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

S. K. Lujara, M. M. Kissaka, E. P. Bhalalusesa, and L. Trojer

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

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

I. INTRODUCTION

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

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

II. THE CONCEPTS OF LEARNING OBJECTS

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

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

III. THE SIZE OF GRANULARITY

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

IV. WHY LEARNING OBJECT APPROACH?

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

Majority of current learning materials such as textbooks and computer-based instructions are designed as large integrated packages rather than as collections of small independent components that can be individually used and modified for

multiple purposes [9]. The development of the learning object approach makes it possible for the reuse of learning materials between schools, over a long period.

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

V. CONSIDERATIONS FOR LEARNING OBJECT DESIGN

A. Needs Analysis

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

1) Users' Analysis

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

2) Context Analysis

Formal secondary education in Tanzania is based on traditional F2F class teaching environment which uses teacher-led approach, where the teacher is the master of the learning process and students are passive. Teaching materials are not digitized and the delivery is still 100% talk and chalk. Generally, there are inadequate and obsolete physical facilities and infrastructure, inadequate qualifying teaching staff, inadequate teaching and learning materials and equipment, curriculum is not demand driven and inadequate funding for education programme [11]. Shortage of teachers is almost in all subjects, with acute condition in mathematics and science subjects. Due to the disparities in rural and urban areas - poor economic and social conditions - many schools are not in a conducive teaching environment. Hence teachers tend to concentrate in urban areas which have better opportunities for their welfare. Secondary Schools in Tanzania differ very much in terms of facilities, teachers' employment, number of students enrolled, performance, school ownership, school location (urban/rural), financial capability etc. In all circumstances, the magnitude of the problems is significant in schools within rural areas. With exceptions of very few private schools, the rest of the private and all government schools follow the national curricular set by the ministry of education and vocational training.

3) Content Analysis

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

4) Technical Analysis

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

B) Instructional Design Subject Model

Integrating the analysis of the current subject structure and instructional design concepts, the instructional design subject model will consist of four major objects: overview object,

content object, summary object and assessment object. The structure of the subject model is as shown in Fig. 1.
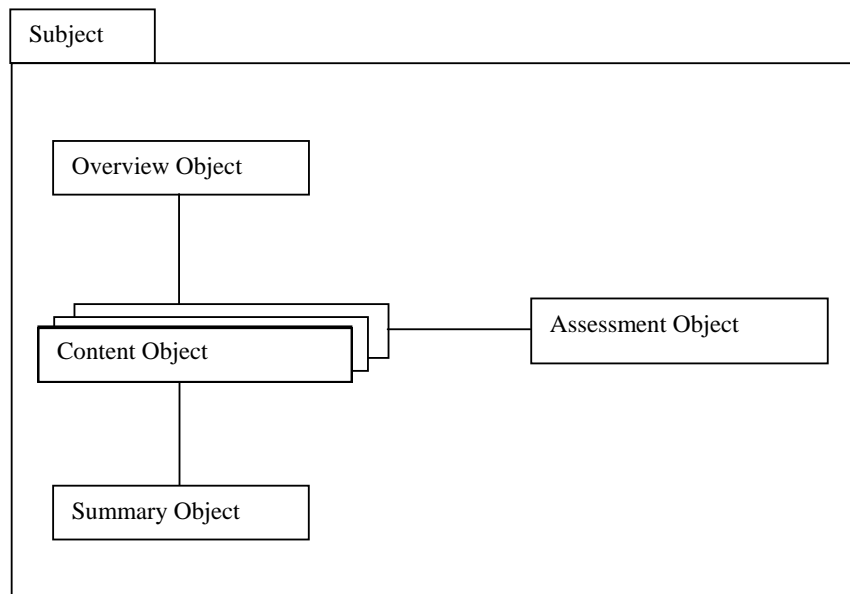

Fig. 1 A Template for Subject Model

1. Overview Object

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

2. Content Object

The content object contains the core content of the subject. The learning object in this case has been treated to have two levels, the first being the chapter level and the second being the topic level. The topic level is formed with a combination of assets, such as a learning objective, required notes, examples and an end of topic exercise. While a chapter level is considered to have aggregation of topics and end of chapter exercise. Some of the attributes in the content object can be domain independent (examples or illustrations which are global) and some can be domain specific situated (example or illustrations which fits in certain circumstances only) depending on the type of the subject and the context of learning. The content objects, that are considered to be domain-independent, are highly shareable and reusable e.g. purpose and descriptions content objects shown in Fig. 2.
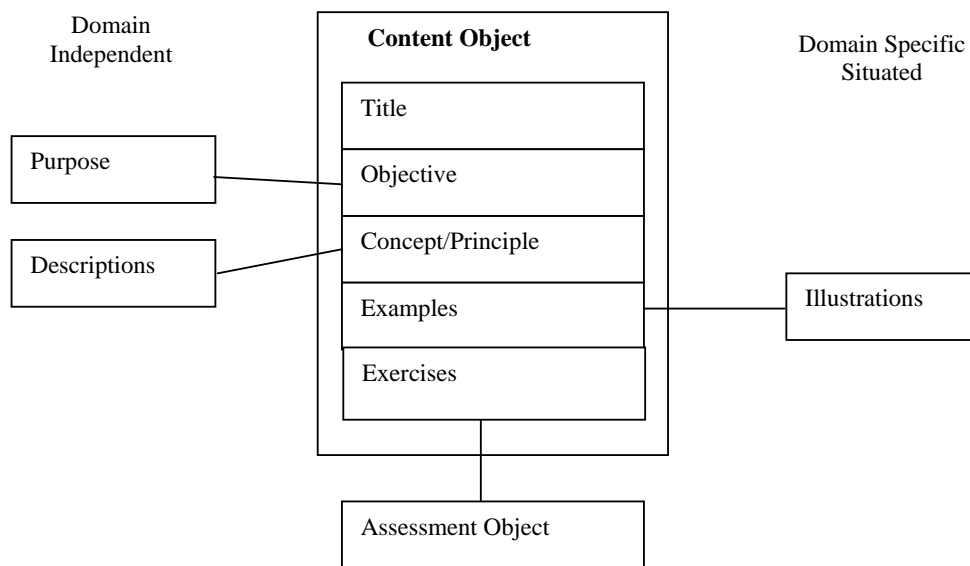
Fig. 2 Template for Content Object embedded with assessment object

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

3. Summary Object

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

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

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

C. Pedagogical Implications

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

VI. CONCLUSION

Learning objects have gained much popularity in recent years, principally because they offer a means of reusing educational material. However, they have been used relatively little in secondary schools education specifically in developing countries. In this paper, considerations for learning
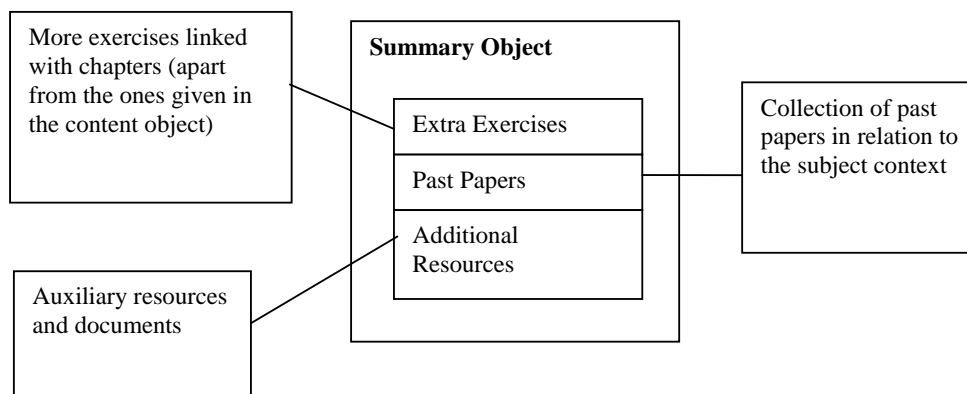
Fig. 3 Template for Summary Object

object designed suitable for developing countries have been elaborated.

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

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

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

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