Chapter 1: Introduction
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1.0 Introduction

Higher Education is evolving through E-learning today. E-learning is fast becoming a force which has presence on almost every campus in developed countries. The role of higher education institutions in E-learning history has been most diverse. In the early days of E-learning, Universities assumed responsibility for concept development from the scratch. Now-a-days besides academic research, universities have found a promising market on work-and study learners who need a more flexible schedule and have specific knowledge needs that can be efficiently matched by on-line learning. E-learning demands a cultural change in the way the learners view education and a methodical change in the way the University faces its new role as a knowledge provider to Virtual Environment instead of traditional classroom based education provider.

As Baker and Gloster [1] aptly point out that “A paradigm shift is taking place in higher education instruction, from a mode of faculty-student interaction occurring in fixed locations at specific times to one in which students can access the same instructional resources in a variety of forms, regardless of location, at their convenience. This is possible because several technologies have matured, supporting major changes in how instruction can be delivered to students, in their homes, or in their work places”. An increasing number of courses, therefore, are now available as hybrid courses in Virtual Learning Environment (VLE).

1.1 Virtual Learning Environment (VLE)

Virtual Learning Environments are defined as the tools that facilitate the integration of Web based materials into the electronic classroom e.g. learning resources, assessment devices, online communication tools [2] [3]. VLE is a growing and dynamic environment in which education is changing culturally,
institutionally and technically [4]. The field of Information Science and Distance Learning is presently passing through a phase of rapid changes. This situation demands an educational system of continuing or life-long learning for new technologies, methods and service procedures. Within this environment, the need is the concept of a planned learning environment which involves the use of technology and is designed in such a way that provides the learners with interactivity between themselves and the instructors. A significant body of research exists that addresses the issues for traditional curriculum development.

This led to the concept of reusability and interoperability of course material so that the students could get the flexibility of anywhere, anytime learning. The terms ‘flexible teaching and learning’ and ‘flexible delivery’ are now commonly used across the higher education sector and in other educational contexts [6]. While the terms are used in many different ways and are associated with many different meanings, one useful definition asserts that flexible approaches to teaching and learning refer both to an educational philosophy and a set of techniques to teaching and learning. The term describes an approach to education that is more learner-centred and that increases the learner’s responsibility for his or her own learning. Flexible approaches increase the degree of student control over when, what, where, how and at what pace they learn.

These include approaches to teaching and learning which are less time and place dependent than more traditional forms of teaching. It is within this environment of teaching and learning innovation that E-learning needs a delivery mechanism using specialized software that assists teachers to create their courses, helps students to use course work and administrators to make previously available coursework reusable. This in the modern scenario has developed the concept of Virtual University Learning Environment. But creating this environment involves the creation of effective E-learning resources which can be transferred for use on other platforms. This is called
Interoperability. The challenge of making resources interoperable across different systems, thus, becomes a major task. At a higher level, tutors often wished to reuse and repurpose learning resources to meet the perceived needs of particular contexts and students. However, learning resources were often monolithic and had to be taken on all-or-nothing basis. The challenge of interoperability, reuse and repurposing of E-learning resources, thus, attracted considerable development effort [7]. The primary response to these problems is a major area of research with numerous international work directed at developing small reusable chunks of educational material in the form of Learning Objects (LOs).

1.2 Literature Review

1.2.1 Limitations to the Current Research Work

The major limitation to this area of research is that the academic users jumped on the fly taking the concept of Learning Objects as the magical box which would eliminate them of the hassles of content creation. They stressed not on their learning value but on their need to be standardized. In the race they developed their own models of E-learning using Learning Objects without resorting to underlying theories and instructional design Principles. The result was obvious, when it turned out that many students did not learn what they were supposed to learn. Undoubtedly some scholars like Wiley [8] investigated the instructional design underneath the Learning Objects in as early as 2000 yet not many others have taken a lead. Therefore, the need of the hour for better and effective utilization of resources is a collaborative model for the generation of learning content that is based on Learning Object paradigm and the learning standards. This integrated approach to the problem of content production includes economic, pedagogical and implementation issues which has seldom appeared in the technical literature. Early academic users in order to follow this open access model, resorted to creating monolithic digital repositories by using proprietary software and
standards without a common data exchange format thereby creating a major limitation in collaborative development of content. The solution to this rests in the development of framework for E-learning using the concept of Learning Objects which when broadened and elaborated can lead to the Model for the Virtual University Learning Environment. To achieve this it is imperative to understand the innermost of the E-learning processes, its life cycle and its infrastructure before proceeding further.

1.2.2 Life Cycle of the E-learning Process

The life-cycle of the e-learning process from planning and preparation of a course to its consumption by the learners is depicted in Figure 1. The life cycle comprises of four phases [9]:-

- **Design** phase, where the targets and requirements are specified
- **Production** phase, where content is produced, assembled and packaged for distribution
- **Deployment** phase, which requires the collaboration of learners in order to distribute the appropriate content
- **Assessment** phase, where the outcome of the whole process is evaluated.

![Figure 1: E-learning Life Cycle [9]](image-url)
For the successful design of a learning process the required features of learners’ profile and the recommended competencies must be defined. It should also specify in detail the educational targets to be achieved by the end of the learning process. The production phase integrates the production of content modules, their build-up based on the initial design, and the packaging of the content to be delivered. The deployment phase that follows considers the ability of users to access the content and collaborate during the learning process. The learning process ends up with the assessment of learners through tests and other activities.

From the above it is visible that during the whole lifecycle, from the design of a course to the final assessment, there is a strong influence between tasks. The learner’s profile is strongly related to the competencies required by the learning process and consequently affects the educational targets. Similarly, the delivery of content requires synchronization of content production, assembly and packaging tasks etc. So to facilitate reusability of content and increase the effectiveness of the learning process, all technical issues must be resolved and interoperability of technologies and systems must be achieved.

### 1.2.3 Learning Objects as E-learning Systems Infrastructure

Learning objects are digital entities that form the basic building blocks to deliver content in an organized and effective way. They have been proven to be effective as aids to accelerate the process of learning. But their construction does not involve a simple method as their nature is directly related to the intricacies of human cognitive and learning processes. Learning Objects differ from ordinary software development because their assembly is not only guided by simple client requirements but by the learning particularities of students who will use them.
Learning Objects are understood to function in three primary ways [10]:

- Guiding (through mentorship, apprenticeship)
- Problem based (opportunities to construct, create, innovate and scaffold)
- Complimentary (supportive material e.g. presentations, glossaries)

Learning Objects contribute to learning by not being the magical black boxes but dwelling upon relationships between them and the learners. According to Polsani [11], a learning object without form or relation is merely a media asset. On the other hand Downes [12] highlights that what counts as a learning object can only be determined by its use, not by its nature. This refers to the pedagogical value a learning object might possess in use. As context and learning aims differ, so any given learning object possesses a pedagogical range. From this it can be concluded that a learning object in itself is merely a tool in the learning process. Learning opportunities and learning experiences need to be facilitated or designed. The pedagogical value of a learning object and a learning object approach is determined by the context of its use and application. Consequently, design for the learning object approach must foreground learning theories that foster relationships between the learning object and engagement. The design of engagement should pay attention to the possible ways in which learning could come about. Just as conventional learning systems are built on theories and models, so e-Learning systems should also be based on appropriate instructional design theories.

1.2.4 Instructional Design Theory

Since for the success of Virtual Learning Environments, the effectiveness of content needs careful consideration at development stages itself so this involves the collaboration of several disciplines [16] such as Instructional System Design (ISD), software engineering and human computer interaction (HCI). ISD is the practice of maximizing the effectiveness, efficiency and
appeal of instruction and other learning experiences. The process consists broadly of determining the current state and needs of the learner, defining the end goal of instruction, and creating some intervention to assist in the transition. There are many instructional design models like ADDIE, Instructional design Plan, Rapid Prototyping etc. but many content development models are based on the ADDIE model with the phases of analysis, design, development, implementation and evaluation. ADDIE is a prescriptive sequential instructional design model which describes the essential components of any instructional development process.

Instructional design theories are design-oriented that describe instruction methods and situations in which these methods should be used. An instructional context defines a relationship between resources and defines the way in which these are presented to the students. An instructional context can define the role that a given resource plays on a learning scenario. Instructional design [13] is important in developing Learning Objects because it permits defining education objectives for which such objects are created and in addition considers different ways of presenting LOs and different uses of such materials having as purpose of Learning.

### 1.3 Perspective of Learning Object approach

The learning object approach allows for teachers and learners to decide on the nature of learning. However, any learning activity inclusive of method, content & assessment will not be suited to every learner so if we consider the essence of the content at conceptual level as in a learning object, then the permutations of its use is more amenable to be used in a design to suit individual needs as they are identified. Teaching will then become less of a mediation of materials and methods, and in VLE it will begin to take on its own personality and identity. Thus, the objectives of the VLE [14] based on Learning Object approach would be summarized as to
• Consider the micro-view of learning object, i.e. what they are, what they seek to do, how they operate, how relationships may be formed between them and learning.

• Consider technologies and tools that facilitate learning through interaction.

• Consider the meta-view of didactical approaches and systems to enable and manage VLE.

• Progress from instructivist to constructivist, from text based to multimedia, from reception to activity & experimentation and from passive to collaborative mode.

• Move towards the participation metaphor

• Personal growth of the learners where:
  ▪ learners begin to learn by working independently and with others, through self determination of what and how they would like to learn
  ▪ by self pacing their own development
  ▪ by beginning to initiate themselves into the community of learning & progressively moving from the periphery towards the centre
  ▪ by determining their individual movement with the zone of proximal development.

Various terms associated with Learning Objects that need deliberation have been defined below:-

1.3.1 Metadata

Metadata are descriptive labels used for cataloging education materials with the purpose of facilitating their tracking and use. They incorporate requirements of materials and the description of the way they can be implemented. Metadata are used for:-

  ▪ Storing descriptive words that are relevant for people using free text search
  ▪ Storing information on the developer
1.3.2 Standards and specifications for developing Learning Objects

The need for reusing materials in different platforms and type of students has caused the creation of standards allowing the documentation, search and distribution of education contents that are generated. Among the most important standards are IMS developed by Global Learning Consortium Inc, Sharable Content Object Reference Model (SCORM) developed by Advanced Distributed Learning Initiative and IEEE Learning Object Metadata (LOM) standard. The idea is to define what metadata or elements of the standard will be used for the learning objects development.

1.3.3 Repositories of Learning Objects

Associating and storing metadata about the Learning Objects makes it possible to search for and locate existing learning objects. For this the learning objects must be stored in an accessible location and form called Learning Object Repositories. The repositories emerge from the need of sharing learning objects coming from several sources and organizing their storage in a way to increase their power of reutilization. As isolated objects they do not have any relevance or real significance. Examples of repositories for learning objects include Wisconsin-Online Resource Center, CLOE, ARIADNE, Merlot, SMETE, HEAL, EduSource etc.

1.3.4 Learning Management System (LMS)

LMS provides an integrated platform for executing, administrating, distributing and controlling teaching learning activities of an organization. Its main functions include managing users as well as education resources and activities, administrating access to the system, controlling and following up
the learning process, making evaluations, generating reports, administrating communication services [15].

1.3.5 Authoring Resources

Authoring resources refer to the tools for creating learning objects. Some of these tools have a traditional perspective while others have a learner-centered perspective.

1.4 Research Objective

So the research effort presented in this thesis aims to address this issue of content development using the Learning object approach and based on this, propose an adaptive user model for the Virtual University Learning Environment (VULE). The research develops a prototype for C++ course thereby depicting how the content development should be done for an effective virtualization of the University Learning Environment. More specifically the research targets the following:-

1. To develop a cohesive and comprehensive Learning Object Model for the Virtual University Learning Environment.

2. To depict how the model for the virtual learning environment can be created with the production of self-paced learning objects catalogued within workforce development curricula.

3. To provide a roadmap that maximises faculty expertise and student’s opportunity to access resources that can be used and reused in teaching and learning environment.

4. To well support the model by demonstrating the authoring, dissemination, packaging and evaluation of learning objects for
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C++ course deliberating on how to meta-tag the authored learning objects and ensure their interoperability and granularity.

During the course of this study, it became apparent that while addressing the above issues, many known standards exist that attempt to answer some of these issues. To avoid re-inventing the wheel, a part of the effort is directed to understanding the motivation and methodologies behind these solutions. A fair comparison is drawn and closest and most efficient standard is chosen towards finding the optimum solution for the learning object. It is also hypothesized that a tool-of-sorts would be needed to demonstrate how these ideas would work in real life. Currently it is envisioned that such a tool will provide functionality to parse the resources, seek metadata and finally assist authors in bundling the resources into learning objects. Additionally, a minimalist implementation, creation and delivery of these digital objects would be required to show how this definition of learning objects would pass through many processes from the time it is created by the author to the time it is archived, stored and finally retrieved and used by the users.

In the longer run, it is hoped that these ideas will help to demonstrate that standardizing the development of learning programs is essential and forms the basic building block for a Virtual University Learning Environment.

1.5 Thesis Outline

The thesis begins first by investigating the current structure of Virtual Universities in Chapter 2. The models that are prevalent and the services that need to be considered while framing a model for Virtual Learning Environment (VLE) in the University is presented in this chapter.

With a clear model of the VLE, it is imminent to see how learning programs would interface with such a system. Though many concepts do exist that
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propose integrating learning programs into VLE, this research (in chapter 3) proposes an updated concept of "learning object" to tackle some of the known and outstanding issues of learning program integration. Additionally, special effort is made to study the various theories and models behind LO creation and based on them this chapter proposes the development model for LO creation that allows reusability and scalability to the content.

Following this, Chapter 4 discusses the technologies that must be chosen for LO development. For this, a study is conducted that compares and contrasts various content development and Learning Management tools and finally identifies the best suitable tool for content creation and VLE. It provides core functionalities of metadata collection, resource compilation and packaging. This chapter stresses upon identifying the effective Content authoring tool and Learning Management System for the study based on certain defined parameters.

Chapter 5 deals with handling, creation and distribution of LO through the chosen Content Authoring Tool and Learning Management Systems (LMS). LMS provides an integrated platform for executing, administrating, distributing and controlling teaching learning activities of an organization. Based on this, Chapter 5 depicts the methodology for creation and dissemination of learning objects using these tools by developing a prototype to teach a course of Programming in C++. Architecture and implementation of the tools is performed with the view to maximize user experience for minimum effort. The GUI layout and usage for the tool is also discussed.

Chapter 6 deals with the evaluation and study of the C++ course designed using Learning Objects. It reviews the current approaches to LO evaluation and allows users to evaluate resources with Learning Object Review Instrument (LORI). This chapter also looks at the student's perception and readiness for learning in a Virtual Learning Environment.
Chapter 7 summarizes the overall tasks accomplished under this thesis work. Based on the inferences drawn, it then proposes an adaptive user Model for a Virtual University Learning Environment. The thesis finally concludes with the future scope of study.

1.6 Thesis Contribution

The aim of this research is to develop collaborative and an adaptive user model for the Virtual University Learning Environment by demonstrating the development of a prototype for teaching and learning of C++ course. The research, in the wake, develops a digitally interactive student management sub system through the application of Open Source Software Architecture & Open Source Course Management Software & Open Standards. The primary aim of this research is to extend the prototype system for providing courseware on C++ course in digital education mode and the secondary aim is to convert the prototype system into a generic platform for delivering all the courses offered by the Virtual University Learning Environment and to propose a model or framework for this learning environment. This model is not restricted to distance education alone, it has all the facilities to support off-campus learning and evaluation activities related to traditional courses of a Virtual University. This model will, therefore, be emerging as a web integrated hybrid E-learning system for delivering C++ course as well as for other traditional courses of any Virtual University. The structure of the proposed model extends support for all three forms of VLE - web-based training, supported online learning and informal E-learning. The software architecture of this model is completely based on Free Open Source Software. This web-based e-learning system will help in

- Establishing interactive student management subsystem
- Producing stronger learning environments, since multiple media can be combined
- Increasing student learning
- Creating an independent study environment
• Providing instant access to information
• Facilitating life long learning
• Ensuring a less hostile learning environment
• Accessing the learning objects from the repository

So the major contribution of this thesis is to design and develop a model for e-learning system which will provide:

• An interactive distributed (Web Based) E-learning system for C++ courseware and a generic VLE to mount and deliver over web all the courseware presently offered by traditional Universities.
• A support system for the traditional class room based courses.
• An integrated learning environment to include
  ❖ Structured learning programmes
  ❖ Learning objects and information resources
  ❖ Communication tools
  ❖ Assessment tools
  ❖ Personal management tools
  ❖ E-tutor tools

To support and validate the design and development of the proposed research model, various research papers have been published by the researcher as part of this research in National and International Journals and few have been presented at the International conferences as well. Papers VIII, IX in the List of Publications (page xv-xvi) relate to the Chapter 2 of the thesis in which the concept of Virtual University Learning Environment (VULE) is elaborated. Research papers XI, XII and XIII are related to the Chapter 3 where the concept of Learning Objects and their correlation to Virtual University Learning Environment is highlighted. Papers I,II deal with Chapter 4 in which the tools to create and disseminate content in VULE are identified. Research Paper IV and VI explains the perception and readiness of students for a Virtual Learning Environment and relates to Chapter 6 and
research paper III, VII, VIII discuss the model for the VULE explained in Chapter 7.

An in-depth study of the literature dwelling upon the models for the development of Virtual University has been studied to propose a framework for the Learning Environment. These models have been dealt with in detail in Chapter 2.