Managing Knowledge With Learning Objects

Dr. Elena Dikova Shoikova, Vladislav Krassimirov Denishev

Technical University – Sofia, Department of Electronices, eLearning R&D Laboratory
tel./fax 962 40 49, http://demlab.vmei.acad.bg, email: shoikova@vmei.acad.bg

This paper presents the anatomy of an e-learning solution, based on the notion for storing information in the form of Learning Objects. It is considering the development of a LCMS for the needs of Bulgarian universities.

1. Anatomy of a Typical E-Learning Solution

At its highest level, a complete e-learning solution is comprised of three core components, with the organization and learner at the heart (Figure 1):

- Content
- Services
- Infrastructure

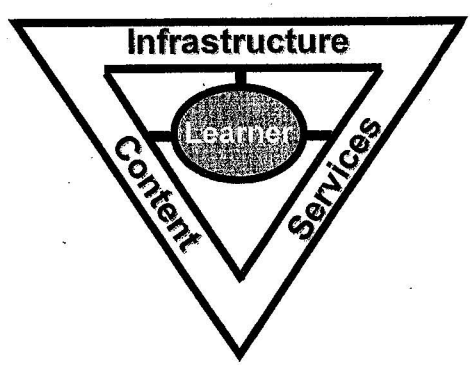

Figure 1: E-learning solution anatomy

Within an organization, content requirements will vary in terms of subject matter, preferred format (text, video, simulations) and language.

Successful implementations of e-learning technology require appropriate planning, customization, integration, and application management.

Infrastructure includes application-level software that allows all aspects of learning, from classroom to web, to be created, managed, delivered, and measured. It allows building on classic networking and enterprise infrastructure services and standards, such as IP-based networks, web browsers, databases and industry standards such as Oracle, Microsoft Windows, and Sun Solaris.

There are three primary sets of technologies that can be integrated to provide an infrastructure framework for delivering e-learning services (Figure 2):

- Learning Management System (LMS),
- Learning Content Management System (LCMS), and
- Virtual Classroom (VC).

The **Learning Management System** includes a database of student records, administration and delivery interfaces for learning. It provides functionality for

competency and skills management, skills gap analysis, resource management, inter-connectivity with VC, LCMS, and enterprise applications.

The **Learning Content Management System** provides a link between knowledge management and e-learning. IDC defines a LCMS as a system that is used to create, store, assemble, and deliver personalized e-learning content in the form of Learning Objects. It provides functionality for content migration and management, learning object repository, content reuse and adaptive individualized learning paths based on learning objects, asynchronous collaborative learning via email and discussion groups, testing and certification, inter-connectivity with VC, LMS, and enterprise applications.

The **Virtual Classroom** technology is designed to support synchronous collaboration by allowing a live classroom experience to be conducted over the web. It should enable the following functionality:

- Voice over IP (VoIP)
- Video conferencing
- Shared whiteboards, application screen sharing, and live feedback
- Archiving of classes as learning objects
- Inter-connectivity with LMS and LCMS.

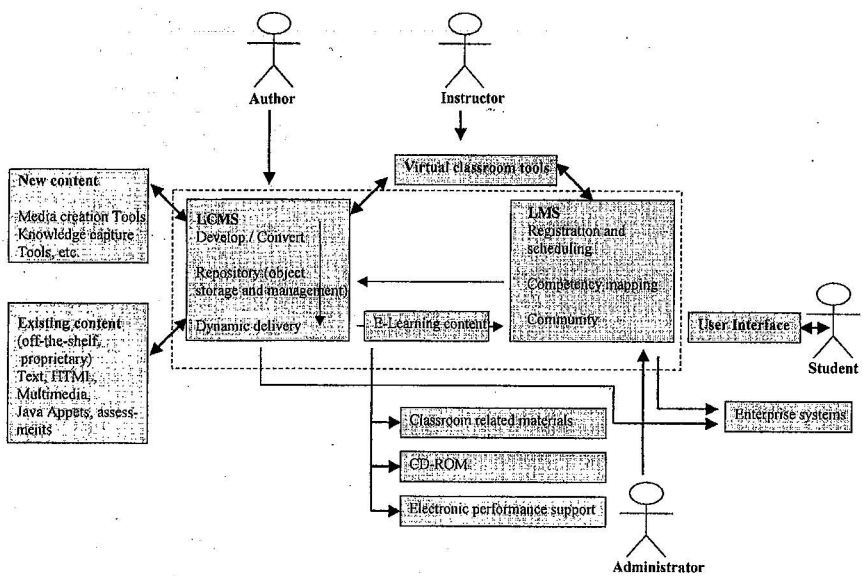

Figure 2: E-learning system architecture

2. INTEROPERABILITY IN E-LEARNING

Interoperability in e-Learning means conveying a message in a uniform method usable by heterogeneous users to learn. It emphasizes the need to have a standard communicating methodology (protocols) between various components of e-Learning.

Any e-Learning system operates on:

- Off-line instructional activities
- On-line content
- Data analysis

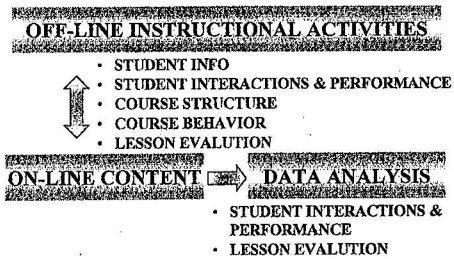

Figure 3: Interoperability in E-learning

On-line content consists of instructional elements, structure and behavioral elements. The instructional elements include all the lessons, tests and other assignable units in the course to meet specific objectives of the course. The structure of on-line content determines the order in which the instructional elements are to be experienced by each student. Behavior can be expressed as the progression logic philosophy for the whole instructional material of a course. It is determined by a specific behavior description.

Off-line instructional activities include functions to define demographic data of students, student classes and assignments. The instructor is responsible to oversee the day-to-day training operations and intervene when necessary. The assignment manager controls student assignments based on sets of rules, standard approach to lesson initiation to provide a method to start-up lessons. Student logon functions control and manage student access. The system maintains student-accessible data records and displays the student's current assignments.

Data analysis is a function to collect and maintain performance data on student at all levels of courseware presentation and to provide standard analysis on performance of the courseware to meet the objectives.

3. MANAGING KNOWLEDGE WITH LEARNING OBJECTS

The notion for Learning Objects allows any part of a course to be modularised, saved, and reused as an entity, essentially leading to the reuse of content at any level of granularity such as courses, lessons, modules, and even a single page. The Learning Object is the fundamental building block of content in an e-learning solution. It essentially is a structured, reusable learning module created to accomplish

a specific learning objective. XML-based metadata describes each learning object in the object repository (Figure 4).

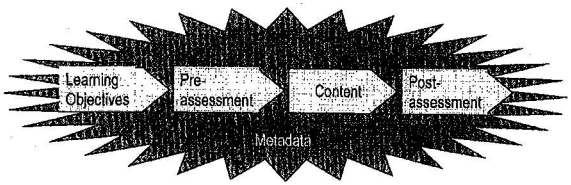

Figure 4: The Learning Object

- **Learning objectives** – the object is assembled to help learners achieve specific educational goals.
- **Learning content** – essentially the material used to convey the subject matter.
- **Pre-assessment** – before working with the content, users may undergo a pre-assessment to ensure the prerequisite knowledge necessary to complete the learning task at hand.
- **Post-assessment** – after working with the content, users typically undergo some form of testing to appraise whether or not they have sufficiently accomplished the objectives.
- **Metadata** – it is used to describe what the object contains. Objects are catalogued using subject-specific metadata and can be indexed, searched, and reused.

The **IMS Content Framework** (Figure 5) provides specifications for on-line learning content that allows authors to build online learning content, administrators to manage and distribute content and learners to interact with and learn from that content. The complete, identified scope of the IMS Content framework is large and complex. To reduce the complexity and decrease the amount of time needed to complete a first specification, the scope was broken down into three, main parts: Content Packaging Scope and Content Management Scope.

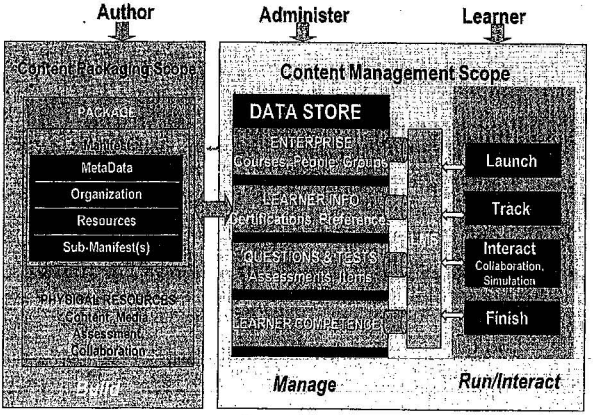

Figure 5: IMS Content Framework

4. Distributing Learning Objects Using Packages

IMS Content Packaging specification aims at facilitating the import, export, split and assembling of learning materials through differentiation between contents and packaging of a resource.

The standard IMS Package consists of two major elements: a special XML file describing the content, organization and resources in a Package, and the physical files being described by the XML. Once a Package has been incorporated into a single file for transportation, it is called a **Package Interchange File** – a single file, (e.g. .zip, .jar, .cab) which includes a top-level manifest file named "imsmanifest.xml" and all other physical files as identified by the manifest. A Package Interchange File is a concise Web delivery format, a means of transporting related, structured information. A **Package** is a logical directory, which includes a specially named XML file, any XML control documents it references (such as a DTD or XSD file), and sub-directories containing the actual physical resources. The **Top-level Manifest** is a mandatory XML element describing the Package itself. It may also contain optional (sub)Manifests. Each instance of a manifest contains the following sections:

- **Meta-data** section – an XML element describing a manifest as a whole.
- **Organizations** section – an XML element describing zero, one, or multiple organizations of the content within a manifest.
- **Resources** section – an XML element containing references to all of the actual resources and media elements needed for a manifest, including meta-data describing the resources, and references to any external files.
- **(sub)Manifest** – one or more optional, logically nested manifests.
- **Physical Files** – these are the actual media elements, text files, graphics, and other resources in their various sub-directories as described by the manifest(s).

A Package represents a unit of usable (and reusable) content. Once a Package arrives at its destination to a run time service, such as an LMS vendor, the Package must allow itself to be aggregated or disaggregated into other Packages. A Package must be able to stand-alone; that is, it must contain all the information needed to use the contents for learning when it has been unpacked.

Packages are not required to be incorporated into a Package Interchange File. A Package may also be distributed on a CD-ROM or other removable media without being compressed into a single file. An IMS Manifest file and any other supporting XML files required by it (DTD, XSD) must be at the root of the distribution medium.

A **Manifest** is a description in XML of the resources comprising meaningful instruction. A manifest may also contain zero or more static ways of organizing the instructional resources for presentation.

The **Resources** described in the manifest are physical assets such as web pages, media files, text files, assessment objects, or other pieces of data in file form. Resources may also include assets that are outside the Package but available through a URL, or collections of resources described by (sub)Manifests. The combination of resources is generally categorized as "content".

5. Storing Learning Objects In Digital Repositories

IMS defines digital repositories as being any collection of resources that are accessible via a network without prior knowledge of the structure of the collection. Repositories may hold actual assets or the meta-data that describe assets. The assets and their meta-data do not need to be held in the same repository.

The IMS Digital Repository Interoperability Architecture maps out three entity types that define the space where e-learning, digital repositories, and Information Services interact, and which provide a context for exploration of the problem space. The three entities are:

- Roles (e.g., Learner, Creator, Infoseeker, Agent)
- Functional Components for Resource Utilizers, Repositories, Access Management, and Procurement Services
- Services, such as Registries and Directories (not part of the DRI Phase 1 scope)

Work is on the way to provide means to:

- Identify and Locate Services, Objects, People and Resources
- Manage Digital Rights
- Organize Request/Deliver Services

6. Conclusions

The learning object paradigm gives the best solution to the problem of reuse and flexibility of knowledge. The proposed models give the foundation of an authoring tool that will enable the creation of learning objects, assessment sequences and course hierarchies. It will also provide instructional support to content authors.

7. References

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