web site" option was chosen for all types of learning material except for the self assessment and assignments
- Adding a new resource page will involve uploading a required resource from the "Files" folder and fill in all required settings for proper representation of resources in the subject page
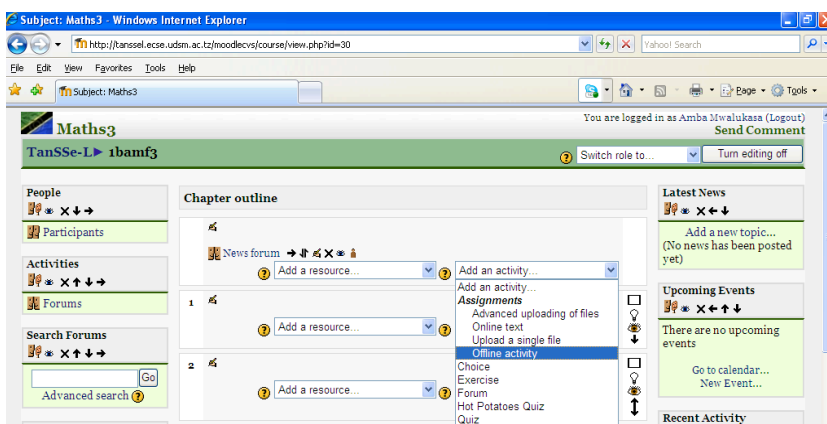
Figure 7.7: Adding an Activity to a Subject

Figure 7.7 shows a screenshot for adding an activity into the subject. The following steps were used:

- Login into the TanSSe-L system as an administrator, and turn editing on, choose and click the subject to open the subject page

- Click Add an Activity – Choose any of the options given in the combo box depending on the type of an activity, in this particular case, formative and summative assignment were uploaded using the "offline activity" and self assessment exercises made of hot potatoes package were uploaded using the "Hot Potatoes Quiz"

- Adding a new activity involved uploading a required resource from the "Files" folder and fill in all required settings for proper representation of activities n the subject page.

When all required resource and activities were uploaded into the subject, the content was arranged as desired with each block occupying one chapter. Chapter contents started from block 1, block 0 was left for discussion forum and some TanSSe-L documents like the TanSS-eL content users' guide, subject composition page, syllabus page and subject summary page. Figure 7.8 shows a screenshot of Subject page with learning materials, when viewed by normal users like students.
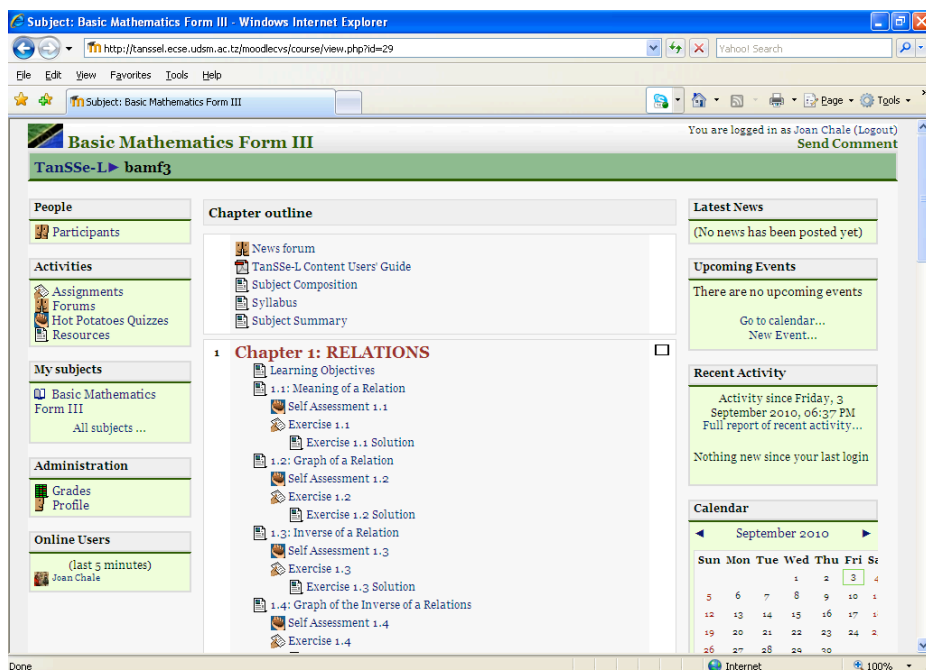
Figure 7.8: Subject Page in a TanSSe-L System

7.1.3   TanSSe-L Content Backup

Learning resources are very valuable hence need to be backed up in case of any unforeseen incidents. There was a need to make sure that versions of TanSSe-L content are protected and backed up to avoid losing the learning resources in case the server or CD-ROMs become faulty or misplaced. Backup method depends on the delivery environment, in this research two backup mechanisms are of consideration, the CD-ROM content backup and TanSSe-L content backup.

TanSSe-L content backup with CD-ROMs involved burning up of CD-ROMs for each version of TanSSe-L content. Since it is not easy to change the content in CD-ROMs, if any changes to the original content are required, changes must be effected followed by the process of burning another CD-ROM. Burning enough CD-ROMs is one of the means of backing up e-Learning content.

TanSSe-L system has its own mechanisms of backing up the TanSSe-L content. Mirroring on local servers from the central server is also another means of content backup via the TanSSe-L system.

7.2   TanSSe-L CONTENT DELIVERY

In the process of delivering e-Learning content to end users, activities that were planned included preparation of a user manuals, presentation and testing. Two users' manuals regarding TanSSe-L content were prepared one for the CD-ROM content and the other for contents in the TanSSe-L system. Users' manuals were saved in soft form and embedded in the respective contents. Users' manuals are self explanatory and can be easily followed.

7.2.1   Presentation of TanSSe-L System and Content at DUCE

The TanSSe-L System and Content was presented to teachers and prospective teachers at DUCE. Most of these are secondary schools' teachers and some will become teachers after graduation.

The TanSSe-L content was uploaded to the TanSSe-L system and the full system was presented from the development environment in a stand alone PC. The presentation explained the aim of the project and demonstrated the work done by then. After presentation we had a thorough discussion regarding the project, most of teachers participated in an open discussion and contributed valuable suggestions in both the system and the content (refer 7.3).

7.2.2   TanSSe-L Content Offline Delivery

Offline TanSSe-L content delivery was tested at ECSE department Kijitonyama campus using a server and computers configured in a Local Area Network (LAN). TanSSe-L content CD-ROM was also delivered using individual computers. The offline delivery does not need the internet connection.

7.2.2.1   Delivery Using Server and LAN

Testing TanSSe-L system and content at ECSE Kijitonyama campus involved replicating the TanSSe-L system from the development environment to the central server, uploaded the contents from the development environment and arrange them in a desired representation.

The TanSSe-L server was assigned a private IP address 192.168.2.15 and the URL http://tanssel.ecse.udsm.ac.tz/moodlecvs or http://192.168.2.15/moodlecvs. The TanSSe-L server was accessed by users mainly researchers using computers in a LAN. With this configuration we had an opportunity to test the functionalities and made modifications where needed.

TanSSe-L content was observed to have some broken links and poor links naming. New links were made especially the link to the subject page which before was just a

fictitious one since the path of the subject page in the TanSSe-L system was not known until the content were uploaded in the system. Most of the pages designed to open in a separate window needed the link to the subject page since by opening in a separate window they lost track of the TanSSe-L system navigation.

7.2.2.2   CD Content Delivery

The TanSSe-L CD-ROM content delivery was tested using individual computers there was no need of a LAN. The CDs were inserted in the computers and the content was easily accessed.

7.2.3   TanSSe-L Content Online Delivery

Online delivery was carried out using client computers accessing the e-Learning content directly from the central server via the Internet. In this case the TanSSe-L server was placed at the University Computing Centre and assigned a public IP address 196.44.161.35 and URL http://tanssel.ecse.udsm.ac.tz/moodlecvs or using the IP address http://196.44.161.35/moodlecvs.

To access contents through TanSSe-L system users must be granted user access rights by the TanSSe-L system administrator (Kalinga, 2008). Different users were assigned the roles of students, non-editing teachers and administrator in order to access the system and the content. Users who accessed the content online were members of e-Learning project, Center for Virtual Learning staff at UDSM, and member from BTH.

7.2.4   Blended Delivery Mode

Due to the problems which are faced by secondary schools, the blended mode of delivery promises to increase access to learning materials. It is not possible to go fully online due to the limited ICT and power infrastructures. Blended learning allows for an organization to move learners slowly from traditional F2F learning to online learning (Lating, 2009). F2F teaching will continue and will be enhanced by the TanSSe-L content accessed through both the TanSSe-L system and CD-ROM. The main reasons for the blended mode are increased access/flexibility and improved pedagogy (Graham et al., 2003). The transmissive (instructivist) and constructivist pedagogies are both taken into consideration so that students will be free to access TanSSe-L content and study at their own pace for revision and perform different learning activities individually or in groups.

Normal F2F content delivery continues to take place in the classroom environment where students sit in the normal class and acquire basic knowledge from their teacher. If the situation allows the TanSSe-L system or CD-ROM delivery can be combined with F2F, allowing open discussion between students and teacher(s) to take place regarding the learning content or any problem being experienced for instance solving problems contained in exercises or discussing on difficult concepts. This may reduce

the time that teachers take to write notes on the blackboard and students copying notes, thus giving more time for discussion.

7.2.5   TanSSe-L Content Delivery Requirements at Pilot Site

The TanSSe-L content can be accessed by the two schools via the TanSSe-L system, CD-ROM or F2F delivery. Each school must have a local server and some computers connected to a LAN. TanSSe-L content can be replicated from central server to local servers and be accessed by students. Incase of reliable internet connection and enough bandwidth the TanSSe-L content straight can be accessed straight from the Central server places at UCC. Moreover TanSSe-L content can be accessed using CD-ROMs and client computers.

The following hardware and software requirements for the TanSSe-L content to be properly accessed and viewed through the TanSSe-L system and CD-ROMs.

Hardware for e-Learning may include computers, servers, modems, networking devices, wireless devices, storage devices (hard drives, CD-ROMs, DVDs and flash disks), printers, scanners, cameras, and microphone (Khan, 2005). In the context of this research, hardware requirements for content delivery included client computers connected in a LAN, central server 1pc, local servers 2pcs, a number of CD/DVD-ROMs, and networking devices.

Software requirements for content delivery in the context of this research included servers in LAMP environment with Fedora Core 9, client computers with Windows XP, Office 2003, Adobe Flash player 9, client computer screen resolution 1224 x 728 pixels, and browsers (Internet Explorer 7, Mozilla Firefox 3).

7.3   TanSSe-L CONTENT FORMATIVE EVALUATION

The effectiveness of e-Learning content depends on users' evaluation. Recommendations obtained from the TanSSe-L presentation done at DUCE had an impact to formative evaluation of the TanSSe-L content. Following is the discussion resulted on the recommendations given by teachers;

7.3.1   Well Formatted Content Structure - Best use of Pedagogy

Pedagogy is how learning content is presented to learners. The arrangement of TanSSe-L content demonstrated to all chapters is consistent. The content is presented in the form of small objects called learning objects. The base learning object is at topic level. Each chapter has chapter objectives, topics, summative assessment, summative assignment and chapter summary. At the topic level, each topic is designed to have topic objectives, facts/concepts and formative assessment and summative assignment. At the subject level, the content is designed to cover chapters and subject summary. The pedagogy used also allows for free navigation to the e-Learning content means easy use.

At the beginning the TanSSe-L content provides users with introductory information which takes the user slowly to the contents. The user guide is also provided to guide users how to go about the TanSSe-L content.

7.3.2   Increase Interactivity

The TanSSe-L content was made out of multimedia assets and few animations. The interactivity was considered for self assessment exercises with prompt feedback. The presence of teacher was needed to help auditory learners. The content was further modified and accommodated audio/video illustration clips to some of the content. This is aimed at increasing content-students' interactions in individual learning and student-student interactions when reading in a collaborative manner. Simulations and animations are some of the aspects which can increase interactivity. A mathematical graphing tool has also been embedded in TanSSe-L content to help users to draw functional graphs, this also increases interaction and retention of the knowledge gained.

7.3.3   Begin with Use CD-ROMs

Due to limited ICT and technical skills to both teachers and students the implementation may start with the use of TanSSe-L content in CD-ROMs. Users can adapt faster to e-Learning content in CD-ROMs due to its easy of use and later migrate to TanSSe-L content in TanSSe-L system since to use Moodle effectively users need external force to understand it. Blended mode of delivery can take care of this since it is possible to combine different delivery modes for the benefit of users.

It was also discussed that support to students and teachers is very crucial for successful TanSSe-L content implementation. The support should come from the Ministry of Education, school administration and researchers. The support should be also to prepare students and teachers for e-Learning settings in schools in order to establish gradual change of mind set.

7.3.4   Develop Teachers ICT Capability – Knowledge of Moodle

For successful implementation it was suggested to develop teachers' ICT capability prior to introduction of e-Learning content to students. Knowledge of using Moodle was suggested to be the first item to consider, hence for proper implementation teachers must be well equipped with the know how of TanSSe-L system. Development of users' guides will support transfer of knowledge regarding the TanSSe-L system during implementation. Further the introduction of ICT curriculum in teachers colleges must be encouraged to impart ICT knowledge and skills to teachers.

7.3.5 Extend Content Accessibility - Students with Disabilities

It was noted that the TanSSe-L content did not cover well students with disabilities like visually impaired and deaf. It was suggested for future work to add some software programs which will increase its accessibility. Examples of tools suggested were;

- Job Access with Speech - a screen reader software for visually impaired users. The software can make computers using Microsoft windows accessible to blind and visually impaired users.

- Dolphin pen – is also a screen reader tool for visually impaired users. Can be used in computers

7.4   CONCLUSION

The implementation phase discussed on different approaches of TanSSe-L content packaging and storage considering delivery mode. Content for CD-ROM delivery must undergo some modifications in order to suit TanSSe-L system delivery. Different packaging and storage options have been explored. Content packaging is necessary for easy transfer of the content from the development environment to either a testing environment or publishing environment. At the destination the content package can be used as it is or unpacked and rearranged as desired to meet learners' needs. The implementation phase was necessary in order to check whether the developed e-Learning content meet users' requirements.

The implementation at this stage resulted on formative evaluation of the TanSSe-L content. Suggestions given in the formative evaluation have been implemented in the TanSSe-L content. Extending content accessibility and summative evaluation of TanSSe-L content is out of scope of this research hence has been considered for future recommendations. Summative evaluation of TanSSe-L content needs more time to judge for users' performance evaluation after using TanSSe-L content.

CHAPTER 8
CONCLUDING DISCUSSION AND RECOMMENDATIONS

The scarcity of learning resources and the inadequate number of teaching staff exists in almost all secondary schools across Tanzania. The situation has become worse due to the sharp increase in number of community secondary schools for each ward which has not been matched by the employment of more teachers and an increase in learning resources. This research has addressed the problem of scarcity of learning resources by using ICT tools in the design and development of e-Learning content and delivery for the self-learning environment to reduce the problem. To avoid the high costs of proprietary software packages, the research used OSS and web-based technologies in the development of the e-Learning content which was platform independent. The research was conducted in Kibaha district, Pwani region in Tanzania, where a pilot site was established incorporated two secondary schools Kibaha boys' secondary school and Wali-Ul-Asr girls' seminary.

In this research sample chapters of web-based e-Learning content for the subject of Mathematics form III have been designed, developed and demonstrated at DUCE and to the e-Learning project members, Center for Virtual Learning staff at UDSM, and a member of BTH both CD-ROM and TanSSe-L system delivery modes.

8.1   RESEARCH ISSUES THAT EMERGED

8.1.1   Hybrid Pedagogical Design in the Context of Tanzania

The research opted to blend instructivist and constructivist pedagogical approaches for e-Learning content design and development for secondary schools in Tanzania. The instructivist pedagogical model creates an educational environment in which learning objectives-based scenarios are used to anchor learning. The learning objectives in this context refer to the successful completion of the task and acquisition of basic knowledge and may not necessarily be the achievement of grades. Students are placed in an authentic situation within which they have the opportunity to learn by doing and practicing making mistakes and receive feedbacks. In order to achieve these learning objectives students need to acquire particular knowledge and make knowledgeable decisions which will require students to access learning content and take part in discussions, thus promoting student-content and student-student interactions.

On the other hand the constructivist pedagogical approach will create educational settings where having acquired basic knowledge, whether by F2F or the e-Learning environment, students can directly start tackling the activities provided in the learning materials. These activities are designed to be worked on either individually or in groups, depending on the instructions given. In this manner, student-student, student-content and student-teacher interactions are increased.

In both environments students are able to learn without the presence of a facilitator, as special directives are given on the Subject composition page. In this way the blend of instructivist and constructivist pedagogies is expected to support students in a self learning environment. This incorporates the changing nature of student learning from one of being 'teacher-directed/centred' to being student-directed/centred' or 'self-directed'.

8.1.2   The Importance of Stakeholders' Collaboration

There is no doubt that ICTs offer tremendous opportunities for developing rich pedagogically resource-based learning environments. But the impacts on learning outcomes rely on the stakeholders' appreciation or acceptance of using the learning materials effectively. e-Learning is quite new to secondary schools in Tanzania, and so it was important that stakeholders' views to be taken into consideration regarding design, development and application in order to meet end users' requirements within the constraints of particular learning environment, thus users play part in taking action leading to a viable solution.

To make use of most of the opportunities that ICTs offer, careful attention needs to be paid to the pedagogy of the learning and teaching. This greatly depended on the collaboration of the main stakeholders (teachers and students in this case) who shared

their experience with researchers in what was really taking place in the classrooms. Consideration was given to how the subject matter content is presented to students and what students are doing with it, what kinds of assessment are used, how feedback is provided, and how learning is supported.

The research valued stakeholders' collaboration which was developed through surveys, interviews and participatory activities. Through these activities cooperation between different parties as stipulated by the triple helix concept, were formed in the creation, dissemination and sharing of knowledge (Saad et al., 2008). People other than academic specialists take part in and judge outcome and quality. The involvement of users was also emphasized by the mode 2 knowledge production concept of the community collaboration and engaging in building knowledge which was applicable to solve a societal problem (Nowotny et al., 2003). Mode 2 involves the interaction of many actors throughout the process of knowledge production, which is transformed from tacit to explicit knowledge (Gibbons et al., 1994). Through collaboration activities users and researchers gain knowledge from each other which contributes to the approved actions leading to a solution.

8.1.3 Integrating Education and Technology

The content development process is not trivial. To produce effective e-Learning materials it is important that guidelines based on principles of education are followed. It is wrong to assume that one guideline may be assumed to fit on all e-Learning content designs. It depends on the purpose of the e-Learning material, available delivery modes and the technology. Therefore it was essential to study the context of the problem then agreed on a design which will meet the needs of end users. The process also involved understanding interdisciplinary concepts of education and software engineering disciplines.

To transform the formulated pedagogical design considerations into e-Learning content, there was a need to integrate education and technology into the methodology used. In the CEM, the ID methodology dealt with the pedagogical design concepts and since the final product is a software package (e-Learning content) it needed SE concepts for its development. The SE also covered the concepts of LOs, multimedia content design and selection of authoring tools.

Educational technology is a very broad term that can be applied to many types of technology used in education. In the encyclopedia of Educational Technology it is defined as "A systematic interactive process for designing instruction or training used to improve performance" (Walden, 2005). This definition harmonizes with the research expectations of designing e-Learning content to improve performance by increasing the accessibility of learning resources.

8.1.4 Free and OSS for Content Development and Delivery

Since the e-Learning content was developed using technology, it was necessary to find out which tools were suitable for this research. There are many proprietary software packages on the market for content development yet no single package would meet all the requirements. Moreover, the proprietary software packages are expensive, have high running costs due to the licence fee and in some cases may not be compatible with the existing technological infrastructure. In view of this, the research opted to go for free and OSS packages and the proprietary software available at UDSM for content development. For content delivery a Moodle LMS has been customized to suit the learning context of Tanzanian secondary schools (Kalinga, 2008).

Free and OSS development is a different model of software development. As discussed in section 6.3.3, the key advantage of the open source model over the proprietary model is that everyone has access to the source code of an application. In this way it enables technical people to collaborate on continual enhancements of the software. The quality of OSS can be better than proprietary software because programmers learn from each other, and there is less pressure from commercial deadline to rush the software on to the market in an unfinished state. Developers are free to view the code they can spot potential bugs, however the quality of the code can decrease if the developer community is very small (Murrain, 2007).

8.2   ORIGINAL CONTRIBUTIONS

In respect of this research, the following contributions are found to be new to the Tanzanian context.

(i)   The courseware engineering methodology used in the research, linked educational and software engineering expertise for e-Learning content design and development.

Development of e-Learning content for educational purposes is a multi-disciplinary research, which involves expertise from different fields, including education, multimedia, hypermedia and software engineering. In this research the first two phases in the ADDIE model determined the educational requirements, the modular subject structure, pedagogy models, and the subject model. The same process can even be followed in the F2F traditional content analysis and design. Depending on the delivery requirements the development and implementation phases for e-Learning content and F2F traditional content vary. From the point of view of this research the content should be of e-Learning delivery, this led to the SE approach for the development and implementation of e-Learning content using SDLC. The CEM used in this research clearly gave guidance on how to design, develop and deliver e-Learning contents.

(ii)   Design and creation of LOs with a blend of transmissive (instructivist) and constructivist pedagogical approaches

e-Learning resources were designed based on the concept of LOs to allow for reusability, adaptability and easy management. With the LO approach, the learning content is designed to be self contained and able to be used in multiple contexts. It is easier to accommodate instructional strategies in chunked materials which resulted in pedagogically rich materials rather than materials which are in a bulky mode. Moreover, sequencing of learning materials is easily managed and adjusted accordingly.

The advantage of using instructivist and constructivist pedagogical approaches in Tanzanian secondary schools problem context aimed at increasing access to learning materials. The constructivist pedagogical approach empowers students' autonomy in the learning cycle. Students become active and collaboratively construct knowledge by participating in solving assignments and assessments, discussing activities, illustrations and even referring to the learning content. For the observed situation, the teacher-led approach will continue to be used in the normal class teaching F2F orientation and the e-Learning content will be used by the students and/or teachers to enhance what has been learnt in the class.

(iii)   Involvement of users in the development of e-Learning content

In the traditional ADDIE model, participation of users is not explicitly shown, unless used with experts otherwise novice content developers may neglect stakeholders' collaboration in the whole process. This research addresses a societal problem and to achieve more relevant and robust results, users were involved in different stages of e-Learning content development. In the modified ADDIE model used in this research, users (with a focus on teachers) participated in discussions about the development of e-Learning content right at the beginning, for instance, in the selection of teaching materials to use during content development, the type of exercises and their solutions and the type of real life examples. In this way users' involvement was encouraged and they became active in the process of content development.

(iv)   Development of contextual web-based shareable e-Learning content for secondary schools in Tanzania

In the current situation, students/teachers/schools access learning resources through books and hard copies. Due to the scarcity of books, this method is expensive since the books available are very costly. For instance, the cost of the mathematics textbook - Secondary Basic Mathematics Book Three is sold for Tshs. 7,500/= ($\approx$ 6USD) in 2009. At this cost not many students/teachers/schools can afford to possess them. Apart from the textbook, there are also other reference books that must be used for a better understanding of the

subject matter. This further increases the cost of books, and so the provision of e-Learning materials introduced by this research is more convenient, reliable and cheap, since the material is available via the TanSSe-L system, CD-ROM or in printed form if the facilities allow. The mechanism used to store the e-Learning content increases access to the availability of up-to-date learning resources, which if used effectively, will greatly reduce the problem of lack of books and non-functional libraries and in turn will considerably improve the students-content interactivity. One access point of e-Learning content is expected to reach many students. Moreover, in the process of learning, students are free to navigate their way round the e-Learning content, which can not be compared to accessing textbooks considering the high student:book ratio.

(v)   Establishment of self-remedial classes via blended delivery mode for sec ondary schools in Tanzania

Blended learning is a new delivery approach for secondary schools in Tanzania. The trend is F2F for both normal and remedial classes are conducted with an aid of a teacher or facilitator whereas with the blended learning delivery approach, students can do remedial classes without a facilitator and at their own time. Students can concentrate on areas in which they face difficulties and study them without having to go through the whole content. Students are also able to do different activities in groups and learn from one another hence increasing student-student and student-content interactions.

(vi)   Scientific contribution to conferences and journals and a licentiate disser tation

Two conference papers/journals and a licentiate dissertation were developed as a result of this research

(a)   "Introduction of Open-Source e-Learning Environment and Re sources: A Novel Approach for Secondary Schools in Tanzania". S. K. Lujara M. M. Kissaka; L. Trojer; and N. H. Mvungi.

(a.1) Proceedings of World Academy of Science, Engineering and Technology (PWASET) Vol. 20, April 2007, ISSN 1307-6884, pp 331-335.

(a.2) 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. Kis saka, E. P. Bhalalusesa and L. Trojer.

(b.1) Proceedings of World Academy of Science, Engineering and Technology (PWASET) Vol. 24, October 2007, ISSN 1307-6884, pp 103-106.

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

(c)   A licentiate dissertation titled "Development of e-Learning Content and Delivery for Self Learning Environment: Case of Selected Rural Secondary Schools in Tanzania". Blekinge Institute of Technology Licentiate Dissertation Series No. 2008:04, ISSN 1650-2140, ISBN 978-91-7295-135-8

8.3   SUMMARY OF ANSWERS TO RESEARCH QUESTIONS

The research was developed to answer two research questions regarding improving availability and accessibility of learning resources and factors to be considered in the design and development of e-Learning resources for self-learning environment. A summary of the answers is as follows:-

8.3.1   Answer to Research Question 1

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

Summary of Answer to RQ1:

The study focused on the development of e-Learning resources using ICT tools as one of the viable solutions for improving the situation of scarcity of learning and reference materials in secondary schools in Tanzania. The introduction of e-Learning resources digitizes the current learning resources which will be easy to maintain and update, thus increasing its availability and accessibility as compared to the present format of hard copy like books and handouts. It is also possible to improve student-content interactions, since learning material from a single source can be accessed by a number of students. Sharing of learning resources will be improved resulting in reducing the inequality experienced by students in accessing the learning materials. The research used CD-ROMs and the TanSSe-L system modes of content delivery, which aims at improving the availability and accessibility of learning materials and offers a reliable means of content storage. The e-Learning material in this research has been developed to supplement the F2F teaching, and is expected to bridge the gap by providing as many useful and appropriate resources as are needed.

8.3.2   Answer to Research Question 2

RQ2:   What factors need to be considered in the design of e-Learning content for self learning environment?

Summary of Answer to RQ2:

In the context of secondary schools in Tanzania, the design and development of e-Learning content for self-learning environment focused on pedagogical and technological factors.

The current traditional pedagogy in use is teacher-led with students relying on their teachers for learning materials. Pedagogical factors were considered in order to provide an appropriate presentation of the learning materials to students, and to make it easy for them to navigate their way round the content. Hence the blend of instructivist and constructivist pedagogy was determined in chapter 4 and designed as shown in chapter 5. The instructivist pedagogy covered all the study materials for students' knowledge acquisition and the constructivist pedagogy is meant to impart collaborative skills to students for studying and solving problems, mostly in groups hence building their confidence throughout the learning cycle.

On the other hand, the technological factors considered the appropriateness and affordability of using the technology for content development and delivery as to whether it suited students' characteristics and the learning environment. To make the content appealing the use of multimedia was considered and so the e-Learning content was designed and developed with different media i.e. text, graphics, diagrams, audio and audio/video clips where necessary. Technological aspects were used to develop and implement the pedagogical models as shown in the development chapter 6. Most secondary schools in Tanzania lack ICT infrastructure and the finances to sustain the schools, however the research used free and OSS and web-based technologies for content development, support interactivity and engage students in learning.

8.4 TanSSe-L CONTENT IMPLEMENTATION LIMITATIONS

8.4.1   Bandwidth and Network Connectivity

Due to narrow bandwidth and unreliable network connectivity, the integration of multimedia contents was limited to texts, equations, figures, and low levels of audio, video and flash animations. A high level of integration involving video or heavy animation or a combination requires wide bandwidth and so will not be feasible for this case. The offline learning mode seemed to be feasible for implementation where TanSSe-L content can be delivered via the TanSSe-L system or CD-ROMs. The use of CD-ROMs (Lating et. al., 2006) was however considered an appropriate technique for delivering the multimedia learning content, even in the context of minimum ICT infrastructures.

8.4.2   Access to Electricity

One of the factors which determined the pilot site was the availability of electric power which was needed for the implementation of the pilot e-Learning content. Information from MoEVT showed that educational resource centres at district level had electricity and that plans were there to fully equip them with ICT facilities. Since many rural areas have got no power from the national grid, these centres could be considered to provide access points to facilitate e-Learning content delivery to the nearby schools and hence support the e-Learning project for further implementation.

8.4.3   ICT Infrastructure and Computer Literacy

Needs analysis revealed that the status of ICT infrastructure varies from one school to another. Generally there are very few computers in many secondary schools, the ICT infrastructure is inadequate and many of teachers and students are computer illiterate. Through the participatory activities it was learnt that the MoEVT is encouraging secondary schools and teachers' training colleges to use of ICT in education by introducing an ICT syllabus for secondary schools, and it has also introduced an ICT programme in the teachers' training syllabus. These initiatives can be used as a catalyst to make sure that the ICT illiteracy of both teachers and students is improved, which would have an impact on the e-Learning project when it comes to further implementation of the project.

8.5   CHALLENGES FACED IN THE COURSE OF DOING THE RESEARCH

A number of challenges were experienced during the research period. Some of the critical ones are discussed in the following sections.

8.5.1   Methodology Used - Integrating Technology in Education

In the context of this research, the CEM used for content design and development was inter-disciplinary, and needed experts from SE and ID to cross the boundaries of the two fields in order to come up with a concrete design. There are certain conditions for teachers that should be met in order to have an effective integration of technology and education. Apart from planning teaching materials teachers must also plan the use of the technology so that it will support students learning. This is a challenge due to the high ICT illiteracy in many teachers and moreover the use of ICT only may not suffice for teachers to be competent enough to integrate education in their teaching. They also have to learn how to use authoring tools in order to be able to make their own content. In this research the TanSSe-L content was developed by the researcher, in real practice this work is supposed to be done by a teacher or a content developer.

Regarding teachers doing the work of content development, the application of the TanSSe-L system will help to motivate teachers to start with a low level integration of technology in education.

This needs MoEVT and schools' administration to collaborate in supporting teachers in this role by providing adequate technological support. However, the condition might be different for some privately owned secondary schools.

8.5.2 Users' Collaboration as Part of the Methodology

Off-the-shelf software products tend to face incompatibility problems when taken to the real field, unless requirements are met. The end product of the research is e-Learning content for secondary schools hence the involvement of teachers and students from the surveyed schools and specifically the pilot site was very crucial for the development of e-Learning resources users.

In some cases users' collaboration was not that straightforward. Despite being given permission to visit the schools by RAS and REO for the schools to participate in the project, some reluctance still existed. Some of the schools were not ready to fully participate in the research. This resulted in either inadequate responses or no responses at all from some of the stakeholders. Users' participation built a relationship of trust between the researcher and the stakeholders and removed any obstruction which would have occurred if users had not collaborated. Therefore, working together with teachers and students from the beginning took account of users' ideas and made them aware of what was going to be the solution to their problem.

8.5.3 Syllabus Inconsistency

Development of learning content depends on the syllabus in use. Syllabus modifications do not have fixed periods but depend on the needs of the society. If the syllabus modification involved major changes then content would also require major changes hence its development becomes difficult and tedious. For instance, when conducting this research the syllabus for sample subject (Mathematics form III) was modified which affected content development process.

8.5.4 Authoring Tools Availability

Most of the authoring tools for content development are commercial. The HTML kit or WYSIWYG editors lack very important features regarding the creation of images, equations, graphs of functional equations and some mathematical or scientific formulas. The research used the free ware, OSS, and readily available software for content development to accomplish the same. Some of these packages were not flexible enough to accomplish the task of content development, but the limitation was overcome when used in combination.

8.5.5   The Choice of Pedagogy

Secondary schools in Tanzania still follow the teacher-led or instructivist pedagogy, where students rely more on what the teacher teaches. The e-Learning environment can offer various pedagogical approaches which can be supported by technology. But the choice of which pedagogy to use was a problem, due to the existing technological infrastructure and searching for software which could best implement the pedagogy. The choice of having a blend of two pedagogical models the instructivist and constructivist was reached to fulfill the requirements of increasing access to learning content and also of having a self-learning environment. The pedagogical factors played an important role in the final content structure adopted by this research.

8.5.6   e-Learning Project Sustainability

The challenge of project sustainability is still in question. Sida/SAREC was 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.

8.6   FUTURE RECOMMENDATIONS

The research resulted in a trial product of TanSSe-L content for sample chapters of Mathematics form III. Following is a discussion regarding recommendations for future research.

8.6.1   Research Scope Expansion

The research resulted in sample chapters of e-Learning content for Mathematics form III, which was implemented for demonstration at DUCE and to members of the e-Learning research group. In future, the research scope could be extended to cover the remaining chapters of Mathematics form III and for other forms in O level schools and implemented in phases starting with the pilot schools. Another phase should consider working on science subjects, like physics and chemistry, or subjects which do not have inadequate learning materials. Since most of the secondary schools in Tanzania use the same syllabus, the research could be further expanded to cover other secondary schools in different phases, depending on the availability of ICT and technology infrastructure. District educational centers could also be used to support learning if schools were to be grouped in clusters and connected to a nearby education center where a local server could be placed to provide learning materials.

The official launching of the International Submarine Fiber Optic Cable SEACOM in Tanzania in July 2009 has opened up opportunities for the country to have wide bandwidth internet connectivity. With SEACOM it will be possible to improve and

increase Internet connectivity in many schools. SEACOM will improve bandwidth capacity which will enable the content to be further improved the contents by the use of higher level multimedia integration like video, educational games and Java applets animations. With a high level of multimedia integration it will be possible to increase the interactivity and hence enhance students' learning.

8.6.2   Proposal for Professional Development Training for Teachers

(i)   Content Development Tools Training

Teachers must be exposed to the development tools, the knowledge of how to choose the tools depending on the availability and how to use them must be imparted to teachers so that they become conversant in content development. The issue of OSS and free software packages must also be introduced as part of the training. The training could also combine the delivery methods for instance CD-ROM delivery and TanSSe-L delivery.

(ii)   TanSSe-L System Training

In order to utilize the benefits of the TanSSe-L system for secondary schools in Tanzania, it is proposed that teachers to undergo professional development training thoroughly so that they can be conversant working with the system and contents. In this way teachers would also be able to develop content which would be viewed by their students.

8.6.3   Delivery Via Mobile Phones

e-Learning content delivery could also be made possible with the use of mobile phones. This is another possible means of reaching many students if pedagogical and technological factors are considered to support content delivery via mobile phones, hence increase learning opportunities through the use of mobile technologies.

8.6.4   e-Learning Content to Cover Special Needs Students

The design and development of e-Learning content for students with special needs is beyond the scope of this research. However, he research could be extended to cover students with disabilities by taking into considerations suggestions discussed in section 7.3.5. However, ample time should be used in searching for better software tools and learn how to use them to effectively be incorporated in the content development for extending accessibility.

8.7 CONCLUDING SUMMARY

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

e-Learning and its technological basis is expected to be an appropriate tool for supporting the learning process efficiently, effectively and satisfactorily. Educational reform must include changing teachers' beliefs and practices to a certain degree. Students working collaboratively and teachers assuming the role of facilitators characterize a constructivist, student-centred learning environment. The new technologies provide students timely access to information, which once was under the control of teachers (Mehlinger, 1996). When resources are in short supply there must be ways to collaborate and share them and this is the situation which is currently faced by secondary schools in Tanzania. Hence if e-Learning content can be utilized properly it could provide one of the solutions to increasing access to learning content to accompany the traditional F2F learning.

References

ADL (2003), "From Local Challenges to a Global Community: Learning Repositories and the Global Learning Repositories Summit", http://www.academiccolab.org/resources/FinalSummitReport.pdf (Retrieved in May, 2006).

ADL (2006), "Sharable Content Object Reference Model (SCORM ®) 2004", 3rd Edition Overview, Version 1.0., http://www.ADLNet.gov (Retrieved in December, 2007).

Akpinar, Y., Simsek, H. and Bal, V. (2004), "An e-Learning Content Development System on the Web: BU-LCMS. In Proc. 5th IEEE International Conference on Information Technology Based Higher Education and Training (ITHET) 2004, 31 May – 2 June, 2004, ISSN:0-803-8596-9, vol. 11, No. 22, pp. 239-243.

Alexander, S. (2001), "e-Learning Developments and Experiences", *Education & Training*, Volume 43, Number 4-5, pp. 240–248.

Anohina, A. (2005), "Analysis of the Terminology Used in the Field of Virtual Learning", *Educational Technology & Society,* 8(3), pp. 91-102.

Avouris, N., Markellos, K., Markellou, P. and Tsakalidis, A. (2003), "Implementing a Web-based e-Learning Environment for Electrical and Computer Engineers", *International Conference on Engineering Education*, July 21–25, Valencia, Spain.

Babu, N. S. C. (2001), "e-Learning Standards", Conference Paper, National Seminar on E-Learning & E-Learning Technologies (ELELTECH), INDIA, August 7-8 2001, http://www.cdac.in/html/pdf/Session6.1.pdf (Retrieved in May, 2007).

Banks, B. and McGrath, K. (2003), "e-Learning Content Advisory Paper", http://www.fdlearning.com/html/company/papers/e-learnContentPaper.pdf (Retrieved in January, 2007).

Barritt, C. and Alderman Lee Jr. F. (2004), "Creating a Reusable Learning Objects Strategy – Leveraging Information and Leaning in a Knowledge Economy", Published by Pfeiffer An Imprint of Wiley, ISBN0-7879-6495-6

Bell, B. (1998), "Investigate and Decide Learning Environments." Journal of the Learning Sciences, 7(1), 65-105.

Berge, Z. (1997), Characteristics of online teaching in postsecondary, formal education. Educational Technology, 37(3), pp 35-47.

Borer, R. (2005), "Standards e-Learning and Their Possible Support for a Rich Pedagogic Approach in a Integrated Learning Context", http://tecfaseed.unige.ch/staf18/modules/ePBL/uploads/proj3/paper18.xml (Retrieved in June, 2007).

Bostock, S. (2003), Courseware Engineering – An Overview of the courseware development process. http://www.keele.ac.uk/depts/aa/landt/lt/docs/atceng.htm (Retrieved in May, 2009).

Boyle, T. (2003), "Design Principles for Authoring Dynamic, Reusable Learning Objects", *Australian Journal of Education Technology (AJET),* 19(1), pp. 46-58.

Brown, A. (1997a), "Designing for Learning: What are the Essential Features of an Effective Online Course?", *Australian Journal of Education Technology (AJET 13)*, 13(2), pp. 115-126.

Brown, J. (1997b),. HCI and Requirements Engineering- Exploring Human Computer Interaction and Software Engineering Methodologies for the Creation of Interactive Software. *Technical Report* CS-TR-97/1.

Bruegge, B. and Dutoit, A. H. (2003), Object-Oriented Software Engineering: Using UML Patterns and Java 2nd Edition. Prentice Hall. ISBN-13: 978-0130471109.

Buzzetto-More, N. A. and Pinhey, K. (2006), "Guidelines and Standards for the Development of Fully Online Learning Objects", *Interdisciplinary Journal of Knowledge and Learning Objects,* Volume 2, pp. 95-104.

Chao, B. T., Shook, C. A. C. and Robert, G. K. L., (2006), "Pedagogy Considerations for E-Learning", *International Journal of Instructional Technology & Distance Learning*, Vol. 3, No. 5, ISSN 1550-6908.

Chen, N. S., Kinshuk, Ko H.C. and Lin, T. (2004), "Synchronous Learning Model Over the Internet", *Proceedings of the 4th IEEE International Conference on Advanced Learning Technologies (ICALT 2004), August 30 - September 1, 2004, ISBN 0-7695-2181-9, pp. 505-509.

Chew, L. K. (2001), "Use of XML in e-Learning Content Packaging", *ITSC Synthesis Journal*, Section 2, Paper no. 3.

Chitnis, M., Tiwari, P. and Ananthamurthy, L. (2007), "UML Overview", http://www.developer.com/design/article.php/1553851, (Retrieved in Dec, 2007).

CISCO Systems (2000), "Reusable Information Object Strategy: Definition, Creation Process and Guidelines for Building" White Paper Version 3.1, http://www.cisco.com/warp/public/779/ibs/solutions/learning/whitepapers/el_cisco_rio.pdf (Retrieved in June, 2006).

Clark, D (1995), "Introduction to Instructional System Design" http://www.nwlink.com/~donclark/perform/process.html (Retrieved in May, 2008).

Cohen, E. B. and Nycz, M. (2006), "Learning Objects and e-Learning: An Informing Science Perspective", *Interdisciplinary Journal of Knowledge and Learning Objects*, Vol. 2, pp. 23-34.

Collin, R. (1987), "Accelerated Learning", Dell Publishing Group, New York, ISBD-10 0440500443, ISBN 13 978-0440500445.

Cot, A. (2004), "Instructional Design", http://meld.medbiq.org/primers/primer_on_instructional_design_scott.htm (Retrieved in June, 2006).

Cullen, J., Hadjivassiliou, K., Hamilton, E., Kelleger, J., Sommerlad E., and Stern E. (2002). *Review of Current Pedagogic Research and Practice in the Fields of Post-Compulsory Education and Lifelong Learning.* http://www.tlrp.org/pub/acadpub/Tavistockreport.pdf (Retrieved in May 18, 2006).

Dabbagh, N. (2005), "Pedagogical Models for e-Learning: A Theory-Based Design Framework", *International Journal of Technology in Teaching and learning*, 1(1), pp. 25-44.

Danchak, M., Walther, J. and Swan, K. (2001) 'Presence in mediated instruction: bandwidth, behaviour, and expectancy violations', *Proceedings of Asynchronous Learning Network (ALN) 2001 Conference,* Orlando, FL, November.

De Villiers, M. R. (2002), "The Dynamics of Theory and Practice in Instructional Systems Design", PhD Thesis, University of Pretoria, Pretoria.

Diaz, D. P. and Bontenbal, K. F. (2000), "Pedagogy-Based Technology Training", In P. Hoffman, and D. Lemke (Eds.), Teaching and Learning in a Network World, Amsterdam, Netherlands: IOS Press, pp. 50-44.

Dick, W., Carey, L., & Carey, J. O. (2005), "The Systematic Design of Instruction" (6th ed.), New York: Allyn and Bacon. ISBN 0205412742.

Douglas, I. (2001), "Instructional Design Based on Reusable Learning Objects: Applying Lessons of Object-Oriented Software Engineering to Learning Systems Design", *31st ASEE/IEEE Frontiers in Education Conference,* October 10 - 13, 2001 Reno, NV.

Duderstadt, J. J. (1999), "Can Colleges and Universities Survive in the Information Age?", In:Katz, R.N. and Associates (Eds), Dancing with the Devil: Information Technology and the New Competition in Higher Education. San Fransisco: Jossey-Bass Publishers, pp. 1-25.

Duffy, T. M. and Cunningham, D. J. (1996), Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), Handbook of Research for 132 Educational Communications Technology. pp. 170-198. New York, NY: Simon & Schuster Macmillan.

Edwards, C. and Fritz, J. H. (1997), "Evaluation of Three Educational Online Delivery Approaches", *Mid-South Instructional Technology Conference Proceedings*, 2nd Murfreesboro, TN April 6-8 1997, http://www.mtsu.edu/~itconf/proceed97/online_3.html (Retrieved in March, 2006).

Eklund, J., Kay, M. and Lynch, H.M. (2003), "e-Learning: Emerging Issues and Key Trends", A discussion paper, ISBN 187757363, http//pre2005/flexiblelearning.net.au/research/2003/elearning250903 (Retrieved in April, 2006).

Esselaar, M. and Associates (2001), "A Country ICT Survey for Tanzania", http://www.sida.se (Retrieved in May 2006).

Etzkowitz, H., and Leydesdorff, L. (2000), The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of University-Industry-Government relations. Research Policy 29, pp.109-123, http://www.uni-klu.ac.at/wiho/downloads/Etzk.pdf (Retrieved in November, 2008).

Fang, J.J. and Huang, Y.C. (2006), "A Multimedia Environment for Creative Engineering Design", www.formatex.org/mice2006/pdf/801-805.pdf (Retrieved in September, 2007).

Ferrance, E. (2000), "Action Research – Education Theme", National and Island Regional Educational Laboratory, Brown University, http://www.alliance.brown.edu/pubs/themes_ed/act_research.pdf (Retrieved in July, 2007).

Foss, J. (2004), "The Four Essential of Modern Web Design", http://www.sitepoint.com/print/essentials-modern-web-design/, (Retrieved in June, 2008).

Freire, P. (2000), "Pedagogy of the Oppressed, Continuum International Publishing Group", 30 Anv Sub Edition, ISBN 10 0826412769.

Friedman B. D. (2008), "How to Teach Effectively A Brief Guide", Lyceum Books, ISBN 10 1933478187.

Gagne, R., Briggs, L. and Wager, W. (1992), Principles of Instructional Design (4th Ed.). Fort Worth, TX: HBJ College Publishers. ISBN:1-59593-224-0.

Gerner, J., Naramore, E., Owens, M. L., Warden, M., (2006), "Professional LAMP, Linux, Apache, MySQL & PHP5 Web Development. Wiley Publishing, Inc., ISBN-13:978-0-7645-9723-7.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, P., S. and Trow, M., (1994), "The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies" Sage Publications, ISBN 0-8039-7794-8.

Gillani, B. B. and Relan, A. (1997), "Incorporating Interactivity and Multimedia Into Web-Based Instruction", In B. H. Khan (Ed.), Web-based Instruction Englewood Cliff, NJ: Educational Technology Pub, pp. 231 – 237.

Glenn, J (2003), "Distance Learning at the Tipping Point", http://www.eduventures.com/research/industry_reserch_resources/distancelearning .cfm (Retrieved in May, 2007).

Golas, K. (2000), "Guidelines for Designing Online Learning", http://www.tss.swri.edu/pub/2000ITSEC_ONLINELEARNING.htm (Retrieved in April, 2006).

Goodyear, P. (1993) Foundations for Courseware Engineering. In R. D. Tennyson (Ed), Automating Instructional Design, Development and Delivery. Berlin: Springer Verlag.

Govindaswamy, T. (2002), "Successful Implementation of e-Learning Pedagogical Considerations", *Internet and Higher Education Journal,* Vol. 4, pp. 287-299.

Graham, C. R., and Allen, S. (2003), Blended learning: An emerging trend in education. In C. Howard & J. V. Boettecher & L. Justice & K. D. Schenk (Eds.), Encyclopedia of Distance Learning: Online Learning and Technologies (Vol. 4). Hershey, PA: Idea Group Inc.

Gros, B. (1997), "Instructional Design and the Authoring of Multimedia and Hypermedia Systems: Does a Marriage Make Sense?" *Educational Technology,* 37(1), pp. 48-56.

Gunasekaran, A., McNeil, R. D. and Shaul, D. (2002), "e-Learning: Research and Applications", *Industrial and Commercial Training*, 34, 2, pp. 44–53.

Hadjerrouit, S. (2007), "Applying a System Development Approach to Translate Educational Requirements Into e-Learning" *Interdisciplinary Journal of Knowledge and Learning Objects,* Volume 3, 2007.

Hammond, N. (1992), Tailoring hypertext for the learner. In: Kommers, P.; Jonassen, D. & Mayes, J. (Eds.) *Cognitive Tools for Learning.* Berlin: Springer Verlag, 1992, pp. 149-160.

Hare, H. (2007), "ICT in Education in Tanzania – Survey of ICT and Education in Africa: Tanzania Country Report", http://www.infodev.org/en/document.432.aspx (Retrieved in December, 2007).

Harmon, S.W., and Hirumi, A. (1996), "A Systemic Approach to the Integration of Interactive Distance Learning into Education and Training", *Journal of Education for Business,* Vol. 71, No.5, pp. 267-71.

Harriman, G. (2005), "Synchronous vs. Asynchronous Distance Learning", http://www.grayharriman.com/e-Learning.htm (Retrieved in July, 2007).

Heinich, R., Molenda, M., Russel, J. D. and Smaldino, S. E. (2002), "Instructional Media and Technologies for learning", 7th edition, Merrill Prentice Hall, ISBN 0-13-030536-7.

Herrington, A. and Bunker, A. (2002), "Quality Teaching Online: Putting Pedagogy First" *Proceedings of the 2002 Annual International Conference of the Higher Education Research and Development Society of Australasia (HERDSA),* ISSN 1441 001X, ISBN 0 908557 52 3, 7-10 July, pp. 305-312.

Herrington, J. and Standen P. (2000), "Moving from an Instructivist to a Constructivist Multimedia Learning Environment", *Journal of Educational Multimedia and Hypermedia* 9, 3 (2000), pp. 195-205.

Hillmann, D. (2000), "Using Dublin Core", http://dublincore.org/documents/2000/07/16/usageguide/ (Retrieved in August, 2007).

Horton, W. (2001), "Leading e-Learning", American Society for Training and Development, http://www.elearninggurus.com/articles.html (Retrieved in March, 2006).

HTML Reference, (2007), "HTML <!DOCTYPE> Declaration", http://www.w3schools.com/tags/tag_doctype.asp (Retrieved in August, 2007).

Huang, Y. C., Fang, J. J. and Yan, H. S. (1998), "A Multimedia Instruction Software for Motion Curves Design and Applications of Disk Cam-Follower Systems", *Proceedings of The First National Conference on the Design of Mechanisms and Machines,* Tainan, TAIWAN, pp. 213-218.

IEEE LTSC (2000), "LOM Working Draft v4.1", http://ltsc.ieee.org/doc/wg12/LOMv4.1.htm (Retrieved in September, 2005).

IEEE LTSC (2003), "Learning Technology Standards Committee", http://ltsc.ieee.org/ (Retrieved in April, 2006).

ITU Website (2006), "International Telecommunication Union Statistics", http://www.itu.int/ ITU-D/ict/statistics/ (Retrieved in November, 2006).

Jacobson, I., Christerson, M., Jonasson, P., & Overgaard, G., (1992), "Object-oriented Software Engineering: A use case driven approach". Revised Edition, Addison-Wesley Professional ISBN-13: 978-0201544350.

Jhurree, V. (2005), "Technology Integration in Education in Developing Countries: Guidelines to Policy Makers1", *International Education Journal,* 2005, 6(4), ISSN 1443-1475, Shannon Research Press, pp. 467-483.

Jonassen, D. H., Grabinger, R. S. and Harris, N. D. C. (1991), "Instructional Strategies and Tactics", Performance Improved Quarterly, 3(2), pp. 29-47.

Jones, E. R. (2002), "Implications of SCORMTM and Emerging e-Learning Standards On Engineering Education", *Proceedings of the 2002 American Society for Engineering Education (ASEE) Gulf-Southwest Annual Conference*, The University of Louisiana at Lafayette, March 20 – 22, 2002.

Juhary, J. (2007), "Pedagogy Considerations for e-Learning in a Military Learning Environment" MERLOT Journal of Online Learning and Teaching, Vol. 3, No. 4, December 2007.

Kabita, B. (2003), "An e-Learning Experience – A written Analysis Based on My Experience in an e-Learning Pilot Project", Research Paper Campus-Wide Information Systems, University of Botswana, Volume 20 No. 5, pp. 193-199.

Kalinga, E. A. (2008), "Development of an Interactive e-Learning Management System (e-LMS) for Tanzanian Secondary Schools" Licentiate Dissertation Series No. 2008:03, Blekinge Instute of Technology, ISSN 1650-2140, ISBN 978-91-7295-134-1.

Kanuka, H. (2006), "Instructional Design and e-Learning: A Discussion of Pedagogical Content Knowledge as a Missing Construct", *e-Journal of Instructional Science and Technology (e-JIST)* Vol. 9, No. 6.

Karagiorgi, Y., & Symeou, L. (2005), "Translating constructivism into instructional design: Potential and limitations". *Educational Technology & Society*, 8(1), 17-27, http://www.ifets.info/ journals/8_1/5.pdf (Retrieved in June, 2008).

Kay, R., and Knaack, L. (2005). Developing learning objects for secondary school students: A multicomponent model. *Interdisciplinary Journal of Knowledge and Learning Objects*, Vol. 1, pp. 229-254.

Kennedy, D. (1998). Software Development Teams in Higher Education: An Educators View, Conference Proceedings, The Australian Society for Computers in Learning in Tertiary Education (ASCILITE '98) December 14 -16 Wollongong, pp.373.

Khan, B. (2005), "Managing E-Learning Strategies: Design, Delivery, Implementation and Evaluation", Information Science Publishing, ISBN 1-59140-634-X.

Kirschner, P. A. (2006), "Learning is Interaction", Utrecht: 2006, 26 Pages Including References and Notes ISBN 90-9020572-1.

Koohang, A. and Harman, K. (2005), "Open Source: A Metaphor for e-Learning", *Informing Science Journal,* Volume 8.

Koper, E. J. R. (2001), "Modelling Units of Study From A Pedagogical Perspective: The Pedagogical Meta-model Behind EML", Document Prepared for the IMS Learning Design Working Group, http://eml.ou.nl/introduction/articles.htm (Retrieved in July, 2007).

Larry B. and David M., (2002), "Blended e-Learning", 2nd Edition, HRD Press, inc, ISBN-10: 08742860X, ISBN-13: 978-0874258608.

Lating, P. O. (2006), "Hybrid e-Learning for Rural Secondary Schools in Uganda", Licentiate Thesis, Series No. 2006:10, ISSN 1650-2140, Blekinge Institute of Technology.

Lating, P. O., Kucel, S. B. and Trojer, L., (2006), "Design and Development of Interactive Multimedia CD-ROMs for Rural Secondary Schools in Uganda", *Proceedings of the First International Conference on Advances in Engineering and Technology*, Entebbe, Uganda, Elsevier Ltd, UK.

Lating, P. O. (2009), "Hybrid e-Learning for Rural Secondary Schools in Uganda, Co-evolution in Triple Helix Process", PhD Thesis, Series No. 2009:01, ISSN 1653-2090, ISBN 978-91-7295-158-7 Blekinge Institute of Technology.

Levin, J. and Waugh, M., (1998), "Teaching tele-apprenticeships: Electronic network based educational frameworks for improving teacher education" Interactive Learning Environments, 6(12):3958.

Low, B. (2002), "Packaging Educational Content Using IMS Specifications", 40-VINE, Volume 32, Number 2 , Issue 127, ISSN 0305-5728, pp. 40-46.

Lujara, S. K., Kissaka, M. M., Trojer, L. and Mvungi, N. H. (2007a), "Introduction of Open-Source e-Learning Environment and Resources: A Novel Approach for Secondary Schools in Tanzania", *Proceedings of World Academy of Science, Engineering and Technology (PWASET)*, Vol. 20, April 2007, ISSN 1307-6884, pp. 331-335.

Lujara, S. K., Kissaka, M. M., Bhalalusesa, E. P. and Trojer, L. (2007b), "Learning Objects: A New Paradigm for e-Learning Resource Development for Secondary Schools in Tanzania", *Proceedings of World Academy of Science, Engineering and Technology (PWASET)*, Vol. 24, October 2007, ISSN 1307-6884, pp. 103-106.

Mc Ardle, G. (1998), "Conducting a Need Analysis". Thomson Crisp Learning, 1st Edition, ISBN-13: 978-1560524236.

Maciaszek, L. A. (2003), *Requirements analysis and system design: Developing information systems with UML*. New York: Addison-Wesley. ISBN: 7-111-11911-8.

Mashinter, G. and Rolf, K.(1997), "Delivering Courseware via a CD-ROM web site", The Australian Society for Computers in Learning in Tertiary Education (ASCILITE '97), December 7 – 10. http://www.ascilite.org.au/conferences/perth97/papers/Mashinter/Mashinter.html (Retrieved in April, 2008).

Mayer, R. (2004), "Should There be a Three-Strike Rule Against Pure Discovery of Learning? The Case for Guided Methods of Instruction", American Psychologist 59 (1), pp. 14-19.

Mayes T. (2004), "Review of e-Learning Theories Frameworks and Models" JISC e-Learning Models Desk Study, http://www.jisc.ac.uk/uploaded_documents/StageLearningModelsVersion201.pdf (Retrieved in June, 2007).

Mazigo, E. M. (2003), "Factors Influencing Poor Performance in Basic Mathematics and Remedies". A Discussion Paper at a Meeting Between Japan Overseas Cooperation Volunteers and Officials of the Ministry of Education and Culture, 20 June 2003.

Mazure, H. N. (1996), "Pedagogy and Teaching on the Internet: What You Need to Know Before You Go Online", http://www.cyg.net/~jblackmo/diglib/list-b.html (Retrieved in April, 2006).

Mbelle, A. and Katabaro, J. (2003), "School Enrolment, Performance and Access to Education in Tanzania", Research on Poverty Alleviation (REPOA), Research Report No. 03.1, Mkuki na Nyota Publishers Ltd, ISBN 9987-686-61-3, pp. 9.

McGreal, R. and Roberts, T. (2001), "A Primer on Metadata for Learning Objects", http://www.elearningmag.com/issues/Oct01/learningobjects.asp, (Retrieved in March, 2006).

McGriff, S. J. (2000), "Instructional System Design (ISD): Using the ADDIE Model", Instructional Systems, College of Education, Penn State University, www.personal.psu.edu/users/s/j/sjm256/portfolio/kbase/IDD/ADDIE.pdf, (Retrieved in May, 2007).

Mehlinger, H. D. (1996), "School Reform in the Information Age", Phi Delta Kappan, February, pp. 300-407.

Mergel, B. (1998), "Learning Theory" http://www.usack.ca/education, (Retrieved in Apr, 2008).

Microsoft Corporation (2001), "How to Make HTML CDs with MS FrontPage version 2002", http://www.microsoftfrontpage.com/content/, (Retrieved in May, 2009).

Moallem, M. (2001), Applying Constructivist and Objectivist Learning Theories in the Design of A Web-Based Course: Implications for Practice, Educational Technology& Society 4(3), ISSN 1436-4522 pp.113-125.

MoCT (2003), "National Information and Communications Technologies Policy", The United Republic of Tanzania. Design and Printing: Colour Print (T) Limited.

MoEC (1995), "Education and Training Policy". URT, Ministry of Education and Culture. Dar es Salaam.

MoEC (2002), "Secondary Education Master Plan 2001 – 2005", URT, Ministry of Education and Culture, http://www.moe.go.tz/pdf/SEMPFINAL.pdf, (Retrieved in March, 2005).

MoEC (2004a), "Education Sector Development Program, Secondary Education and Development Plan (SEDP)", Final Document, URT, Ministry of Education and Culture.

MoEC (2004b), "Education Sector Development Programme: Mechanism for Posting Teachers to Government Secondary Schools for Secondary Education Development Plan 2004 - 2009", Ministry of Education and Culture.

MoEC (2005), "Basic Mathematics Syllabus for Secondary Schools" Form I-IV, Ecoprint Ltd. Designed and prepared by Tanzania Institute of Education (TIE).

MoEC (2006), "The United Republic of Tanzania, 10 Year Plan for Education Sector 2006 - 2015", http://www.moe.go.tz/education.html (Retrieved in March, 2006).

MoEVT (2007), "Information and Communications Technology (ICT) Policy for Basic Education", URT, Ministry of Education and Vocational Training.

MoEVT BEST (2006), "National Data - Basic Education Statistics in Tanzania 2006" United Republic of Tanzania, Ministry of Education and Vocational Training.

MoEVT BEST (2007), "National Data - Basic Education Statistics in Tanzania 2007" United Republic of Tanzania, Ministry of Education and Vocational Training.

MoEVT BEST (2008), "National Data - Basic Education Statistics in Tanzania 2008" United Republic of Tanzania, Ministry of Education and Vocational Training.

MoEVT BEST (2009), "National Data - Basic Education Statistics in Tanzania 2009" United Republic of Tanzania, Ministry of Education and Vocational Training.

Montilva, J. A., Sandia, B., & Barrios, J. (2002), Developing instructional web sites – A software engineering approach. *Education and Information Technologies*, 7(3), pp. 201-224, http://www.springerlink.com/ content/qh6838g3234561nl/fulltext.pdf (Retrieved in May, 2007)

Moore, D., Bates, A. and Grundling, J. (2002), "Instructional design", In Mishra, Arun K. and Bartram, John (Ed.) Skills Development Through Distance Education, http://www.col.org/skills/ (Retrieved in June, 2007).

Morrison, G. R., Ross, S. M. and Kemp, J. E., (2003), "Designing Effective Instruction", John Wiley & Sons, ISBN-10 0471216518, ISBN-13 978-0471216513.

Motive, (2000 – 2009), "The Motive Web Design Glossary" http://www.motive.co.nz/glossary/linking.php (Retrieved in May, 2008).

Moulali, S. (2006), "Effects of Different Teaching and Learning Methods", http://www.iicd.org/projects/articles/iicdnews.2006-08-31.9498106700/ (Retrieved in May, 2007).

Murrain, M. (2007), "Choosing and Using Free and Open Source Software: A Primer for Non Profits", http://www.nosi.net/projects/primer (Retrieved in January, 2008).

Muzio, J. A., Heins, T. and Mundell, R. (2002), "Experiences with Reusable e-Learning Objects from Theory to Practice", *Internet and Higher Education Journal*, Vol. 5, pp. 21-34.

NECTA Examinations Results Statistics (1994 – 2005), "Subject Grade Distribution and Subject Comparative Performance, 1994 – 2005".

NECTA Website (2004 – 2009), "NECTA CSEE Results", http://www.necta.gz.co/results.html, (Retrieved in Nov, 2009)

Nichols, M. (2003), "A Theory for e-Learning", *Educational Technology & Society*, 6(2), ISSN 1436-4522, pp. 1-10.

Nowotny, H., Scott, P., and Gibbons, M. (2003), 'Mode 2' Revisited: The new production of knowledge. *Minerva*, Vol. 41, No. 3, pp. 179-194.

Nunes, J. & Fowell, S.P (1996), Hypermedia as an experimental learning tool: a theoretical model. *Information Research New*, Vol. 6, No.4, 1996, 15-27.

O'Brien R. (1998), "An Overview of the Methodological Approach of Action Research", http://www.web.net/~robrien/paper/arfinal.html (Retrieved in April, 2007).

Olgren, C. H. (1998), "Improving Learning Outcomes: The Effects of Learning Strategies and Motivation", In C. Gibson (Ed.) Distance Learners in Higher Education: Institutional Responses for Quality Outcomes pp. 77-95, Madison, WI: Atwood.

Oluchi, E., (2006), "Policy Choices in Secondary Education in Africa: Challenges seen from Different Perspectives in an African Country A Case Study of Tanzania Mainland as Seen by Tanzania Teachers' Union (TTU)".

OMG, (2003), "Unified Modeling Language Specification", Ver 1.5, formal/03-03-01, http://www.omg.org/technology/documents/formal/uml.htm, (Retrieved in May, 2008)

O-saki, K (2004), Reflections on the state of science education in Tanzania. In K. O-saki, K. Hosea & W. Ottevanger (Eds.), Reforming science and Mathematics Education in Sub-Sahara Africa (pp. 11-26). Dar es Salaam: Teams Project.

Özen, R. (2008), Inservice Training (INSET) Programs via Distance Education: Primary School Teachers' Opinions. *Turkish Online Journal of Distance Education-TOJDE* , 9 (1).

Paul, E. S. (2008), "Assessment of ICT Status in Tanzania". A Dissertation submitted at the University of Dar es Salaam, October, 2008

Philemon, C. (2007), "ICT4Africa – Country Report Tanzania", http://www.wikieducator.org/ICT4Africa/Country_Report_Tanzania (Retrieved in February, 2007).

Philemon, C., Mzee, O. and Jensen, N. (2006), "ICT in Secondary Schools, The e-School Program Presentation", Rural Connectivity Workshop, Dar es Salaam, May 2006.

Polsani, P. (2003), "Use and Abuse of Reusable Learning Objects", *Journal of Digital Information*, 3(4), Article No 164.

Porter, L. R. (1997), Creating virtual classroom: Distance learning with the internet. New York: J. Wiley & Sons. ISBN-13: 978-0471178309.

Ras, E., Memmel, M. and Weibelzahl, S. (2005), "Integration of e-Learning and Knowledge Management – Barriers, Solutions and Future Issues", Professional Knowledge Management, Lecture Notes in Artificial Intelligence (Vol. 3782), Springer, Berlin, pp. 155-164.

Ravasio, P., Schluep, S. and Guttormsen-Schär, S. (2003), "Metadata in e-Learning Systems: Focus on its Value for the User", *Proceedings of the Second International Conference on Multimedia and ICTs in Education (m-ICTE2003)*, Badajoz, Spain, Dec 3 – 6, 2003. pp. 879-882.

Reeves, T. C. and Reeves, P. M. (1997), "The Effective Dimensions of Interactive Learning on the WWW", In B. H. Khan, (Ed.), Web-Based Instruction. Englewood Cliffs, NJ: Educational Technology, pp. 59-66.

Reigeluth, C. M. (1999), "What is Instructional Design Theory and How is it Changing? In Instructional-Design Theories and Models: A New Paradigm of Instructional Theory", Vol. 2, Lawrence Erlbaum Associates, Mahwah, USA, pp. 5-29.

Rice, W. H. (2006), "Moodle E-Learning Course Development, A Complete Guide to Successful Learning Using Moodle", ISBN 1-904811-29-9 [Packt] Publishing Birmingham – Mumbai.

Riley, F. (1995), "Understanding IT Developing Multimedia Courseware", Information Technology Training Initiative (ITTT), University of Hull, ISBN: 1-85889-099-3.

Roschelle, J., Pea, R., Hoadley, C., Gordin, D. and Means, B. (2001), "Changing How and What Children Learn in School with Computer Based Technologies". The Future of Children, 10(2):76101.

Rural Schools FAQs (2006), http://www.raconline.org/info_guides/schools/schoolsfaq.php (Retrieved in July, 2007).

Saad, M. and Zawdie, G. (2008), "Triple Helix in Developing Countries – Issues and Challenges", Technology Analysis and Strategic Management, Vol. 20, No.6, pp. 649 – 652.

Salmon, G. (2002), "Approaches to Researching Teaching and Learning Online", In C Steeples and C. R. Jones (Eds) Networked learning: Perspectives and Issues. London: Springer-Verlag.

Senzige, J. P. and Sarukesi, K. (2004), "An Approach to ICT Based School Education in Tanzania", *African Journal of Finance and Management,* Vol. 12, No. 2, pp. 88-97.

Sharma, V. K. and Meenakshi, S. (2005), Content Authoring Tools and Standards – A Self-Reliant Mechanism for Content Development Sharma et al.,. National Seminar, e-Learning and e-Learning Technologies (ELELTECH) INDIA 2005 pp. 45-49, http://elearn.cdac.in/eSikshak/eleltechIndia05/papers.htm, (Retrieved in June, 2007).

Shaw, M. (2000), Defining a Viable Multimedia Courseware Engineering Approach. Educational Research, December, 2000, http://www.shawmultimedia.com/course_eng.pdf (Retrieved in May, 2008).

Singh, H. (2003), "Building Effective Blended Learning Programs", *Issue of Educational Technology,* Vol. 43, No. 6, pp. 51-54.

Smith, J. M. (2001), "Blended Learning An Old Friend Gets A New Name", http://www.gwsae.org/executiveupdate/2001/March/blended.htm, (Retrieved in April, 2006).

Smith, R. A. (2004), "Guidelines for Authors of Learning Objects, The New Media Consortium NMC", http://www.nmc.org/guidelines/nmc (Retrieved in April, 2006).

Stellman, A. (2008), "Understanding Non-Functional Requirements", http://broadcast.oreilly.com/nonfunctional-requirements-how.html (Retrieved in Feb, 2008).

Stephenson, J. (2001), "Teaching and Learning Online: Pedagogies for New Technologies", Kogan Page, London.

Stevens, P., and Pooley, R. (2006). Using *UML: Software development with objects and components.* London:Addison-Wesley. ISBN: 9780321269676.

Stronkhorst, R. J. (2001), Improving Science Education in Swaziland: The Role of inservice Education. Doctoral Dissertation. Enschede: University of Twente. http://doc.utwente.nl/36334/1/thesis_Stronkhorst.pdf, (Retrieved in August, 2009).

Sun, L. and William, S. (2004), "An Instructional Design Model for Constructivist Learning" In L. Cantoni and C. Mc Loughlin (Eds), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications (ED-MEDIA)*, pp. 2476-2486.

Tanzania Development Vision 2025 (2006), http://www.tanzania.go.tz/vision.htm (Retrieved in May, 2006).

Teo, C. B., Cheong, S., Chang, A., Gay, R. and Leng, K. (2006), "Pedagogy Considerations for e-Learning", *International Journal of Instructional Technology & Distance Learning,* Vol. 3, No. 5, ISSN 1550-6908.

The Citizen (2008), "Tanzania: New Salaries Next Month", http://allafrica.com/stories/200806100534.html (Retrieved in Feb, 2009).

The JORUM Team (2005), "Report on Open Source Learning Object Repository Systems", http://www.jorum.ac.uk/docs/pdf/ JORUM_osswatch_final.pdf (Retrieved in May, 2006).

Thompson, N. (2001), "Why ID? The Benefits of Instructional Design Models", *Teaching with Technology Today (TTT) Journal,* Vol. 7, No. 6, February 15, 2001.

TIE Website (2008), http://www.tie.go.tz, (Retrieved in May, 2008).

Tong, W. T. (2004), "e-Primers on Free/Open Source Software", UNDP Asia-Pacific Development Information Programme, ISBN 81-8147-565-8, http://www.iosn.net/education/foss-education-primer/fossPrimer-Education.pdf (Retrieved in May, 2007).

Uden, L., (2002), "Courseware Engineering Methodology", Jounal of Computing in Higher Education Fall 2002, Vol. 14 No. 1, pp. 50-66.

UN ICT Task Force (2002), "Information and Communication Technologies in Africa", – A Status Report. Third Task Force Meeting United Nations (UN) Headquarters 30th September – 1st Oct 2002.

URT Website (2005), "National Strategy for Growth and Poverty Eradication", http://www.tanzania.go.tz/pdf/nsgrptext.pdf (Retrieved in May, 2007).

Valiathan, P. (2002), "Blended Learning Models. Learning Circuits", ASTD, http://learningcircuits.org/2002/aug2002/valiathan.html (Retrieved in October, 2005).

Vichuda, K., Ramamurthy, K. and Haseman, W. D. (2001), "User Attitude as a Mediator of Learning Performance Improvement in an Interactive Multimedia Environment", *International Journal of Human–Computer Studies*, 54(4), pp. 541–583.

VTT Information Service (2007), "Image, Video and Sound File Formats", http://www.unesco.org/webworld/participer/guidelines/pub-img-ileformats.htm. (Retrieved in Sep, 2008).

W3C (1994-2009), Why Validate?, http://validator.w3.org/docs/why.html (Retrieved in Jan, 2009).

Wagner, E. D. and McCombs, B. L. (1995), Learner centred psychological principles in practice: Designs for distance education. Educational Technology, 35(2):32-35.

Walden, S. (2005), What is Educational Technology? In B. Hoffman (Ed), *Encyclopedia of Educational Technology,* http://coe.sdsu.edu/eet/articles/edtech/start.htm (Retrieved in October, 2008).

Walsh, S. (2007), "The Use of the Triple Helix Concept in Accelerating the Pace of Commercialization of Micro and Nano Technology based products", www.cmc.ca/news/events/cwmems01/presentations/walsh.pdf (Retrieved in Nov, 2008).

Watkins C., Carnell E., Lodge C., Wagner P. and Whalley C. (2002), "Effective Learning", NSIN Research Matters, Institute of Education, University of London, http://www.ioe.ac.uk/iseic/research.pdf (Retrieved in May, 2006).

Wedgwood, R. (2005), "Post Basic Education and Training in Tanzania", – UK Forum for International Education and Training (UKFIET), Oxford 8th International Conference on Education and Development, 13 – 15, September 2005.

Wentling, T. L., Waight, C., Gallaher, J., La Fleur, J., Wang, C. and Kanfer, A. (2000), "E-learning - A Review of Literature", Knowledge and Learning Systems Group NCSA, http://learning.ncsa.uiuc.edu/papers/elearnlit.pdf (Retrieved in May, 2006).

Wieseler, W. (2000), "A Standards-Based Approach for Reusable Information Objects", http://www.cousenet.com/html/products/ (Retrieved in April, 2006).

Wiley, D. (2000), "Connecting Learning Objects to Instructional Design Theory: A Definition, a Metaphor, and a Taxonomy. The Instructional Use of Learning Objects", http://reusability.org/read/chapters/wiley.doc (Retrieved in April, 2006).

Wong, P. K. (2002), "ICT Production and Diffusion in Asia: Digital Dividends or Digital Divide?" *Information Economics and Policy*, 14(2), pp. 167-187.

Wood, E.J. (2004) Problem-based learning. *Acta Biochimica Polonica*, Vol. 51, No.2, pp. XXI – XXVI.

World Bank (2004), "Programme Document for a Proposed Financing to the United Republic of Tanzania for a Secondary Education Development Program", Washington DC, World Bank, Report No 27613.

Yang, C. H., Moore D., Burton, J. K. (1995), "Managing Courseware Production: An ID Model with a Software Engineering Approach", Educational Technology Research and Development ETR & D, Vol. 43, No. 4, 1995, pp. 60 – 70, ISSN 1042-1629.

Yang, H. and Tang, J. (2003),'Effects of social network on students' performance: a web-based forum study in Taiwan', *Journal of Asynchronous Learning Network,* Vol. 7, No. 3, pp. 93–107.

Youm, J. H., and Black, J. B. (2005), The potential for an object-oriented model of learning. *Proceedings of E-LEARN 2005,* Nov 1-5, Washington DC, USA, pp.1583-1586.

Bibliography

Kissaka, M. M. and Greyson, A. K. (2004), "Survey Report on ICT Status at Earmarked Secondary Schools in Moshi Urban and Hai Districts".

Kissaka, M. M. and Greyson, A. K. (2004), "Survey Report on ICT Status at Earmarked Secondary Schools in Mwanga District".

Mjema, E. and John, C. (2004), "Survey Report on ICT Status at Earmarked Secondary Schools in Same District".

Mjema E., and Juma, M. M. (2004), "Field Work Report on Audit of the Pilot Seconday Schools on e-Readiness in Mkuranga and Kibiti Districts".

Mvungi, N. H. and Anatory, J. (2004), "Survey Report on ICT Status at Earmarked Secondary Schools in Morogoro and Ifakara Districts".

Mvungi, N. H. and Kalinga, E. (2004), "Survey Report on ICT Status at Earmarked Secondary Schools in Iringa District".

Mwinyiwiwa, M. M., Simalenga, C., and Simba, F. (2004), "Survey Report on ICT Status at Earmarked Secondary Schools in Kilwa, Kibaha and Bagamoyo".

Appendices

Appendix A – Sample Letters for Permission to Collect Data

A1 – Letter to MoEVT

<div align="center">

UNIVERSITY OF DAR ES SALAAM

COLLEGE OF ENGINEERING AND TECHNOLOGY

FACULTY OF ELECTRICAL AND COMPUTER SYSTEMS ENGINEERING

</div>

Department of Telecommunications Engineering
 P.O. BOX 35131   DAR ES SALAAM   TANZANIA

Tel: +255-22-2410321. (Direct)		**Telegrams: Univeng Dar es Salaam**
** 2410501-9 (General) Ext. 2852.**		
Fax: +255-22-2410377/ 2410321/ 2410454		Telex: 2410854 Uneng/2410561 Univip
E-mail: kissaka@ee.udsm.ac.tz		
Website: http://www.ee.udsm.ac.tz		**2410327 Uniscie**

Date: 9th January, 2007
Your Ref.:
Our Ref.   CSE/PGS/008/NHM/sjo

To: Principal Secretary,
Ministry of Education and Vocational Training.

u.f.s.   Dean,
          Faculty of Electrical and Computer Systems Engineering,
          University of Dar es Salaam.

Sir/Madam,

RE: PERMISSION FOR DATA COLLECTION IN THE USE OF ICT IN SECONDARY SCHOOLS IN YOUR MINISTRY

Ms. Ellen A. Kalinga and Ms. Suzan K. Lujara are Ph.D. students at the University of Dar es Salaam, Faculty of Electrical and Computer Systems Engineering, Department of Computer and Systems Engineering. They are conducting a research on the development of learning content management platform and e-learning content for secondary schools in Tanzania.

Their research work needs some data regarding ICT readiness and the use of ICT in secondary schools. In the process of data collection, they have prepared a questionnaire and would like to meet with officials from some sections for smooth running of their work. The requested data is vital for their research to progress. The data shall be used for academic purposes only.

In view of the above I am seeking for permission for our researchers to conduct their research in your ministry.

It is my hope that your office will be willing to furnish the requested data at no charge considering that the researchers are doing this as part of their academic activities and also the results of this research will benefit all Tanzanians.

Thanking you in advance for your cooperation and assistance.

Yours faithfully,

Dr. M.M. Kissaka,
Research Coordinator/Sida/SAREC Extended Support ICT Project

c.c.   PG Coordinator, CoET
c.c.   Research and Publication Coordinator, CoET
c.c.   PG Coordinator, CSE Department
c.c.   Supervisor

A2 – Letter to the Executive Secretary NECTA

27th June, 2006

The Executive Secretary,
NECTA.

u.f.s.   Dean,
          Faculty of Electrical and Computer Systems Engineering.

u.f.s.   Head,
          Department of Computer and Systems Engineering.

Sir/Madam,
RE: REQUEST FOR PERMISSION FOR DATA COLLECTION AT NECTA

Mrs. Lujara is a Ph.D. student at the University of Dar es Salaam, Faculty of Electrical and Computer Systems Engineering. She is conducting a research on e-learning content development for secondary schools in Tanzania.

Her research work needs some statistical data regarding the performance of form IV for about 10 years backwards from last year i.e. 1995-2005, so that she can see the performance disparities if any, between rural and urban schools in three subjects; i.e. Mathematics, Physics and Chemistry. The requested data is vital for her research to progress. The data shall be used for academic purposes only.

Thanking you in advance.

Yours faithfully,

Dr. M. M. Kissaka,
Research Supervisor/UDSM.

UNIVERSITY OF DAR ES SALAAM

COLLEGE OF ENGINEERING AND TECHNOLOGY

FACULTY OF ELECTRICAL AND COMPUTER SYSTEMS ENGINEERING

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Website: http://www.ee.udsm.ac.tz		**2410327 Uniscie**

Date: 18th January, 2007
Your Ref.:
Our Ref.   CSE/PGS/008/NHM/sjo

To: Regional Administrative Secretary,
         ARUSHA.

u.f.s.   Dean,
         Faculty of Electrical and Computer Systems Engineering,
         University of Dar es Salaam.

Sir/Madam,

**RE: PERMISSION FOR DATA COLLECTION IN SOME OF THE SEC-
ONDARY SCHOOLS IN YOUR REGION**

Ms. Ellen A. Kalinga and Ms. Suzan K. Lujara are Ph.D. students at the University of Dar es Salaam, Faculty of Electrical and Computer Systems Engineering, Department of Computer and Systems Engineering. They are conducting a research on the development of learning content management platform and e-learning content for secondary schools in Tanzania.

Their research work needs some data regarding ICT readiness and the use of ICT in secondary schools. In the process of data collection, they have prepared questionnaires and would like to meet with the concerned parties i.e. students, teachers and the regional officials for effective and efficient data collection for reliability. The requested data is vital for their research to progress. The data shall be used for academic purposes only and can be beneficial to the schools.

In view of the above, I am seeking for permission for our researchers to conduct their research in your region in the secondary schools that can be reached.

It is my hope that your office will assist in furnishing the requested data considering that it is for academic purpose that shall enable the researchers to complete their studies but even more significant perhaps is that project aims at using ICT to assist the secondary schools hence they shall be beneficiaries. Much as we would have liked to pay for services in data collection exercise, it is not possible at present since the project does not have financer at this stage.

Thanking you in advance for your cooperation and assistance.

Yours faithfully,

Dr. N. H. Mvungi,
Head, Department of Computer and Systems Engineering,

c.c.   PG Coordinator, CoET
c.c.   Research and Publication Coordinator, CoET
c.c.   PG Coordinator, CSE Department
c.c.   ICT Project Coordinator
c.c.   Supervisors

A4 – Letter to Regional Educational Officer

<div align="center">

UNIVERSITY OF DAR ES SALAAM

COLLEGE OF ENGINEERING AND TECHNOLOGY

FACULTY OF ELECTRICAL AND COMPUTER SYSTEMS ENGINEERING

</div>

Department of Telecommunications Engineering
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Date: 18th January, 2007
Your Ref.:
Our Ref.   CSE/PGS/008/NHM/sjo

To: Regional Education Officer,
        DODOMA.

u.f.s.   Dean,
        Faculty of Electrical and Computer Systems Engineering,
        University of Dar es Salaam.

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gional officials for effective and efficient data collection for reliability. The requested data is vital for their research to progress. The data shall be used for academic purposes only and can be beneficial to the schools.

In view of the above, I am seeking for permission for our researchers to conduct their research in your region in the secondary schools that can be reached.

It is my hope that your office will assist in furnishing the requested data considering that it is for academic purpose that shall enable the researchers to complete their studies but even more significant perhaps is that project aims at using ICT to assist the secondary schools hence they shall be beneficiaries. Much as we would have liked to pay for services in data collection exercise, it is not possible at present since the project does not have financer at this stage.

Thanking you in advance for your cooperation and assistance.

Yours faithfully,

Dr. N. H. Mvungi,
Head, Department of Computer and Systems Engineering,

c.c.   PG Coordinator, CoET
c.c.   Research and Publication Coordinator, CoET
c.c.   PG Coordinator, CSE Department
c.c.   ICT Project Coordinator
c.c.   Supervisor

A5 – Letter to School Head Master/Mistress

<div align="center">

UNIVERSITY OF DAR ES SALAAM

COLLEGE OF ENGINEERING AND TECHNOLOGY

FACULTY OF ELECTRICAL AND COMPUTER SYSTEMS ENGINEERING

</div>

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Telex: 2410854 Uneng/2410561 Univip
2410327 Uniscie

Date: 18th January, 2007
Your Ref.:
Our Ref.   CSE/PGS/008/NHM/sjo

The Headmaster/Headmistress,
Name of School:………………………………………………………………….

u.f.s.   Dean,
          Faculty of Electrical and Computer Systems Engineering,
          University of Dar es Salaam.

Sir/Madam,

RE: REQUEST FOR DATA COLLECTION

Ms. Ellen A. Kalinga, and Suzan K. Lujara, are Ph.D. students at the University of Dar es Salaam, Faculty of Electrical and Computer Systems Engineering, Department of Computer and Systems Engineering. They are currently conducting a research on the development of content management platform and e-learning content for secondary schools in Tanzania.

Their research work needs some data regarding ICT readiness and the use of ICT in secondary schools. I therefore request you to allow and assist our researchers to collect

necessary data in your school. In data collection process, they have prepared question-naires and would like to meet with the concerned parties i.e. students and teachers for smooth running of their work. The requested data is vital for their research to progress. The data shall be used for academic purposes only.

It is my hope that your office will be willing to furnish the requested data at no charge considering that the researchers are doing this as part of their academic activities and also the results of this research will benefit all Tanzanians.

Thanking you in advance for your cooperation and assistance.

Yours faithfully,

Dr. H. N. Mvungi,
Head/ Department of Computer and Systems Engineering,
University of Dar es Salaam.

c.c.   PG Coordinator, CoET
c.c.   Research and Publication Coordinator, CoET
c.c.   PG Coordinator, CSE Department
c.c.   ICT Project Coordinator
c.c.   Supervisor

Appendix B – Sample Questionnaires

B1 - Ministry Questionnaire

1. Introduction

1.1   Ministry Contact Information:

Postal Address: …...………………………………………………………..

Telephone No. ………………………………Fax No………………………….

Email Address: ……………………………………………………………………

Web URL ……...………………………………………………………………...

Contact Person…………………………………………………………………..

Position………………………………………………………………………

2. ICT Awareness

2.1   Is the Ministry aware of the National ICT policy ☐YES/ ☐NO

If YES, does it adequately cover issues related to education? ☐ YES/☐ NO

If NO, what is missing? ……….…………………………………………..

2.2   Does the ministry have its own ICT policy? ☐YES/ ☐NO

2.3   Does the ministry have as ICT master plan? ☐YES/ ☐NO

2.4   To what extent is the ICT policy implemented in percentage……..…..%

2.5   Are there any constraints hindering the implementation of ICT policy?

☐ YES/☐ NO

If YES what are they? Tick all which apply

Lack of ICT policy awareness ☐

Lack of funds   ☐

Given low priority   ☐

Lack of master plan   ☐

Reluctant personnel   ☐

Other: Specify………………………………………………………….

2.6   Does the ministry have ICT steering committee? ☐YES/ ☐NO

If YES is the committee active? ☐YES/ ☐NO

2.7   Does the ministry consider ICT as a means to assist schools in teaching and learning? ☐YES/ ☐NO

If YES are there any special consideration for such schools □ YES/ □NO

2.8　What are the constraints hindering implementations of ICT in schools? Tick all which apply;

        Lack of computers　　　　　　　□

        Lack of computer literate personnel □

        Low priority　　　　　　　　　□

        Lack of master plan　　　　　　□

        Reluctant staff/students　　　　□

        Lack of electricity　　　　　　□

        No teaching curriculum　　　　□

        Other: Specify……………………………………………………….

2.9　Does the ministry conside ICT as a means to assist schools in teaching and learning? Plan □YES/ □NO

    If YES, are there any special consideration(s) for such schools?　□ YES/ □NO

    If YES, what has been done? Tick all which apply;

        Training of teachers in computer application □

        Supplied computers to school　　　　　□

        Developed Computer Curriculum　　　　□

        Conducted ICT awareness to schools　　□

        Providing Internet connectivity　　　　□

        Other: Specify……………………………………………………….

2.10　Please tick Yes or No for the following variables in the implementation of the ICT Policy

    (i)　　Master Plan □YES/ □NO

    (ii)　　Time Frame □ YES/ □NO

    (iii)　　Budget Plan □ YES/ □NO

    (iv)　　Programme for Teacher Training in ICT □YES/ □NO

    (v)　　Programme for ICT Curriculum Development at O - Level □YES/ □NO

    (vi)　　Monitoring and Evaluation schemes □YES/ □NO

2.11　Is there a budget allocated by the government for the implementation of the national policy on ICT? □YES/ □NO

2.12　If NO, where does the fund come from?

    □Other companies　　□Other donor/funding agencies

    □Other(s)………………………………………………………..

2.13   If YES, indicate the percentage set from allocated budget for the following items:

    ☐ Hardware and software procurement ………………%

    ☐ Development of software applications for education ……………%…

    ☐ Training ……………%

    ☐ Network connectivity ……………%…

    ☐ Maintenance and repair …………….%.

    ☐ Other(s)…………………………………………………………………..

2.14   Does the national ICT policy consider remote schools? YES/NO

2.15   Please indicate current and previous projects in-connection with ICT implementation in education.

s/n	Title	Sponsor/Donor	Scope	Comme-ncement Date	Duration (years)

2.16   What are your comments on the use of ICT in education?

    …………………………………………………………………………..
    …………………………………………………………………………..
    …………………………………………………………………………..
    …………………………………………………………………………..…
    …………………………………………………………………………..

B2 – Head Master/Mistress Questionnaire

1. Introduction:

1.1   Full Name (Optional):………………………………………...Gender: F/M

1.2   Age in Years: □Under 30   □ 30 - 45   □45 - 65

1.3   Work Experience (years):

        □ under 5   □5 – 10   □10 – 15   □15 – 20   □20 - 30   □30 – 45

1.4   Name of School: …..…………………………………………………….

1.5   How old is the school (in years) …………………………

1.6   School Location: □Urban   □Semi-urban   □Rural

1.7   School Type: □Government   □Private   □ Seminary   □Community

1.8   School Specialization:

        □Science   □Arts   □Commerce   □Other………………….……….

2. Academic Qualification(s):

2.1   Qualification(s)……………...………………………………………………

…………………………………………………………………………………..

…………………………………………………………………………………..

…………………………………………………………………………………..

2.2   Specialization: □Science   □ Arts   □Commerce   □ Other………..…….

3. Teaching Activities:

3.1   Name of Subject(s) you teach: □Mathematics   □Physics   □ Chemistry

        □ Geography   □Biology   □ Other(s)

        ……………………………………………………

        …………………………………………

3.2   Books and reference materials availability: □Adequate   □Not adequate

        If not adequate how do you solve for this condition.………………………….

        ……………………………………………………………………………

        ……………………………………………………………………………

3.3   Teachers' details:

s/n	Full Name	Qualification(s)	Expr (Year)	Subject(s) in-charge

Expr. - Experience

3.4   Lecture Delivery Mode: ☐ Chalk and talk   ☐ Using Overhead Projector
                                 ☐ Using Computer

3.5   Please provide the total number of students/form for the current year;

Form	No. of students
Form I	
Form II	
Form III - Science	
Form III - Arts	
Form IV - Science	
Form IV - Arts	

3.6   Students performance in Mathematics, Physics and Chemistry at Certificate
       Secondary Education Examinations (CSEE) at your school for three years
       consecutively;

Year	Subject	A	B	C	D	E	F
	Math						
	Phy						
	Chem						
	Math						
	Phy						
	Chem						
	Math						
	Phy						
	Chem						

Math – Mathematics, Phy – Physics, Chem – Chemistry

3.7   How do students evaluate your teaching? …………………………..…………….
       ……………………………………………………………………….……………..
       ……………………………………………………………………….……………..

3.8   How do you help for the poor school performance? ....
       ……………………………………………………………………………………..
       ……………………………………………………………………………………..

4. ICT Awareness

4.1   Computer Literacy: □ Excellent   □ Very Good   □ Good   □ Poor

4.2   Do you use computers?   YES/NO

      If Yes, where?   □ Education   □ Internet   □ Entertainment

        Other …………………………………………..…….

4.3   Does the school have access to the internet? YES/NO

4.3   Do you agree in using ICT in teaching?

      □ Strongly Agree   □ Agree   □ Disagree   □ Strongly Disagree □ Neutral

4.4   In which subjects do you use ICT?

      □ Computer □ Mathematics □ Physics   □ Chemistry □ Biology

      □ None   □ Other(s)…………………………….

4.5   Please provide statistics on the following variables in the table;

s/n	Item	Total Number
1.	Desktop Computers	
2.	Overhead Projectors	
3.	Multimedia/LCD Projectors	

4.6   What are your comments on the use of ICT in education?

      …………………………………………………………………………..

      …………………………………………………………………………..

      …………………………………………………………………………..

      …………………………………………………………………………..

      …………………………………………………………………………..

B3 – Teacher's Questionnaire

1. Introduction:

1.1   Full Name (Optional):…………………………………...Gender: F/M

1.2   Age in Years: ☐Under 30   ☐30 - 45   ☐45 - 65

1.3   Work Experience (years):

        ☐under 5   ☐5 – 10 ☐10 – 15   ☐15 – 20 ☐ 20 - 30 ☐ 30 – 45

1.4   Current Post:…………………………………………………………

1.5   Name of School:…..………………………………………………….

1.6   School Location: ☐Urban   ☐Semi-urban   ☐Rural

1.7

2. Academic Qualification(s):

2.1   Qualification(s)……………...……………………………………………

………………………………………………………………………………..

………………………………………………………………………………..

………………………………………………………………………………..

2.2   Specialization: ☐Science   ☐Arts   ☐ Commerce   ☐Other……….

3. Teaching Activities

3.1   Name of Subject(s) you teach: ☐ Mathematics   ☐Physics   ☐ Chemistry

                                              ☐ Geography   ☐Biology   ☐ Other(s)

                                              …………………………………………

                                              …………………………………………

3.2   Books and reference materials availability: ☐ Adequate   ☐Not adequate

        If not adequate how do you solve for this condition………………………….

        …………………………………………………………………………

        …………………………………………………………………………

3.3   What is the current format of your teaching materials?

        ☐ Hand written   ☐Hard copy   ☐Softcopy   ☐ Other …………………..

3.4   Lecture Delivery Mode: ☐Chalk and talk   ☐ Using Overhead Projector

                                          ☐Using Computer

3.5   Single Lecture Preparation Time: ☐ Less than one hour   ☐1-2 hours

                                              ☐ 2-3 hours   ☐3-4 hours

                                              ☐ Other……………………...

3.6   Single period duration: □ 60mins   □ 40min   □ 30min

□ Other………..

3.7   Subject Work load: ………period(s)/week   …………time/week

3.8   How long is your term/semester? ………………..weeks

3.9   Time Division in hrs: Lecturing………Tutorials………..Laboratory…….…...

3.10   Do you give assignments? YES/NO

If Yes, how often?

□Frequently (at the end of each □class, □topic, □lesson, □module)

□Not Frequently   □No

If No, why? …………………………………………………………………..

…………………………………………………………………………..

3.11   Students' performance in your subject(s) for the three consecutive years.

Year	Term	A	B	C	D	E	F
	1st						
	2nd						
	1st						
	2nd						
	1st						
	2nd						

3.12   How do students evaluate your teaching? ……………………..…………….

…………………………………………………………………………..

…………………………………………………………………….…………

3.13   How do you help weak students in your subject (s)? ....

…………………………………………………………………………..

…………………………………………………………………………..

…………………………………………………………………………..

4. ICT Awareness

4.1   Computer Literacy: □ Excellent   □ Very Good   □ Good   □ Poor

4.2   Do you use computers?   YES/NO

If Yes, where? □ Education   □ Internet   □ Entertainment

□ Other ………………………………………………...…….

4.5   Do you agree in using ICT in teaching?

□ Strongly Agree   □Agree   □Disagree   □Strongly Disagree   □Neutral

4.6   In which subjects do you use ICT?

□Computer   □Mathematics   □Physics   □ Chemistry   □Biology

□None   □Other(s)……………………………….

4.7   Do you have email address? YES/NO

If Yes, please indicate; ……………………………………………………...

4.8   Have you attended any computer course? YES/NO

If Yes, When (dates)…………………..……...………...………………..………….

Where (Name of College/School).......…..………..………..………………………..

Achievement…………………………………………….…………………………

4.9   What are your comments on the use of ICT in education?

………………………………………………………………………………..

………………………………………………………………………………..

………………………………………………………………………………..

………………………………………………………………………………..

………………………………………………………………………………..

B4 – Librarian's Questionnaire

1. Introduction:

1.1 Full Name (Optional):…………………………………………...Gender: F/M

1.2 Age in Years: □0 – 30   □30 – 45   □45 – 65

1.3 Work Experience in years:

□ 0 – 5   □ 5 – 10   □l0 – 15   □ 15 – 20   □ 20 – 30   □ 30 – 45

1.4 Current Post:.……………………………………………………………

1.5 Name of School:…..………………………………………………………

1.6 School Location: □Urban   □ Semi-urban   □ Rural

2. Academic Qualification(s):

2.1 Qualification(s)………………...…………………………………………

………………………………………………………………………………..

………………………………………………………………………………..

………………………………………………………………………………..

2.2 Specialization: □Science   □Arts   □ Commerce   □Other……….

3. Library Activities

3.1 Books availability

□ Adequate   □Inadequate   □ No books

3.2 Books Source of Funds

□Private   □ Government □ Donors   □Other(s) …………………………..

3.3 Students accessibility to the library books and materials

□ Very Frequently   □ Not Frequently   □ Not at all

3.4 Library opening time in hours

Weekdays: □8 - 18   □8 – 20   □ 8 – 22   □ Other………………………..

Weekend/Public days: □8 - 14   □8 – 16   □8 –18 □ Other……..…………

3.5 Any other services conducted in the library

□   Photocopying   □ Internet Surfing…□..Other(s)

4. ICT Awareness

4.1 □ Computer Literacy: □Excellent   □ Very Good   □ Good   □ Poor

4.2 Do you use computers? (Not necessarily at school only) □YES/ □NO

If Yes, for what?   □ Education   □ Communication   □ Entertainment

□ Other; Specify………………………………………….…….

4.3 How many computers do you have in the library?

□ 1 – 10 □10 – 50 □ 50 – 100 □Other ………………

4.4 Do you agree on using ICT in education?

□ Strongly Agree □ Agree □Disagree □ Strongly Disagree □ Neutral

4.5 In which library activities do you use ICT?

□ Library Information Management System

□ Surfing for educational reference/materials

□ None □ Other(s)…………………………….

4.6 Do you have email address? YES/NO

If Yes, please indicate; ………………………………………………...

4.7 Have you attended any computer course? YES/NO

If Yes, When (dates)……………….…..…..………...………….….……

Where (Name of College/School)......…..……..……….………………….

Achievement…………………………………….………………………

4.8 What are your comments on the use of ICT in education?

…………………………………………………………………………..
…………………………………………………………………………..
…………………………………………………………………………..
…………………………………………………………………………..
…………………………………………………………………………..

4.9 What type of computer based services do you need to facilitate easy conduction of your duties?

…………………………………………………………………………..
…………………………………………………………………………..
…………………………………………………………………………..
…………………………………………………………………………..
…………………………………………………………………………..

B5 – Student's Questionnaire

1. Introduction:

1.1   Full Name (Optional):………………………………………...Gender: F/M

1.2   Age in Years: □11 – 15   □15 – 18   □18 – 25

1.3   Current Study Form

□ Form I   □Form II   □Form III   □Form IV

1.4   If you are in Form III or IV which stream?

□Science   □Arts   □ Other………………………………….

1.5   Name of School:…..………………………………………………………

1.6   School Location: □Urban   □Semi-urban   □Rural

2. Learning Activities

2.1   Which are your favourite subjects □Mathematics □ Physics

□ Chemistry   □ Geography

□ Biology   □ Other(s)

…………………………………………………

…………………………………………………

2.2   Books and reference materials availability: □Adequate   □ Not adequate

2.3   Lecture Delivery Mode: □ Chalk and talk   □ Using Overhead Projector

□ Using Computer

2.4   Are you satisfied with the current mode of teaching? YES/NO

2.5   Please indicate where you need improvement in the whole training;

□ Content Delivery …………………………………………………

□ Assignment …………………………………………………….

□ Time Management …………………………………………………..

□ Feedback …………………………………………………….

□ Laboratory …………………………………………………………...

2.6   Single period duration: □60mins   □40min   □30min

□ Other………..

2.7   Subject Work load: ………period(s)/week   ………….time/week

2.8   Do you have time for any other curricular activities? YES/NO

If NO, why? …………………………………………………………………….

………………………………………………………………………………….

3. ICT Awareness

3.1   Computer Literacy: □ Excellent   □ Very Good   □ Good   □ Poor

3.2   Do you use computers?   YES/NO

If Yes, where?   □ Education   □ Internet   □ Entertainment

Other …………………………………………..…….

3.3   Do you agree on using ICT in education?

□ Strongly Agree   □ Agree   □ Disagree   □ Strongly Disagree □ Neutral

3.4   In which subjects do you want to use computers and related ICTs?

□ Mathematics □ Physics   □ Chemistry □ Computer Studies

□ None   □ Other(s)……………………………

3.5   Do you have email address? YES/NO

If Yes, please indicate; …………………………………………………...

3.6   What are your favourite activities if given a chance of using computers?

□ Surfing the net for information   □ Download music   □ Play games

□   E-mail   □ Chat □ Educationally

3.7   What are your comments on the use of ICT in education?

……………………………………………………………………………..

……………………………………………………………………………..

……………………………………………………………………………..

……………………………………………………………………………..

……………………………………………………………………………..

Appendix C – Publications

In the course of conducting this study, 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.