DESIGN, IMPLEMENTATION AND EVALUATION OF A LEARNING CONTENT MANAGEMENT SYSTEM

by

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ABSTRACT

DESIGN, IMPLEMENTATION AND EVALUATION OF A LEARNING CONTENT MANAGEMENT SYSTEM

Learning content management systems (LCMS) are designed to enable subject matter experts to design, to create, to deliver and to measure the result of e-learning courses quickly. LCMS applications offer a scalable platform to deliver proprietary knowledge to individual learners. This study aims to develop and to implement a SCORM compliant LCMS that can be used by educators with varying degrees of background knowledge on educational technologies. Therefore, the study will mainly focus on understanding the usability of the developed system among students at the faculty of education with varying degrees of computer literacy.

In order to anticipate usability problems and errors as early as possible in the software development process, two usability studies were conducted, namely beta and validation study. Beta study had been conducted at the late development phase of the system and aimed to test BU-LCMS with target user groups performing representative tasks to ensure able/functional product. The system and data collection tools were also revised according to the results of the beta study. After completing the revisions that beta study results emphasized, a validation study, conducted at the end of the development process, aimed to verify that BU-LCMS meets previously identified users needs. The results of the study indicated significant improvements in mean usability scores from the beta to the validation study, indicating that the assessments and revisions following the beta version were effective in improving the usability needs. Furthermore, in order to show that BU-LCMS could effectively be used by different groups of educators, the mean of usability scores calculated for different groups and results showed that there is not statistically significant difference among groups.

ÖZET

BİR ÖĞRENME İÇERİK YÖNETİM SİSTEMİNİN TASARIMI, GELİŞTİRMESİ VE UYGULANMASI

Öğrenme içerik yönetim sistemleri (ÖİYS) konu uzmanlarının e-öğrenme derslerini hızlıca tasarlamasını, oluşturmasını, dağıtmasını ve sonuçlarını ölçmesini sağlar. ÖİYS uygulamaları bireysel öğrencilere uygun bilgiyi sunmak için ölçeklenebilir platform sunar. Bu çalışma eğitim teknolojileri ile ilgili değişik seviyelerde bilgi sahibi olan eğitimcilerin kullanabileceği SCORM uyumlu bir ÖİYS uygulaması geliştirmeyi ve uygulamayı amaçlamıştır.

Uygulama geliştirme süreci içinde, kullanılabilirlik problemlerinin ve hataların mümkün olduğunca erken farkına varmak için pilot ve geçerleme olmak üzere iki değerlendirme çalışması yapılmıştır. Pilot çalışma, BU-LCMS'in hedef kullanıcı grubu ile seçilen görevlerin gerçekleştirebildiğini test etmek için geliştirme aşamasının sonlarına doğru yapılmıştır. Bu çalışmanın sonuçlarına göre sistem ve veri toplama araçları gözden geçirilmiş ve geliştirilmiştir. BU-LCMS'in geliştirilmiş versiyonunun daha önce tanımlanan kullanıcı ihtiyaçlarını karşıladığını test etmek amacıyla geçerleme çalışması yapılmıştır. Pilot çalışması ile geçerleme çalışması arasında kullanılabilirlik testi sonuçları bakımından anlamlı bir değişme tespit edilmiştir. Bu sonuç, pilot çalışmadan sonra yapılan revizyonların kullanıcılarının sistemi kullanma kolaylığını arttırmada etkili olduğunu belirtmektedir. Ayrıca, değişik seviyelerde teknoloji becerilerine sahip ve farklı özelliklerdeki eğitimcilerin BU-LCMS'i kullanışlılık açısından değerlendirmeleri arasında istatiksel olarak anlamlı bir fark olmadığı tespit edilmiştir.

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LIST OF ABBREVIATIONS

ADL	Advance Distributed Learning
AJAX	Asynchronous JavaScript and XML
ANOVA	Analysis of Variables
API	Application Program Interface
CMC	Computer Mediated Communication
CMS	Content Management System
CRM	Customer Relationship Management
CSS	Cascading Style Sheet
ERP	Enterprise Resource Planning
HRMS	Human Resource Management System
HTML	Hyper Text Markup Language
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
KMS	Knowledge Management System
LCMS	Learning Content Management Systems
LMS	Learning Management System
LOM	Learning Object Metadata
PIF	Package Interchange File
SCO	Sharable Content Object
SCORM	Sharable Content Object Reference Model
UTF	Unicode Transformation Format
WML	Wireless Markup Language
WYSIWYG	What You See Is What You Get
XML	Extensible Markup Language

1. INTRODUCTION

Current interest regarding web use coincides with increased use of different methods of teaching and learning at universities and with increasing use of the Web to deliver courses to internal and external students (Collins and Murphy, 1997). All the academic community is reaching out to join with educators in the creation of new information resources and instructional materials. Teaching is no longer a knowledge transfer task. It is, however, a mediating process where the instructor aids and guides students to construct knowledge with the help of educational technology. University instructors are expected to take professional approach to teaching. They need to know more than merely their subject. They need to know different styles of teaching the subject; how students perceive the subject, what misconceptions students may develop, and how students develop meta-cognitive skills. Academics should change the way they approach to teaching, as knowledge, students and supportive technologies change. The universities should not only work on producing more environmentally friendly, economical and productive systems, they should also concentrate on learning with technology to improve the quality of education and training (Akpınar and Erkunt, 2003). As Serdiukov (2001) puts it "a distance higher educational institution should be able to satisfy any request by a current or potential student". A school providing distance education has to contain and offer all possible materials, tools and support for the students. Basically, only the most comprehensive system will survive the competition and test of time. Considering this, universities to run and support learning and teaching activities over web can easily integrate their current tools, databases, record keeping facilities and intranets to distant support and learning resources to be developed in-house.

In this particular study, it is aimed to develop a learning content management system (LCMS) that can be used in order to create interactive learning content. The system was designed to be used not only by computer specialist but also computer literate educators. In order to assess and improve the usability of the system, two studies were conducted,

2. LITERATURE REVIEW

2.1. Learning Content Management Systems

2.1.1. Obstacles to Web Based Learning

The key benefits of e-learning packages and environments supported by e-learning include several advantages (Alistair, Ling and Joosten, 1999; Akpınar, 2002; Berge, Collins and Dougherty, 2000). Firstly, increased quality and value of learning is achieved through greater student access and combination of appropriate supporting content, learner collaboration and interaction, and on-line support. Secondly, accessibility and flexibility enable learners to engage in the learning process anytime, anyplace and on a just-in-time basis. Furthermore, they allow for decreased cost of learning delivery, and reduced travel, subsistence costs and time away from the job. Finally, they enable increased flexibility and ability to respond to evolving business requirements with rapid roll-out of new and organizational-specific learning to a distributed audience.

To manage web supported and web based learning content and educational facilities; there are different software environments mostly developed by commercial companies. However there have been many obstacles to realize online courses for campus based students, some of these obstacles may be summarized as follows (Akpınar, 2002):

- Overvaluing technology tools: Many practitioners and education market assume that software tools such as www, e-mail, ftp, Internet search engines that are able to solve problems of learning environments. Some of those tools are used to convey and transfer the content. Others are to be used when the users do not understand the content and wish to improve the presented materials. The pedagogical use of tools mainly depends upon the strategies and construction of the learning environment, hence instructional designers. The software tools alone should not be seen as the learning environment. The content to be conveyed and discussed through tools should be the focal point of instruction.

- Graphic manipulation tools require special hardware and expertise: Although hardware and software are getting relatively cheaper, manipulating graphics professionally and editing videos require rich hardware and experience in using those software tools.

- Academicians' dilemma over distance-learning environment: Many academicians are biased on distance-learning environment. They approve students of other institutions to attend distance courses and they accept delivering online courses to students of other institutions. On the contrary, they do not approve their students to attend distance courses.

- Unreliability of Web based measurement and evaluation: Some measurement and evaluation activities may be online in e-education. Non-proctored online measurements are seen unreliable. Many people and institution think that the grades in online courses are superficial, that, in turn, makes distance degrees unaccountable.

- Adults are not used to read and study materials online: Many adults have problems with screen-based information perception and don't have online study habits. That makes setting online instructional strategies difficult.

- Individuals spend long hours in front of computer screen: Having to spend long hours in front of computers full of unusable screen objects may be harmful for individuals.

- Limited digital resources in libraries: Since libraries, a must for learning, are still short of resources such as e-journals and e-books, students in online modules may lag behind on-campus students.

- Market pressure to universities: Software companies and marketing business force universities to use new technologies in learning and demand

implementation of e-learning. That requires universities to re-structure sources, procure new hardware and software for e-learning.

- Limited number of experts in developing distant courses: Courseware development is a professional activity requiring a group of experts. There are limited number of individuals educated in instructional design, courseware development and media design for instruction. Hence the materials prepared for online instruction are poor in embedded instructional strategies.

- Limited laboratory facilities for applied disciplines: Off-campus students, especially in applied disciplines, need to work with laboratory facilities; however those sources are not easily accessible. That makes online modules limited in practical works.

- Unequal opportunity for online distance education: Since online learning costs, generally high cost, to institutions and that has to be shared with individual customers. Online distance education becomes for wealthy individuals only.

2.1.2. From Content to Learning Content Management Systems

In institutions and organizations of today, from employees to costumers need speedy access to information and knowledge. Information exchange between business and consumers, between business and business, between business and employees provide the core of knowledge, experience and expertise which support both organizations and their users and customers. To collect all information in an organization continuously requires great effort as they will be provided by different individuals/departments in different formats including text, graphics supported with text, images, videos and audio and may be animation. The format of each chunk of information may comply with a different set of digital applications. A department might provide its textual information in MS Word format, another provides it in Adobe pdf format, an information author submits his training materials in slide presentation and another author submits his materials in an authoring system file. Once information is collected, it is to be made accessible, understandable,

linked to relevant body of information resources and perhaps reorganized. The collected information is also to be updated, corrected, approved and archived. In this cycle, it is obvious that information content is an asset that must be managed. Hackos (2002) proposes that if the content developed in a modular and structured form, updating chunks of content without having to recreate the entire collection will be easy; chunking, structuring and labeling turn content into a valuable commodity. To ensure integrity, volume, creation, dissemination and storage of content, organizations need the support of technology to keep the system active. The technology that supports information creation, storage and dissemination is defined as content management system. A content management system (CMS) in an organization may be used for product development, marketing, sales support, order management, customer relations, supply chain, information development, technical support and publication and training. Four primary components of a CMS are authoring, linking and publishing, assembly, and repository (Hackos, 2002). In a typical CMS, information is either authored by the organization or brought in from outside the organization, but it is the content and once linked and placed into the CMS, it is ready for viewing and studying by the target users. The content in a CMS is kept in the form of information objects stored in CMS repository. Information objects can be searched and retrieved by authors and others in need of information. All the interactions of users with the information objects may be monitored and controlled by the CMS. The concern of learnability of the content is not a question and the most effort is put on the setup and production of the content.

Data and information are not enough to make decisions based upon organized and filtered knowledge. As the amount of knowledge increases and as the characteristics of knowledge changes, knowledge based decision become more and more critical. Furthermore, rapidly accessing knowledge becomes vital for both academic and non-academic organizations. Knowledge and information have become the medium in which business problems occur. As a result, managing knowledge represents the primary opportunity for achieving substantial savings, significant improvements in human performance, and competitive advantage. Knowledge management can be thought of as the deliberate design of processes, tools, and structures. with the intent to increase, renew, share, or improve the use of knowledge represented in any of the three structural, human and social elements of intellectual capital (Haggie and Kingston, 2003). Hence, content

management systems are specialized as typical data/information management systems and, as an evolutionized format, knowledge management systems (KMS). Although these systems contain data, information and knowledge as a content may also be an ingredient of a learning/training environment when structured within a curriculum frame. Because any content in any form can not be interacted with students, new type of content manipulation and management systems are needed.

2.1.3. Learning Content Management Systems

Unlike CMSs and KMSs, in learning content, there is plenty of content components to disseminate and interact with students. All concern is on shaping the content to the curriculum, organizing a learning environment for it or with it, considering learner profiles, arranging learning activities and planning evaluation schemes. In the first outlook, it seems that there is at least one difference between a CMS and LCMS and that is the learnability/teachability of the content, a pedagogic spirit. Thus a CMS cannot be a LCMS. Many LCMSs that are available in the market either provide features that belong completely to CMSs only or neglect the pedagogic spirit of learning content. There is therefore need to develop LCMSs which can embed and integrate interactive activities and other pedagogic components into the learning content package.

To realize web based learning, organizations need to own and/or have access to some e-learning tools: these are e-learning content development platform(s), web based assessment tools, content management systems and learning management systems. The tools in the first three categories are now compiled in a Learning Content Management System (LCMS) which is the corporate version of traditional course management systems that were initially developed for higher education. These systems are designed to enable subject matter experts, to design, create, deliver and measure the result of e-learning courses quickly (Chapman and Hall, 2004). LCMS applications offer a scalable platform to deliver proprietary knowledge to individual learners. Whereas learning management systems (LMS) enable organizations to plan and track the learning needs and accomplishments of students, employees and customers. An LMS can link organizational goals to employee jobs and competencies. It can also provide a catalogue of available (and relevant) courses, books, and training events, and deliver content in classroom-based or e-

learning formats. The system also has the ability to register learners for courses or charge expenses to the appropriate credit card or cost center.

Learning management software markets remain immature, with widely varying sets among products and diverging views about what systems should do and where the markets should be headed in the future (Jonassen and Churchill, 2004). Major universities and corporations tend to have online education and training services groups that develop in-house learning systems. A study showed that there are 434 different Learning Management Systems available (Chapman and Hall, 2004). An easier approach is to license complete LMSs from vendors. Small enterprises tend to contract with turnkey providers that specialize in assisting faculty with the conversion of their course content to web pages. Technology is seen as the easy part, but hard part is institutionalizing the technological facilities. Customization of vendor made LMSs is expensive and as time consuming as developing a new LMS. Moreover it is difficult to adapt them to already used organizational databases and knowledge management software. Getting to know vendor made complex systems such as LMSs and training staff for administration and maintenance is costly and more time consuming. Content development systems present either very sophisticated tools or very simple templates for authoring distance education material. To produce a sound distance-learning environment the authors have to work long hours, develop new skills or work with an experienced programmer or script-writer.

LMSs have fully evolved into Web-based systems, managing both online and off-line courses, supporting a global enterprise system and being integrated into other enterprise-level systems (e.g., CRM, ERP and HRMS, or human resource management system, applications). The term “learning content management system” (LCMS) was coined by a consortium of software vendors to differentiate from standard LMS vendors. LCMSs and LMSs share similar names, they do, however, have different functions. LCMSs are focused on content whereas LMSs are focused on learners. A LMS's primary function is to manage the learning process for a student. This process typically includes identification of a need, such as a skill gap, registration of students for a learning activity (including classroom-based activities), tracking of a student’s progress, and reporting and analysis. LCMSs and LMSs are complementary technologies. For example, content generated by an LCMS should be easily catalogued in an LMS so that learners can find it,

launch it, and have their progress tracked by the LMS. Although the implementation of an LMS is an important tool for strategic deployment of learning and the long-term benefits are important, it doesn't guarantee that a company or an institution will actually deploy e-learning. Chapman and Hall (2005) outline features of LMS and LCMS as in Table 2.1.

Table 2.1. Some features of a LMS, a LCMS and the BU-LCMS

	LMS	**LCMS**	**BU-LCMS**
Primary target users	Training managers, instructors, administrators	Content developers, instructional designers, project managers	Content developers, instructional designers, Teachers and trainer
Provides primary management of...	Learners	Learning content	Learning content
Management of classroom, instructor-led training	Yes (but not always)	No	No
Performance reporting of training results	Primary focus	Secondary focus	Secondary focus
Learner collaboration	Yes	Yes	Yes
Keeping learner profile data	Yes	No	No
Sharing learner data with an ERP system	Yes	No	No
Event scheduling	Yes	No	No
Competency mapping – skill gap analysis	Yes	Yes (in some cases)	No
Content creation capabilities	No	Yes	Yes
Organizing reusable content	No	Yes	Yes
Creation of test questions and test administration	Yes	Yes	No
Dynamic pre-testing and adaptive learning	No	Yes	No
Workflow tools to manage the content development process	No	Yes	No
Delivery of content by providing navigational controls and learner interface	No	Yes	Yes
Learning object repository	No	No	Yes
Task and activity space for learning objects	No	No	Yes

2.1.4. Learning Content Authoring and Industry Standards

In order to define technical foundations of a Web-based learning environment Advanced Distributed Learning (ADL) organization developed a model for creating and deploying e-Learning. The model is named as Sharable Content Object Reference Model,

commonly known with the acronym of SCORM. It is a model of a set of interrelated technical guidelines designed to meet requirements for learning content and systems. The SCORM aims to foster creation of reusable learning content as "instructional objects" in a common technical framework for both computer-based and Web-based learning (Adlnet, 2005). SCORM specifies a "Content Aggregation Model (CAM)" and "Run-Time Environment (RTE)" for learning objects to support presentation of content based on criteria such as learner objectives, preferences and performance. Although this process is said to be adaptive, it has limitations.

SCORM targets the Web as a primary medium for instruction delivery assuming that anything that can be delivered by the Web can easily be used in other instructional settings. This makes fewer demands on accessibility and network communications. SCORM, is continuing to evolve, currently provides an Application Programming Interface (API) for communicating information about a learner's interaction with content objects, a defined data model for representing this information, a content packaging specification that enables interoperability of learning content, a standard set of meta-data elements that can be used to describing learning content and a set of standard sequencing rules which can be applied to the organization of the learning content. Conformance assures that SCORM conformant content can be deployed in a SCORM conformant LMS. Designers/developers of content make decisions regarding reusability, data tracking and sequencing based on the project requirements. Therefore, SCORM conformant does not mean that all elements of content is reusable. Mainly, SCORM conformant means that an author or owner has tested the content or LMS using the Conformance Test Suite software developed by ADL (Adlnet, 2005).

Similar to ADL, Instructional Management Standards (IMS) develops and promotes the adoption of open technical specifications for interoperable learning technology. The scope for IMS specifications, broadly defined as "distributed learning," includes both online and off-line settings, taking place synchronously (real-time) or asynchronously. This means that the learning contexts benefiting from IMS specifications include Internet-specific environments (such as web-based course management systems) as well as learning situations that involve off-line electronic resources (such as a learner accessing learning resources on a CD-ROM). The learners may be in a traditional educational environment

(school classroom, university), in a company or government training setting, or at home. For example, the IMS Learning Resources Meta-data Specification (www.imsglobal.org/metadata), benefits the learner looking for information with a meta-data aware search tool both when the search is of web-based resources and when she or he is searching through a CD-ROM or DVD-ROM encyclopedia in their computer at home. IMS affiliates with many organizations such as Advanced Learning Infrastructure Consortium (ALIC), Coalition for Networked Information (CNI), IEEE/LTSC – Learning Technology Standards Committee, MERLOT, Online Computer Library Center (OCLC), and Schools Interoperability Framework (SIF).

IMS technical specifications to be used in SCORM are in four categories of information:

(1) IMS Content Packaging: provides the functionality to describe and package learning materials, such as an individual course or a collection of courses, into interoperable, distributable packages.

(2) IMS Metadata: aims to create a standardized set of descriptors for educational and, by extension, scientific resources. These descriptors must be both machine and human readable.

(3) IMS Question Test and Interoperability: describes a basic structure for the representation of question (item) and test (assessment) data and their corresponding results reports.

(4) IMS Simple Sequencing: defines a method for representing the intended behavior of an authored learning experience such that any learning technology system (LTS) can sequence discrete learning activities in a consistent way.

As there are many organizations and bodies on development of specifications for learning technologies, the detailed information and background on learning standards may be obtained from the following sources:

Though there are many settlements on learning technologies and their specifications, there has been a fierce debate over SCORM. According to Rehak (2002), "SCORM is essentially about a single-learner, self-paced and self-directed. It has a limited pedagogical model unsuited for some environments." He emphasized that SCORM is not the right approach for higher and primary education. This is mainly a consequence of the needs of US Department of Defence which is the main initiators of SCORM. Their needs are mainly in the area of training for specification. Wiley (2002) states that software vendors and standards bodies describe their learning object related work as being “instructional theory neutral; however many critics have challenged that assertion, claiming that the standards tend to ignore the importance of pedagogy. Other critics (e.g. Jonassen and Churchill, 2004) believe that SCORM, far from being “pedagogically neutral” encourages a pedagogy that is behaviorist, didactic and instructive. Although the rationale and the structure of SCORM is not yet mature, the lesson for LCMS developers and/or LCMS seekers is to look for a system conformant to at least some of the SCORM requirements so as to help maturation of the standards and content exchange.

2.1.5. Difficulties in Developing a SCORM Compliant LCMS

In order to make a LCMS conformant to SCORM requirements, main difficulties may be outlines as follows:

First, SCORM standards are immature and rapidly changing.

Second, although SCORM has comprehensive manuals, finding SCORM compliant examples are not easy or found examples are not finished completely.

Third, finding information or experienced person about SCORM standards is extremely hard, especially when the technical help is needed.

Fourth, there are many SCORM tags and applying all of existing SCORM tag is a big burden both programmer and user. Deciding the tags which are necessary is not a simple task most of the time.

Fifth difficulty is that SCORM standards highly based on the client scripting and needs SCO files in HTML format not in a dynamic format such as .aspx or .php. So, quizzes and other measurement tools in the SCOs must rely on client scripting. It restricts the flexibility of the programmer and also brings security weaknesses.

Sixth, although the term, SCORM, is widely known in e-learning companies and in related departments of universities; it is not known by the users, teachers and students.

Last difficulty is that manual implementation of the SCORM standards requires technical knowledge and experience.

Chapman and Hall (2005) also stress another criticisms in their study that there are some dismal failures where learning content management technology has been completely misused or misunderstood; where technology designed to make modular learning content easily reusable has literally created a source of mass information overload, in which learning objects (topics) are linked together in sequences that don't make sense or provide misinformation when presented out of context, serving to confuse rather than educate. In some ways the technology has outpaced our ability to use it wisely. LCMS vendors continue to add innovative new feature sets, when most authors are still grappling with some of the basic concepts of learning object design.

2.1.6. Learning Objects in Learning Content Management Systems

One product of the SCORM is learning objects. The term, learning object, has been getting attention of many educators and trainers in recent years. Wiley (2002) implies that learning objects may have other uses as well as instructional usage. There are LCMSs and web sites for creating and editing learning objects. Some of these are very challenging in terms of helping to create interactive learning objects even though they provide environments simpler than any standard web site development and free management environment.

The information sets contained and delivered in electronic systems are somehow managed either as files or database record or objects. The file size and structure in those systems differ. In the context of LCMSs, size of asset or element changes from author to author. One can choose to define a letter, word, sentence or paragraph as the smallest granule, asset or element of her course or subject matter to be taught. According to the Institute of Electrical and Electronics Engineers (IEEE) Learning Technology Standards Committee (LTSC) - Learning Object Metadata Working (LOMW) Group (ltsc.ieee.org), learning objects are any digital or non-digital entity which can be used, reused or referenced during technology supported learning. In this definition, the entity is actually controversial and has been the cause of many debates. Computer Information Systems Corporation (CISCO) systems defined a two level hierarchy of objects in which five types of reusable information objects, as concepts, facts, principles, process and procedures were used to build a larger structure based on a single terminal objective called reusable learning object. Barritt and Alderman (2004) define a learning object as "an independent collection of content and media elements, a learning approach (interactivity, learning architecture, context), and metadata used for storage and searching" (see Figure 2.1 for a typical learning object structure). The term metadata refers to a collection of keywords, attributes and descriptive information that tells authors, learners and systems about characteristics of a learning object. This relatively rich set of data is critical when using applications and databases throughout learning object creation and delivery process. Learning objects should take account of the following features (Barritt and Alderman, 2004):

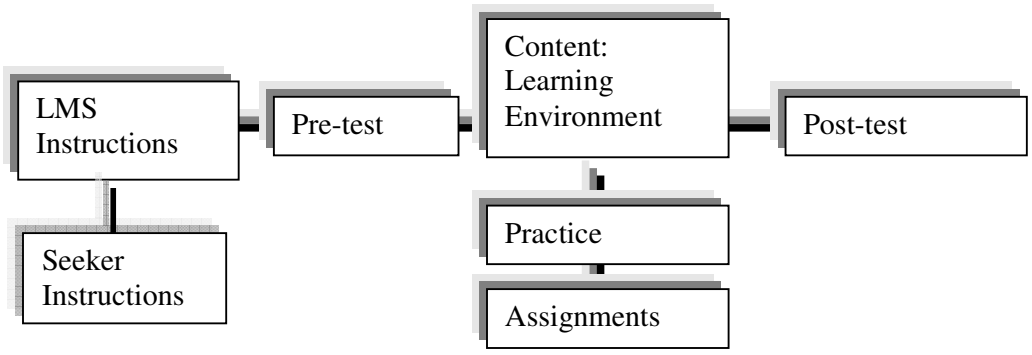

Figure 2.1. A typical learning object structure

- Objective based: Learning objects should aid accomplishing at least a single instructional objective by combining a set of elements of content, media and interactivity.

- Context free: Content, media and interactivity are combined to form a meaningful structure so that the learning object can stand alone from the rest of its associated hierarchy, making it independent, portable and reusable learning experience.

- Interactive: Although it is not always a required property, engaging learners and making them active participants in the learning experience is a key to technology based learning.

- Self-descriptive: Search data (metadata or identity elements) associate with each element and learning object to be used by the system, authors and learners.

- Self-contained: Each learning object is capable of serving alone.

- Single-sourced: A learning object is prepared in a way that can be used by multiple authors in many learning environments in many delivery formats.

- Format free: To be used in multiple delivery media ranging from print to e-learning, learning objects should be created format free. Formatting happens during delivery.

2.1.7. Problems with Learning Objects in Learning Content Management Systems

Each learning object should cover an instructional learning objective in order to have context free and granular structure, and in order to be used more than one content area. However, instructional objectives in many learning tasks are not a few, but more than thirty. In order to prepare one learning object for each learning objective and to aggregate

certain number of learning objects for a learning task may be a complex task for some. Once each objective of a learning unit is to be covered in a separate learning object, then it would not be possible to embed the entire learning unit into a story which would contextualize, concretize and proceduralize the content. Jonassen and Churchill (2004) also argue that (1) the reusable learning strategy poses vital problems from a learning perspective as it reflects traditional behavioral learning theory that sequences frames; (2) no learning objects have been defined by CISCO or LTSC for learning by doing; (3) separating knowledge from application de-contextualizes the content which robs it of from its meaning, (4) reusable learning objects must be expanded to support the more complex interactions that are required for meaningful learning. Thus, a learning object should also be designed to enable accomplishment of a set of instructional objectives rather than a single objective.

The IEEE Learning Technology Standards Committee (LTSC) is chartered by the IEEE Computer Society Standards Activity Board to develop accredited technical standards, recommended practices, and guides for learning technology. Learning Object Metadata Working Group of the IEEE Technology Standards Committee has identified seventy-four categories fewer than nine mainstream categories for describing the types of data contained in a learning object. Table 2.2 outlines those categories. This meta-tagging is tedious and many of those categories seem to be unnecessary, and complicate the instructional design process which is already a neglected process. As teachers or adult learners will select learning objects by comparing them, meta-tagging with some 74 tags make it difficult to compare learning objects.

Table 2.2. An outline of learning object metadata categories and some subcategories

Category	**SubCategory**
General	Title Language Description Keyword
Life cycle	Version Status
Meta-metadata	Metadata scheme Language
Technical	Format Size Location Duration
Educational	Interactivity type Learning resource type Interactivity level Difficulty
Rights	Cost Copyright
Relation	Kind Resource
Annotation	Entity Date Description
Classification	Purpose Taxonomy path Description Keyword

Educational issues in learning objects are addressed in one set of categories with insufficient critical information about instructional interactions on the objects. The interactivity type classified as “active, mixed and expositive” does not take the nature of learning into account sufficiently. The learner-learning object interaction could be so rich that it cannot be simplified. On the contrary, the interactivity level is classified under five sub categories as very low, low, medium, high and very high. The categories of interaction type are expected to be more than categories of interaction level. It seems that interaction is

only seen as physical manipulation of the objects, and not as a form of cognitive involvement. A further mechanical look to instruction and learning in metadata categorization is about the difficulty of a learning object. For example, the difficulty level seems to be taken as an absolute rather than being considered in relation to learner characteristics. When difficulty of a learning object is tagged as "very difficult" which would then be studied by a student who has necessary cognitive entry behaviors and skills, and who can easily connect existing knowledge to content of the learning object, would the learning object be still very difficult or would such tagging be meaningless? Learning objects are developed to help learning that means a particular learning object is easy to learn and learning with that learning object would be easier, in this regard, tagging learning objects as difficult or very difficult would not be meaningful. The metadata should focus more upon interactivity, cognitive involvement and functionalities of the learning setting.

Jonassen and Churchill (2004) suggest multiple metadata describing a learning object as information, activity, conversation, knowledge, thinking and learning artifact objects, but this study suggests a different approach where rather than focusing on labeling, learner-content interaction should be the primary requirement and possibly the only standard. Once learner-content interaction is met, practical tagging could be implemented. They also argue that current conceptualizations of learning objects support traditional, objectivist forms of instruction. While there are no implicit restraints on the concept of learning objects in terms of their complexity, interactivity, and cognitive functionality, the current industry standards cannot describe the rich interactions necessary for meaningful learning, such as problem solving. Therefore, in addition to be able to facilitate the development of learning objects for individual learning objectives, this study will further explore that an LCMS with facilities to construct large in size and SCORM compliant learning objects that may help online material developers.

2.1.8. Related Studies

Experiences with the LMS (Akpınar, 2002; Akpınar and Erkunt., 2003; Major, Ainsworth and Wood, 1997) showed that having entire control of multi-function tools like LMSs give flexibility and freedom to make any modifications required by the users. The experiences and the collected data from the lecturers who used the LMS (Akpınar and

Erkunt, 2003) also demonstrated that currently available authoring systems have many facilities but their use is problematic. Major issues that seem problematic can be listed as;

1) Developing interactive programs with authoring tools needs intensive scripting.

2) Planning and developing instructional material with authoring tool also take time.

3) Authoring environments are expensive compared to conventional programming platforms.

4) Long script developing requires advanced knowledge of authoring.

5) Authoring environments may create problems when used in server platforms.

6) Video editing on authoring environments is still problematic and requires advanced knowledge.

7) Creating web based materials through authoring tools require expertise.

Commercial software developers bombard teachers with a wide variety of software packages even for a single learning unit. Teachers, therefore, must be aware of potentials of presented software packages; be selective and conscious of the pedagogical value so that correct packages are chosen and used efficiently. Real classroom interaction requires the addressing of specific learning problems and customization of lessons on an on-going basis. When teachers are able to design and alter applications, they will then be better able to solve learning problems. Many educators (Twining; 1995, Finlayson and Perry; 1995; Resnick, 1993) believe that using computers efficiently in instruction demands knowledge and understanding of hardware and software, philosophical understanding of the nature of subject and pedagogical skills and abilities related to class organization, management and teaching styles. According to Dunlop et al (2000) teachers need (1) to derive information from, monitor the use of, and utilize the special resources that computer network technology makes available; (2) to have quick and easy access to the information salient to

their planning; (3) notification of salient information and feedback about student progress and problems as well as teaching changes, and (4) ways of managing computer group work that allow for a better understanding of the actions of computer-mediated groups and their instructors and a better ability for teachers to make adjustments. Moreover, planning for remote collaborative work needs to be more flexible and relaxed to allow for instructional differences.

Computerized learning environments should not be built only by expert programmers. Rather, it is necessary to continue developing new types of cognitive environment tools, so that all teachers can participate in the construction of new technology rich learning environments. A number of sophisticated tools have emerged for creating interactive multimedia software including commercially available products. The general purpose tools serve a variety of functions; however offer little in the way of design constraints governing the type of software which can be produced. The result is a tool supporting a broad range of possible applications, but none of these applications can be created with much guidance from the tool itself. Tools for the design of educational software still aim to support creation of any possible kind of instruction. In doing so, they base the interaction around general models of instruction, which unfortunately are too general to serve as a specification for a piece of educational software and fail to help a teacher in creating such software (Bell, 1999). There is a rough principle that authoring tools tailored for specific tasks or instructional situations can better support the needs of the student and author/teacher for those situations (Murray et al., 2003). Many researchers (Salomon, 1990; Welch and Brownell, 2000) point out that technology is effective when developers thoughtfully consider the merit and limitations of a particular application while employing effective pedagogical practices to achieve a specific objective. For example, Hasebrook and Gremm (1999) argue that learning gains are mainly due to instructional methods and thus many researchers aim at making their tutoring systems more effective using "intelligent" software technologies to adapt to the learners' demands, abilities and knowledge. The same applies to web-based educational applications, which are often limited to the capabilities of "electronic books" with little scope of interactivity for the student. Recently, there have been many research efforts to transfer the technology of intelligent tutoring systems and authoring tools over the Internet. However the development of such educational programs is a hard task that needs much effort from

domain and computer experts. Since available courseware packages alone may not meet adaptability requirements of students in different needs and teachers may need cooperation of other teachers in coping with students' learning problems, the courseware packages should invest on teachers' intellectual capacity and provide teachers with collaboration tools to make courseware facilities fit to individual students.

As Major, Ainsworth and Wood (1997) state that the task of authoring must be simple enough that a trained teacher without experience in computational skills would be able to use the system effectively. Although relatively little research has been undertaken to assess the difficulties of these tasks for different groups of authors (*e.g.* experts and novices), what evidence suggests is these demands are hard even with experienced teachers who are highly computer literate (Major, 1994). To achieve usability at the instructional level, the authoring system must offer instructional control which provides the teacher with the key decisions in a way that can easily be manipulated. It must provide the critical dimensions of a strategy without offering so many instructional choices that the task becomes unreasonably complex. Unlike traditional authoring tools such as Toolbook or Authorware, LCMSs have a centralized content repository which resides on a server. This enables multiple users to easily share and re-use content, even if they are at different geographical location. For example, if someone has already created an image, everyone authorized can search for it in the repository and insert it into a lesson without having to create it from scratch.

2.2. User-Centered Design and Usability Testing

Software should be easy to learn, easy to remember and allow users to accomplish their task in a reasonable amount of time (Wahl, 2000). It means system should be usable. According to ISO 9241-11, Guidance on Usability (1998), usability is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." Similarly, Graham (1998) defines usability as "how easy an interface design is to understand and to use". Graham also lists properties of a user-friendly document as;

1) let the user read or play any content at will;

2) have unambiguous interactive controls and

3) a clear navigational scheme.

Rubin (1994) defines user-centered design (UCD) as techniques, process, methods, and procedures for designing usable products and systems. Another definition of UCD is "an approach to designing ease of use into the total user experience with products and systems" (Vredenburg, Isensee, and Righi, 2001). Principles of usability were listed as; self-descriptiveness, controllability, suitability for task, conformity with user expectations, error tolerance, suitability for individualization, and suitability for learning (Wahl, 2000).

Usability testing and laboratories appeared in the early 1980's (Shneiderman, 1998). In software design, evaluation of usability starts with first step of software life cycle which is need analysis and continues up to the end of the software development process (Rubin, 1994). Wahl (2000) categorized evaluation techniques as; Participatory design, focus group research, surveys, design walkthroughs or structured walkthroughs, paper and pencil evaluations, expert evaluations, usability audit, usability testing, field studies, and follow up studies.

Usability is one of the most important facet of the overall quality of interactive applications such as LMSs and LCMSs, it has been mainly applied to general features of applications, such as interface design, choice of the icons, interaction style, etc. (Nielsen, 1993; Schneiderman, 1992), but very few methods have been proposed that take into the proper consideration the specific nature of an application. LCMSs need to be evaluated in different ways with all target users including teachers, system administrators, database and network managers, and software engineers.

In sum, findings and suggestions from recent theoretical and empirical studies show us that the development of a SCORM compliant Learning Content Management System can help teachers design their courses in an electronic environment if it provided that it is flexible and easy to use. The present study was inspired by a need to develop a system that can easily be used by in-service and pre-service teachers or by any educators. The main

concern during both the development and evaluation of system was to afford that it could be easily be used by educators even when their computer literacy was limited.

3. METHODOLOGY

3.1. Research Question

This study aims to develop and to implement a SCORM compliant Learning Content Management System that can be used by the educators who possess varying degrees of background knowledge on educational technologies. Therefore, the study will mainly focus on understanding the usability of the developed system among education faculty students with varying degrees of computer literacy.

3.2. Development of BU-LCMS

The issues that discussed with eight lecturers who used previously developed LMS to prepare online materials and the relevant literature (Chapman & Hall, 2001; Alistair et al., 1999; Bourdeau &. Bates, 1997; Akpinar, 2002; Berge et al., 2000) raised that the lecturers use educational materials ranging from paper based notes and PowerPoint presentations to simulations and videos both in conventional learning environments and web based instruction; Most lecturers have limited opportunity to restructure their learning material, as they work under time pressure and lack technical skills; Managing very different learning assets either in categories of gif, text, sound, animation, video and drill files compiled in folders is a hassle for some lecturers; Keeping stacks of course assets, monitoring versioning of these and reorganizing and reusing these for different learning tasks may be a complex task for some lecturers; To easily manage and aggregate small modular learning objects, users need technical support by L(C)MS; The lack of widely established standards for the structuring and representation of learning content is a hindrance for the application of learning objects; As agreed by some of the lecturers, in standard authoring tools and web page editors, learning content and environment are statically connected. Hence for each topic, every subtopic has to be produced anew (Hitzke et al., 2002); It was confirmed that currently available authoring systems have rich content development tools, but use of these tools require experience and skills that the lecturers who are interviewed do not have time to do; Dressing learning content with standard tags

(e.g. SCORM) is not known and is neglected by the lecturers. In addition to these, the literature review revealed the following features from a LCMS.

To overcome the aforementioned disadvantages of content and authoring platforms and to provide lecturers with the tools facilitating student learning, this study aimed to develop, an easy-to-use LCMS (BU-LCMS) requiring content authors with little technology expertise and integrate it to an already in-house developed LMS, BULMS (Serdiukov, 2001). The target system is able to accommodate dynamic nature of instructional content and learner needs. It therefore provides design and implementation teams with a software kernel structure to which teachers; designers and programmers can easily attach any content with small amount of effort. The architecture can handle and execute any content inputted. It helps to integrate textual content, sound, movie and animations to software packages, and enabling multimedia platform creation. Further it supports SCORM standards (SCORM, 2004; Schluep, 2003), allowing developed content to be used in different LMSs based on the idea of reusable learning content as sharable content object. In the LCMS developed by this study, the system should allow and encourage developers to design and construct interactive objects where ILE features will flourish.

The type of information that a LCMS or a learning environment will handle through authoring or organizing can take many forms:

- Different type of text, structured or unstructured, linear or non-linear
- Links and relationships,
- Photos, two and three dimensional images, drawings and video images,
- Sound, music and voice,
- Gifts, animations and simulations,

- Web pages and sites,
- Slides,
- Symbols,
- Imaged information such as forms and template documents, and
- Data.

All these information might be created using traditional tools such as scanner software, spreadsheets, word processing, painting tools, HTML editors, gifmakers, video editors/capturers and some general and specific purpose software. No matter what the source of information and content is, all of them stored in a file management system will be labeled in some way like (1) typical file names stored on a server, (2) tags to identify and address internal parts of each file, (3) metadata attached to the files or objects stored in a database. By using file and content manipulation; this study will further explore and realize a LCMS with the following guidelines in mind.

- All teachers can participate in the construction of new technology rich learning environments. Easy to use interface is needed.
- Teachers may need cooperation of other teachers in coping with students' learning problems. LCMS should provide teachers/authors with facilities that take students' learning problems into account. The learning object metatagging should also be extended to cover experiences with a particular learning object. If there has to be tags associated to learning objects, tags should be about effectiveness of set of learning activities, learning objects or learning asset. Students' or trainees' reaction to learning materials are more informative to learning object seeker.

- Since available courseware packages alone may not meet adaptability requirements of students in different needs and teachers may need cooperation of other teachers in coping with students' learning problems, the courseware packages should count teachers' intellectual capacity and provide teachers with collaboration tools to make courseware facilities fit to individual students.

- Multiple users should easily collaboratively construct, share and re-use content within a LCMS as well as re-use after development. Reusable learning objects must be expanded to support the more complex interactions that are required for meaningful learning. Thus, a learning object should also be designed to enable accomplishing a set of instructional objectives. Size of learning object should be determined by authors.

- The learning object to be developed should be objective based; activity based, but more importantly should allow learning by doing.

- The learning object to be developed should be interactive and embed knowledge into story, hence contextualization is encouraged.

- The learning object to be developed should be format free.

- The metadata should focus more on interactivity and cognitive involvement and functionalities of the learning setting,

- LCMS should help online material developers, time, place and platform independent content authoring should be facilitated.

To enhance reusability of learning content, a LCMS should follow the strategies suggested by Shleup, Ravasio and Schär (2003): (1) use of small modular Learning Objects, (2) a standard mechanism to embed multimedia, (3) standardized structured content, (4) cross-media publishing, (5) centralized content management, (6) workflow support, and (7) internationalization (this may not be a principle for a non-commercial

product). Additionally, requirements specification phase of the LCMS development provided a description of what the final LCMS is expected to provide. Lecturers using or plan to use e-content were asked to provide information about type of facilities they prefer in a LCMS. The data is combined and synthesized with the design team's LCMS configuration. The requirement specification study revealed that the facilities of the BU-LCMS (The architecture of BU-LCMS is given in Figure 3.2 and some database components are given in Figure 3.1.) should be as follows:

- Tools to design, create, deliver content
- Instructional design templates
- Accommodate content created in different authoring systems
- Adapt content to fit a learner's personal profile
- Enable control of content (content aggregation)
- Have easy to use conversion tools for different file formats
- Interface to LMSs
- Maintain a secure set of user privileges, permission levels
- Manage course content and timing
- Manage enrolment and progress of learners
- Provide facilities for on-demand tutoring
- Provide facilities for students to collaborate (chat, forums, e-mail etc)

- Provide facilities for subject experts/lecturers to coach

- Support reusable learning objects

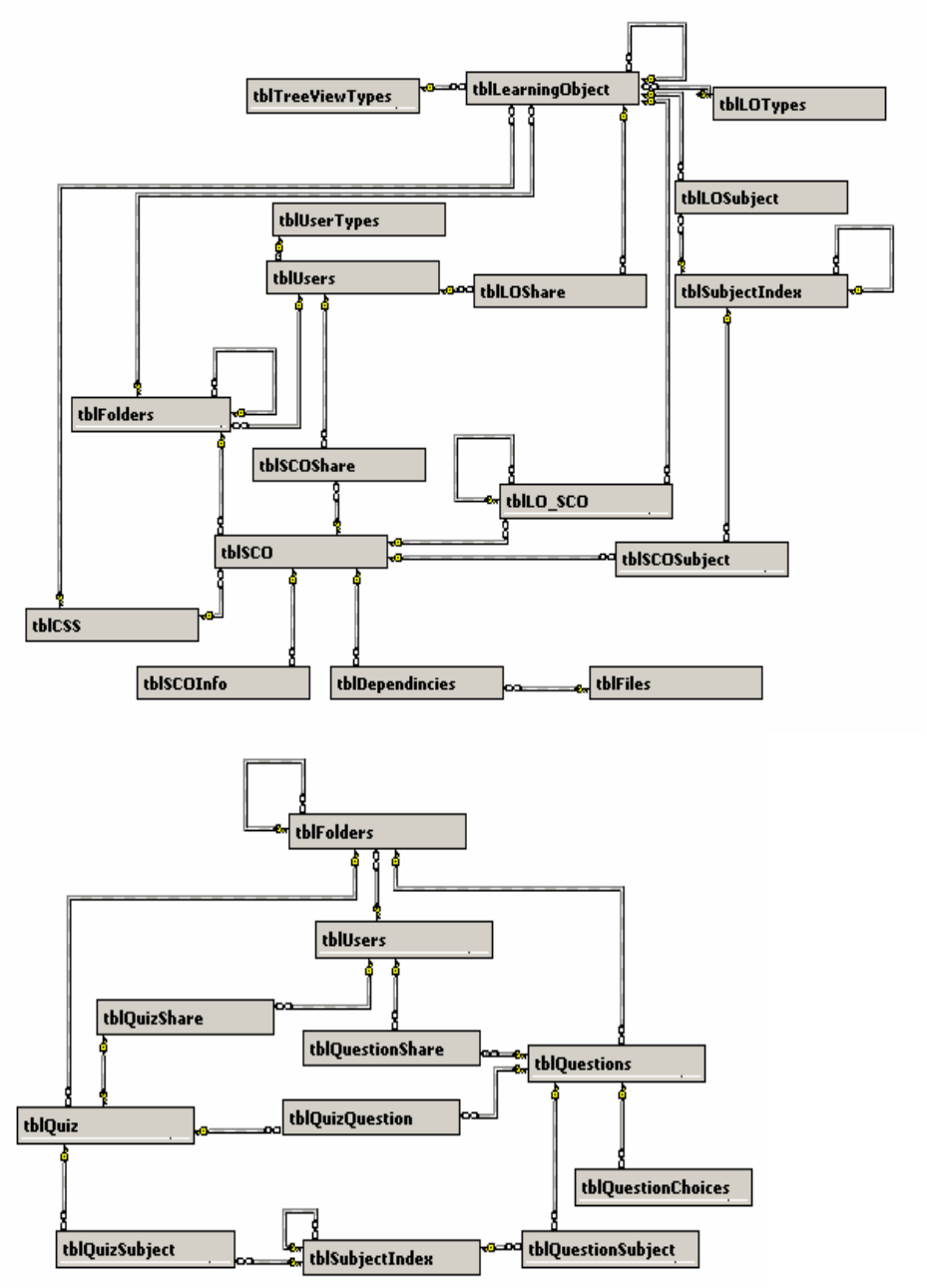

Figure 3.1. Structure of the BU-LCMS database and learning object repository

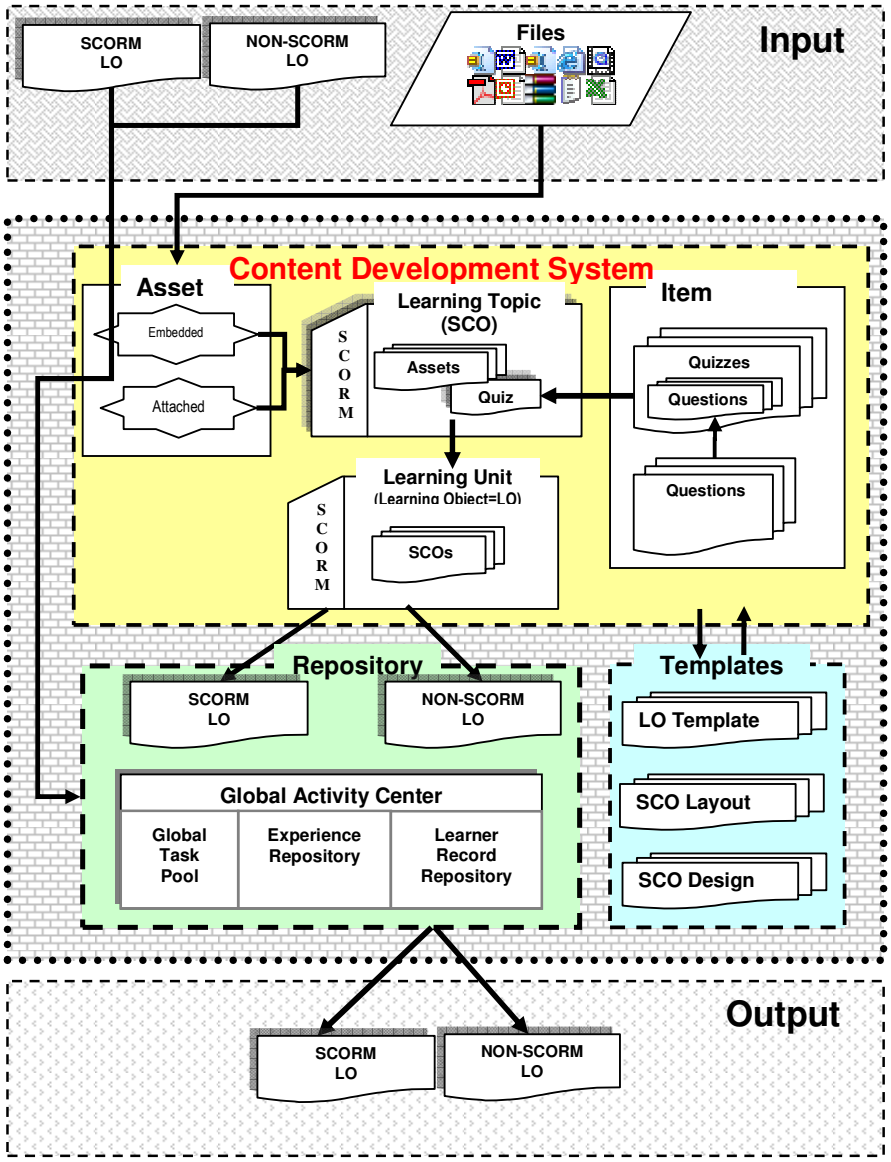

Figure 3.2. Architecture of the BU-LCMS

3.2.1. Task Authoring and Teacher Collaboration Tools in BU-LCMS

In conventional learning environments, teacher plays an important role in determining what and how students learn throughout their activities. Teachers are responsible for monitoring the flow of each student's activities, playing a meta-cognitive function for the students by probing their knowledge and reasoning, monitoring participation and student engagement. Student activities must be rich and needs based so

that teachers make their educational diagnosis and intervention accordingly (Akpinar & Bal, 2006). As student needs vary and those needs may be fulfilled with different task regimes, it would be functional for teachers to have access to a large activity pool which is constructed and enriched by teachers. BU-LCMS accommodates such an activity pool managed within a global activity center.

Because Internet provides a means of easy communication and knowledge exchange platform, teachers can collaborate to construct and tailor task based upon their students' performance records. A set of online tools and resources support teachers as they, in turn, support the students through active process. This set of online resources outlines a suggested sequence of activities based on what has worked in the past; each activity listed is linked to additional information regarding the purpose of the given activity, an elaboration of what the activity entails, and tips for when to intervene. This set of resources provides a teacher with practical strategies for how to guide students' work. To accomplish these functionalities and to make them an internet communication medium, this study constructed a three module collaborative work platform for teachers: These modules, accommodated under a Global Activity Center, are Global Task Pool, Experience Repository and Learner Record Repository.

Global Task Pool (GTP): It is a database of task prepared by teachers and uploaded to the system. It contains tasks, objects of tasks, operators to be used for tackling each task and prompt for each task and level of students for whom tasks could be used. The task pool would be enriched by contribution of other teachers teaching the learning task. Through criticism and suggestions over a particular task or task regime would enable teachers to work with better quality tasks constructly validated by colleagues. An important characteristic of study tasks which are used in this type of learning and teaching environment is the authenticity of the activity to be engaged in. Teachers' collaboration will help producing more authentic activities and GTP will store them for further usage.

Learner Record Repository: One of the benefits of computational learning environment is to keep record of students' performances in a given learning activity. When those performance records are taken into account in developing new or altered activities, the learning environment is more likely to respond students' needs. When teachers

customize learning activities, they may refer to students' records provided by other teachers of different school(s) in the same or different regions, and have an idea of students' behaviors over a series tasks. They may either use the same series of tasks or data from using that similar series of tasks. Such learners' record repository would be more helpful to the teachers when the records contain information about students' learning difficulties and teachers' experiences on overcoming those difficulties and teachers' experiences on student reactions.

Experience Repository: Global task pool provides teachers with a set of tools in order to share their experiences about student reactions to a task or task regime. Once a teacher uploads her tasks used in a classroom may also share her experiences and observations about students' performances and outcomes. These could be result of comprehensive analyses of particular students' learning process of work or a description of learner-task interaction. Further, students' task manipulation and learning styles, actions after an activity the type of intervention they needed, and the type of additional help required may be stored in the Experience Repository.

An activity building community is to be achieved through fast communication means of Internet. Then, colleagues experience sharing, a rich learners' profile and large number of authentic tasks may be obtained. The productivity of interactions in the global activity center is to a large extent dependent on the amount of time available for communication, number of teachers willing to cooperate and teachers' contributions to the pool. Design of global activity center should encourage participant teachers to engage in developing meaningful practices through cooperative collaborative processes. The global activity center will develop a climate where commenting on each others' work and giving and receiving feedback are integrated and routine part of the collaborators' work.

3.2.2. Creating Sample Learning Object in BU-LCMS

To create a small set of learning content, an authorized author has to follow these steps:

- In the LCMS, learning materials are grouped to constitute a learning unit, size of which varies and depends on its author. The author clicks at the root icon, kernel of the system, to initiate creating a learning unit. In the root, the author may get a list of available learning units and learning topics; a learning topic is a subset of a learning unit. The LCMS supports both constructing a learning unit and constructing an asset, a granular learning content.

- The author specifies the title and description of the material she is creating, selects a template, object type, tree view type, background and foreground colors, selects style sheet; selects to create as template or to share it as "public template", and decides to include it in the subject index of the LCMS. The subject index of the LCMS may be used by the system to search the object repository of the LCMS, or by the authors to manage associations of their materials for learning topics and units.

- Once the author enters relevant information and selects, for example, LO template tutorial-1, the learning unit frame will be created. The author will then receive screen where the name of her materials appears with four sub-sections, namely Introduction, Objectives, Images and Free others. The author may select any sections and designs (see Figure 3.3, Figure 3.4 and Figure 3.5).

- The object order in the system is very hierarchical, once a LO template is used, the author may make modifications in the order of the learning topics, digital components of the unit. For example in the template, LO template tutorial-1, the author is given four sections namely Introduction, Objectives, Images and Free others. The author may wish to re-order the sections and may want "Free others" to appear after "introduction" section:

- The author may use the editing palette to design and modify screen layout of each learning topic or asset. The edit palette contains facilities to edit text, picture, table, web page, hypertext and external file management including file insertion.

- Once the set of learning material is organized by the author(s), the author may wish to scormify and pack it. The LCMS handles these tasks as follows:

- There are two facets of the implementation of the SCORM standard in a LCMS. One is the human side, interface part, the second is the machine, technical part. Since the target group that will use the BU-LCMS is neither computer engineers nor e-learning specialist [instructional designers] but university teachers, users' effort have to be minimal in both of these phases. SCORM uses some strict names like asset, sco, learning object, etc. for the components of the e-learning content. In BU-LCMS, in user interface part, these labels were converted into ones that are more understandable such as files, learning topics and learning units. Content organization of the learning object is provided manifests and sub-manifests in SCORM. In BU-LCMS, tree view architecture is used to create and manage the content organization of the learning units. In order to provide a usable interface for the LCMS, some advanced SCORM tags are hidden under the "advanced" button.

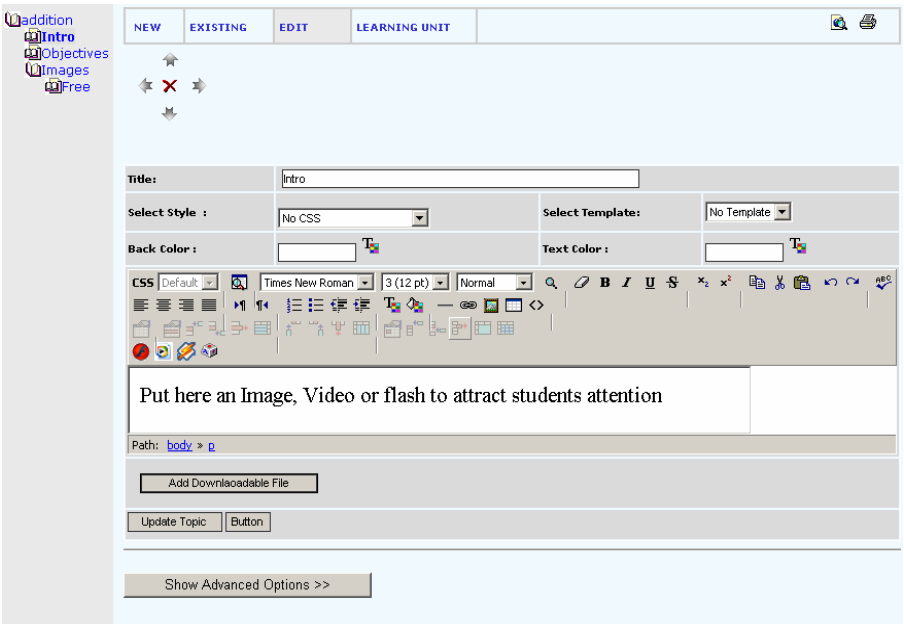

Figure 3.3. A screenshot from BU-LCMS: Editing object

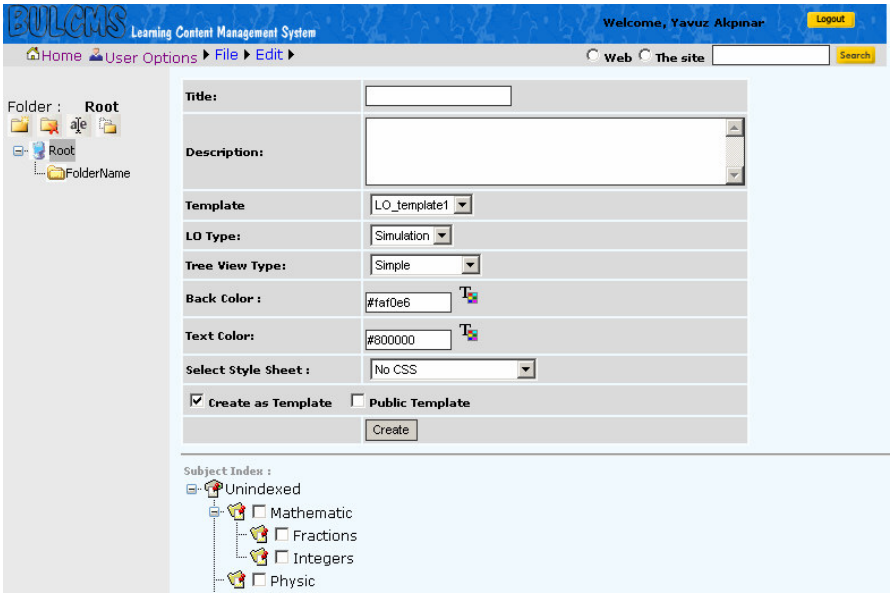

Figure 3.4. A screenshot from BU-LCMS: Defining object

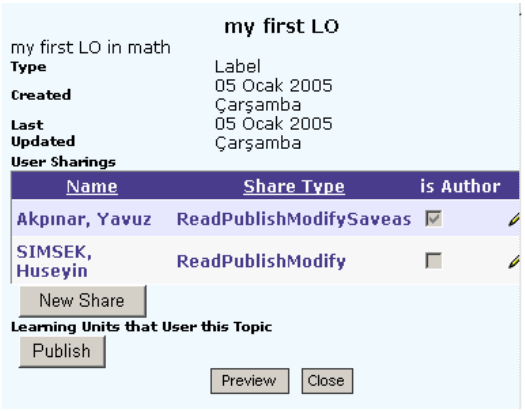

Figure 3.5. A screenshot from BU-LCMS: Viewing object sets

- In technical part, all of the jobs that are necessary to make a SCORM compliant content package is to select “SCORM compliant” checkbox in the export menu. The system creates necessary SCOs as html files, and copies these SCOs and dependent files (images, multimedia and other files) into the same folder. In SCO files, necessary SCORM functions (LMSIntiliaze, LMSFinish and other custom functions) are written by the LCMS. Then, imsmanifest.xml file which holds all information about content organization and metadata is created

according to the learning unit database information and saved the same folder with the SCOs. Lastly, JavaScript functions that are responsible from finding SCORM API and running other SCORM functions are created and saved. The content package components should be bound in the form of a compressed archive file which is named the Package Interchange File (PIF). SCORM recommends that content packages be created as PIFs. The PIF files should be conformant with RFC, and in the format of PKZip v2.04g (.zip) that is conformant to RFC1951 (SCORM, 2004). Thus, the LCMS may compress all content packages into a zip file and presents the user.

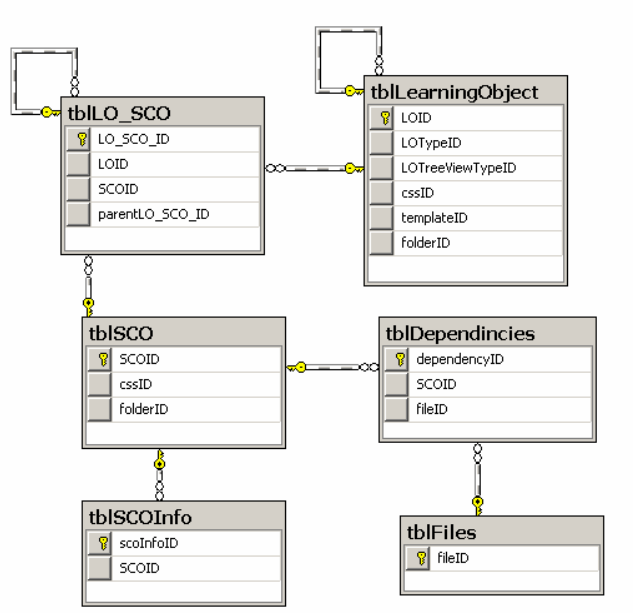

Figure 3.6. Learning Object Structure is Stored in Relational Database

3.2.3. Handling Files and Folders in Scormification

SCORM package includes contents files, manifest file (imsmanifest.xml), JavaScript function files that are responsible to find and communicate with LMS API. In BU-LCMS, learning object structure is stored in relational database instead of XML files (Figure 3.6). So in the export process, manifest file is created according to database information. Bodies of the content files also are stored in database and they should be created in the export

process.

```
<?xml version="1.0" encoding="utf-8" standalone="no"?>
<manifest identifier="LO_57" version="1.3" xmlns="http://www.imsglobal.org/xsd/imscp_v1p1"
    xmlns:adlcp="http://www.adlnet.org/xsd/adlcp_v1p3" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
    instance" xsi:schemaLocation="http://www.imsglobal.org/xsd/imscp_v1p1 imscp_v1p1.xsd
http://www.adlnet.org/xsd/adlcp_v1p3 adlcp_v1p3.xsd">
  <metadata>
    <schema>ADL SCORM</schema>
    <schemaversion>CAM 1.3</schemaversion>
  </metadata>
  <organizations default="TOC1">
    <organization identifier="TOC1">
      <title>usability</title>
      <item identifier="SCO_204" identifierref="RES_204">
        <title>Introduction</title>
      </item>
      <item identifier="SCO_205" identifierref="RES_205">
        <title>Objectives</title>
      </item>
      <item identifier="SCO_206" identifierref="RES_206">
        <title>Images</title>
        <item identifier="SCO_207" identifierref="RES_207">
          <title>Principles to support usability</title>
        </item>
      </item>
    </organization>
  </organizations>
  <resources>
  <resource identifier="RES_204" type="webcontent" adlcp:scormType="sco"href ="SCO_204. html">
        <file href="SCO_204.html"/>
      </resource>
      <resource identifier="RES_205" type="webcontent" adlcp:scormType="sco" href="SCO_205.html">
        <file href="SCO_205.html"/>
      </resource>
      <resource identifier="RES_206" type="webcontent" adlcp:scormType="sco" href="SCO_206.html">
        <file href="SCO_206.html"/>
      </resource>
      <resource identifier="RES_207" type="webcontent" adlcp:scormType="sco" href="SCO_207.html">
        <file href="SCO_207.html"/>
      </resource>
</resources>
</manifest>
```

Figure 3.7. Sample manifest file (imsmanifest.xml)

When a simple learning object is exported in BU-LCMS, a new folder in the server is first created to contain all related files. Some of the files are the same for all learning objects, such as JavaScript function files (FindLMSAPI.js, LMSAPI.js, LMSDataModel.xml, LMS_Errors.xml, etc.), XML schema files (adlseq_v1p3.xsd, adlcp_v1p3.xsd, imscp_v1p1.xsd, imsss_v1p0.xsd, etc). See Figure 3.7 for whole list and see Appendix D for whole content of the XML schema files. These files are copied from

common files folder to the new folder. At this step, some files that are not related to SCORM also copied to the content folder in order to make that learning object to run in a stand-alone fashion. Then, a new folder with the name “files” is created in the learning object folder in order to store the files used in SCOs. System reads database information about learning objects and starts to create manifest file which contains metadata information (underlined components in Figure 3.7).

Further SCO structure is read from database and begins to create first SCO. While a SCO is exported, BU-LCMS;

- Creates necessary entries in manifest file under the “organization” and “resource” tags (shown in bold fonts in Figure 3.7); Checks if SCO uses any style sheet, if so, creates the CSS file according to the “cssID” used in SCO and if it has not created before and copies it to “files” folder.

- Creates the SCO files header information such as title, links to used CSS file, and links to API functions if necessary.

- Checks the files that are used in SCO and copied them into “files” folder unless they are exist and correct the links to these files.

- Copy body of the SCO into html file, put links for the extra files if there are any and closes the SCO file.

This process repeated for each SCO that exists in a learning object. Files associated to a created learning object in BU-LCMS are given in Figure 3.8.

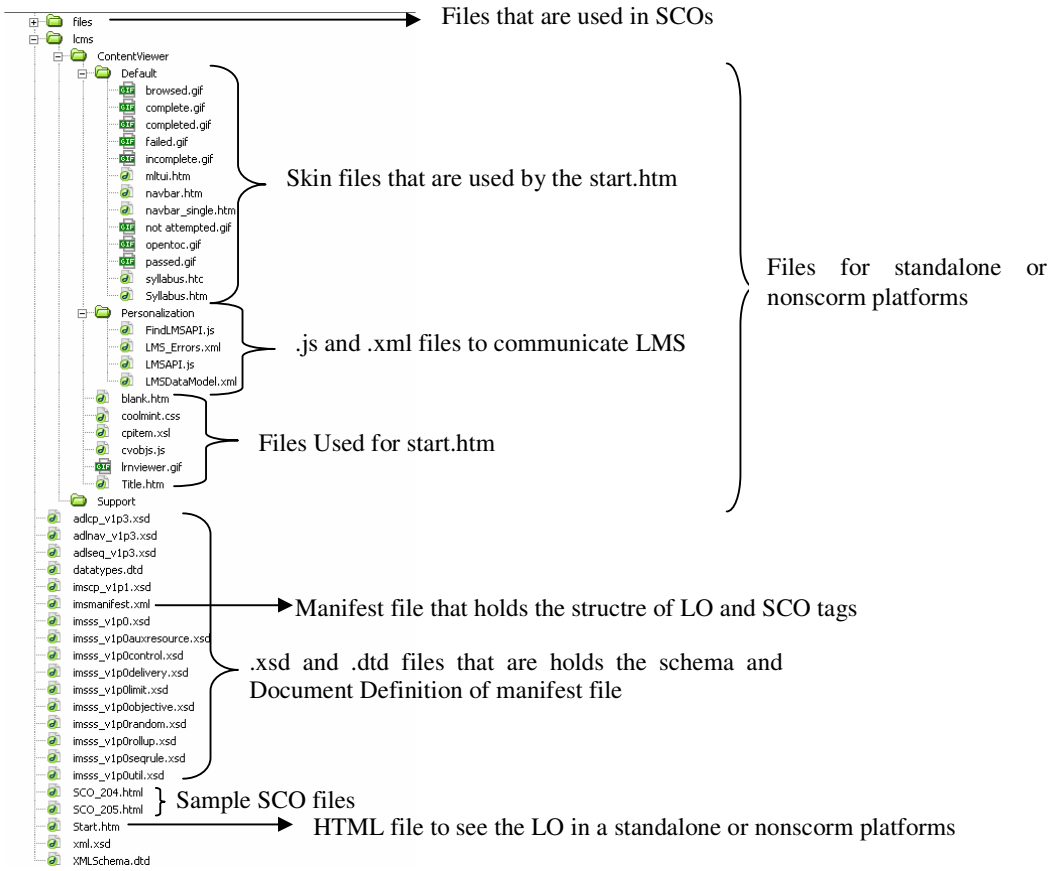

Figure 3.8. Files associated to a created learning object in BU-LCMS

3.2.4. Implementation of the System

The design issues outlined in this work have been implemented to a large extend. Software tools employed in developing and implementing the above configuration of BU-LCMS are MS Visual Studio.NET (ASP.NET, C#.NET) Macromedia MX, XML and SQL Server. The Teacher source space in the system was constructed with asp.net and ado.net. In a Web application, the client, browser, and server are different programs often running on different computers and even on different operating systems. The .net platform was chosen for some reasons, primarily the flexibility property. For asp.net pages, the framework understands the circumstances of the client side configuration and re-manages the web pages for the client. Servers serve web pages, in asp.net terminology it's called web forms. Second .net framework use system recourses with maximum efficiency. It's caching pages and created disconnected connection to database makes the system faster for

client responses. Web Forms are an ASP.NET technology that you use to create programmable Web pages. ASP.NET technology runs on the server that dynamically generates Web page as an output to the browser, client device or mobile device. Web Forms page output may contain almost any HTTP-capable language, including HTML, XML, WML, and ECMAScript (Jscript, JavaScript).

In asp.net pages ADO.net was used to communicate with data source. ADO.NET is the application-level interface for providing data access services in the Microsoft .NET Platform. ADO.NET maximizes data sharing by reducing the number of active connections to the database - reducing the possibility of multiple users contending for limited resources on the database server. ADO.NET provides several ways to access data. ADO.NET provides data commands and data readers to communicate directly with the data source. Direct database operations using data commands and data readers include running queries and stored procedures, creating database objects, and performing direct updates and deletes using DDL commands. ADO.NET maximizes data sharing by supporting an XML-based persistence and transmission format for the fundamental object of distributed ADO.NET applications: the dataset.

The following hardware and software are required for implementing BU-LCMS database and asp.net files. Server operating system should be one of the following;

- Microsoft® Windows® 2000 Professional with Service Pack 2.0
- Microsoft® Windows® 2000 Server with Service Pack 2.0
- Microsoft® Windows® 2000 Advanced Server with Service Pack 2.0
- Microsoft® Windows® 2000 Datacenter Server with Service Pack 2.0
- Microsoft® Windows® Server 2003 family

The operating system should have Microsoft Internet Information Services (IIS) 5.0 or higher. The server should have minimum Pentium 133 MHz or faster with 128 MB or higher RAM hardware configuration. For data connection, Microsoft Data Access Components (MDAC) 2.7 should be installed on the server.

It was planned to conduct two usability studies for BU-LCMS to catch usability problems and errors as early in the software development process as possible. First study was conducted as a beta test of the system, and second one was conducted as validation study.

3.3. Beta Study

The beta study had been conducted at the late development phase of the system. It is aimed to test BU-LCMS with target user group performing representative tasks to ensure able/functional product. Also, according to the results of the beta test, the system were revised.

3.3.1. Participants

The sample of the beta study consists of students, from Boğaziçi University Education Faculty attending Instructional Technologies and Material Development (CET 360) course at the 2004/2005 Summer term. The study was conducted with 34 students, 23 of them were female and 11 of them were male. Distribution of the sample according to the department, age groups and computer skills were given in the below tables. Classification of subjects in computer skill was based on the self rated question in the usability test.

Table 3.1. Sample of students for each department

Department	Science Education	Foreign Language Education	Pre-school Education	Guidance	TOTAL
Number of students	4	10	11	9	**34**

Table 3.2. Distribution of sample according to age groups

Age Group	18-21	22-26	27-30	TOTAL
Number of students	15	16	2	**33**

Table 3.3. Distribution of sample according to computer skills

Computer Skills	Novice	Experienced	Expert	Total
Number of students	10	23	0	**33**

3.3.2. Data Collection Tools

3.4.2.1. Usability Test. To collect data about usability of the system, a usability test (Appendix A) was used by revising the usability test which is developed by Akpinar (2002) and used to assess the usability of similar syste(BU-LMS). The data collection tool use a Likert scale-rating scheme (five-point) based on the suitability of the tool for performing various tasks. The test consisted of 44 Likert type items, its key is as follows: (1) Strongly disagree, (2) Disagree, (3) Neutral, (4) Agree, (5) Strongly agree; 5 demographic questions about subjects' age, department, sex and computer skills; and two open-ended questions for detailed subjects' opinion.

Likert-type questions can be grouped in two categories. While first 23 items and last item are about overall system performance and design, the rest of them are questions about the specific facilities of the system.

3.4.2.2. Validity and Reliability of the Usability Test. After the revision of the test, it was checked by three academicians who are experts on computer based instruction including the author of the original test. The reliability coefficient (alpha) of the original scale was calculated as 0.91 in its original study. Also, after the revision, Cronbach's Alpha reliability coefficient of the questionnaire was calculated as 0.936 in the beta study, demonstrating that items in the test consistently measure the traits the test aims.

3.4.2.3. Screen Captures. In a computer laboratory environment, samples will be asked to work with predefined tasks and all of their interaction with computer was saved by a program, Camtasia. Screen captures were used as a qualitative data about the usability of the LCMS.

3.3.3. Procedure

Beta Study of the BU-LCMS was made in two sessions which lasted 90 minutes each. Students were first provided with a username and a password to the LCMS server. Then they were taken to a computer lab where they also take some of their information

technology courses. The lab was equipped with 20 PCs and one server; all connected to the net and the organization of the PCs in the room was in U shape. In the first session, researcher explained basics of BU-LCMS and demonstrated how a learning unit is created in BU-LCMS in the first half of the session. In the second half of the session students are free to make observations and exercises with BU-LCMS.

In the second session, the subjects were asked to use the system facilities and to construct a series of web based course for a chosen learning unit. They were instructed to use any sort of learning materials from video segments to static graphics, but they were free to use anything. Before the subjects started the task, the researcher run the Camtasia program on all computers to save screen captures. During their usage of the system, the researcher was present in the lab but did not intervene in the participants' work. After the end of second session, they were given a usability questionnaire.

3.3.4. Results

The participants' responses to the usability questionnaire were converted into numerical values using their rating on the scale of each question: Strongly disagree: 1, Disagree: 2, Neutral: 3, Agree: 4, and Strongly Agree: 5.Average score for each item is calculated and item-total statistics was calculated. The item analysis details are given in Table 3.6. Then each participant's total usability score was estimated. The mean of those scores is 166.94 and the highest possible score is 220.00. A list of descriptive statistics of the usability score of each user is given Table 3.4 and summary of item statistics is given in Table 3.5. (For Inter-Item Correlation Matrix, see Appendix B).

Table 3.4. Descriptive statistics of usability scores

	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation	Variance
TOTAL	34	113.00	216.00	166.94	4.01	23.39	547.33

Table 3.5. Summary item Statistics

	Responses Mean	**Minimum**	**Maximum**	**Range**	**Maximum / Minimum**	**Variance**
Item Means	3.98	3.04	4.50	1.45	1.47	.10

The mean for the total usability score was 166.94 where the response mean for separate items was 3.98 indicating a tendency to “agree” with the statements included in the usability test. As all items included statements that favored the usability of the system, the observed tendency to agree with these statements indicates that the specified features were considered to be useful.

Data was initially analyzed using “response mean” obtained from each item of usability test in Table 3.6.

Table 3.6. Item-Total statistics

Item	Mean	Item-Total Correlation	Cronbach's Alpha if Item Deleted
1) Highlighting and button actions on the screen was helpful	3.97	.536	.935
2) Reading characters on the screen was easy	4.24	.303	.937
3) The screen layouts were helpful	4.00	.495	.936
4) Arrangements of information on screen was logical	4.00	.593	.935
5) Next screen in a sequence was predictable	3.76	.440	.936
6) Sequence of screens were clear	3.97	.602	.935
7) Throughout the system terms were used consistently	3.91	.452	.936
8) The terminology used was well related to the work I was doing	4.12	.564	.935
9) Messages appearing on the screen were clear	4.00	.311	.937
10) Messages appearing on the screen were consistent	4.12	.644	.935
11) The system always kept me informed about what it was doing	3.79	.638	.934
12) Error messages on the system were helpful	**3.35**	**.606**	**.934**
13) Learning to navigate the system was easy	3,62	.554	.935
14) Exploration of the system features by trial and error was encouraged	**3.12**	**.465**	**.936**
15) Remembering names and use of commands/links was easy	3.77	.640	.934
16) Tasks can always be performed in a straight forward manner	3.76	.653	.934
17) Help messages on the screen was clear	3.76	.760	.933
18) Use of graphics in the system was sufficient	**3.32**	**.645**	**.934**
19) The system is reliable	3.65	.729	.934
20) Response time of the system was relatively fast enough	3.82	.265	.937
21) The system always warns the user about potential problems	**2.94**	**.398**	**.936**
22) Correcting my mistakes on the system was easy	**3.18**	**.279**	**.938**
23) Needs of inexperienced users were always taken into consideration	**3.26**	**.547**	**.935**
24) Creating folder was easy	4.29	.353	.936
25) Managing (editing/deleting) folders was easy	4.18	.422	.936
26) Uploading a file to the system was an easy task	4.24	.233	.937
27) Creating a learning unit was easy.	4.15	.330	.937
28) Learning unit templates was easy to use	4.06	.582	.935
29) Creating a learning topic under a learning unit was easy	4.06	.400	.936
30) Buttons to manage orders of topics of a learning unit were placed appropriately	3.97	.599	.935
31) Editing functions of a learning topic were appropriate	3.88	.376	.936
32) Editing a learning unit was easy	4.00	.112	.939
33) Publishing a learning unit was easy	4.15	.511	.935
34) Editor facilities to create a learning topic were satisfactory	3.74	.418	.936
35) Buttons on the editor were placed appropriately	4.15	.220	.937
36) Text formatting facilities of the editor was easy to use	3.97	.596	.935
37) Design templates for creating a learning topic were functional	3.94	.594	.935
38) Layout templates for creating a learning topic were functional	3.82	.699	.934
39) Inserting/editing an image to a topic was easy	3.91	.356	.937
40) Inserting/editing a flash animation to a topic was easy	**3.53**	**.562**	**.935**
41) Inserting multimedia to a topic was easy	**3.38**	**.317**	**.937**
42) Sharing a learning unit was easy.	3.76	.712	.934
43) Subject index was functional	3.68	.604	.934
44) My overall reactions to the system is satisfying	4.15	.628	.935

Differences between different user categories were initially analyzed by comparing novice and experienced users that were grouped on the basis of their computer skills. Personal statements were used when forming the groups. The participants who rated themselves as novice and the ones rated as experienced ICT user were compared Comparisons based on the total test score are presented in Table 3.7 and Table 3.8.

Table 3.7. Descriptive statistics for novice and experienced learners (total score)

Computer Skill	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Novice	11	165.45	25.93	7.82
Experienced	23	167.65	22.66	4.72

Table 3.8. Independent samples test results for novice and experienced learners

T	**df**	**Sig.(2-tailed)**	**Mean Dif.**	**Std. Error Dif.**
-.253	32	.802	-2.19	8.70

The participants who rated themselves as novice and the ones rated as experienced ICT user were compared. The t-test carried out on the participants' usability data showed (Table 4.4) that there is not a meaningful difference between the novice users' (M=165.45, SD=25.93) and experienced users'(M=167.65, SD=22.66) in terms of the total usability scores on the system, t(32) = .25, p=.80. The result indicates that the participants' average perception of the system facilities measured through each usability item of the questionnaire was received 4 out 5: The current state of the most facilities was confirmed. However, 12th item (Error messages on the system were helpful) did not receive an entirely positive response from the users. That may indicate that those error messages must be checked and revised to assist the users. The need for such change was confirmed by the responses to items 21 (The system always warns the user about potential problems), 22 (Correcting my mistakes on the system was easy), and 23 (Needs of inexperienced users were always taken into consideration). On those items the users were not positive.

Similarly the responses to 14th item (Exploration of the system features by trial and error was encouraged) showed that the LCMS did not encourage its users to explore the system by trial and error. The users might have felt under pressure, but the system features must be modified to "look" as transparent components encouraging users to get into the system without fear. The responses to the item 18 (Use of graphics in the system was sufficient) and item 41 (Layout templates for creating a learning topic were functional) recommend to re-design the layout and graphics of the system. Inserting/editing a flash animation to a topic (item 40) was also required. To point out whether the users' responses to these eight items are due to being novice or experienced IT users, further statistical analysis were also carried out (Table 3.9 and Table 3.10).

Table 3.9. Descriptive statistics for novice and experienced learners (eight problematic items)

Item	Computer Skill	N	Mean	Std. Deviation
I12	Novice	10	4.10	.56
	Experienced	23	3.04	.97
I21	Novice	10	3.10	.99
	Experienced	21	2.90	.700
I22	Novice	10	2.80	1.13
	Experienced	23	3.35	1.26
I23	Novice	10	3.40	.84
	Experienced	23	3.30	1.29
I14	Novice	10	3.30	1.16
	Experienced	22	3.14	1.08
I18	Novice	10	3.40	.51
	Experienced	23	3.30	1.06
I40	Novice	10	3.90	.73
	Experienced	23	3.48	1.27
I41	Novice	10	3.20	1.03
	Experienced	23	3.57	1.08
Eight Items Total	Novice	10	27.20	3.73
	Experienced	20	26.50	6.13
Total without eight Items	Novice	10	143.50	19.04
	Experienced	23	141.95	17.77

Results obtained from comparisons of the eight items can be summarized as follows. On Item 12, although the mean response pattern indicated that "error messages on the system were not considered as helpful" within the entire sample, the further analysis in Table 5 showed that the novice user group agreed with the statement of item 12 (Error messages on the system were helpful) more than the experienced group did. This may be an indication that the system messages were designed in considering the novices more, and/or the experienced did not actually apply for the help, probably they found the error messages difficult understand. This issue should be further studied and error messages should be designed to hit the experienced as well. The two groups did neither differ on the (remaining) seven items nor on the rest of the test (Table 3.10).

Table 3.10. Independent samples t-test results of problematic items

Item	t	df	Sig. (2-tailed)	Mean Dif.
I12	3.180	31	.003	1.06
I21	.633	29	.532	.19
I22	-1.177	31	.248	-.54
I23	.252	25.8	.803	.09
I14	.388	30	.701	.16
I18	.347	30.4	.731	.096
I40	1.193	28.1	.243	.42
I41	-.904	31	.373	-.36
Eight Items Total	.330	28	.744	.70
Total without eight Items	.224	31	.824	1.54

Usability scores of different user categories were also compared for groups based on gender, age and department.

In order to investigate whether the usability test scores differed between genders, independent samples t-test statistics was used. The results showed that females' test scores

(M= 164.27, SD=23.13) was not significantly different from males' test scores (M=168.21, SD=23.92), t(32) = .454, p=.65.

Also, usability test scores were not significantly different among age groups, F(2,30)=725.05, p=.70 (see Table 3.11 and Table 3.12).

Table 3.11. Descriptive statistics for different age groups (total score)

Age	**Mean**	**Std. Deviation**	**N**
18-21	165.60	23.95	15
22-26	165.18	22.91	16
26-30	180.00	35.35	2

Table 3.12. One-Way ANOVA results for different age groups (total score)

Source	**SS**	**df**	**MS**	**F**
Between groups	402.51	2	201.25	.706
Within groups	17158.04	30	571.94	
Total	17560.55	32		

Moreover, usability test scores of students does not significantly change among students who are on different department, F (3, 30) =1.185, p=.332. (See Table 3.13 and Table 3.14)

Table 3.13. Descriptive statistics for different department groups (total score)

Department	**Mean**	**Std. Deviation**	**N**
Foreign Language	160.30	24.73	10
Guidance	172.00	22.29	9
Pre-school Education	162.90	23.31	11
Science Education	183.25	20.27	4

Table 3.14. One-Way ANOVA results for department groups (total score)

Source	**SS**	**df**	**MS**	**F**
Between groups	1914.12	3	638.04	1.185
Within groups	16147.75	30	538.25	
Total	18061.88	33		

Observations, open ended questions in the usability questionnaire and screen captures were used as qualitative data. Most users did not answer open ended questions. Given responses are summarized as Table 3.15.

Table 3.15. Frequencies of issues specified in open-ended questions

Mentioned Issue	**Frequency**
System is useful	7
System is easy to use	6
System is enjoyable	4
System is slow	4
Managing images is difficult	4
Lack of warning about potential problems	4
Lack of ready templates	3
Problem in changing templates	3
Managing multimedia	3
Similarities between known systems make system easy to learn	2
System encourages teachers	2
Managing links is hard	2
There is no quiz facility	1
Managing tables is hard	1

These findings mostly support the usability testing results. Moreover, observation during the study and analyze of screen capture also support previous findings.

Once such a facility rich but menu-embedded, hierarchical and user-tailored system is easily used by different groups of individuals both experienced and novice users of information technology, then the system may contribute task accomplishment of the users. Since typical users of LCMSs are academicians among whom there are novice IT users, the findings of the usability tests is encouraging and promising.

The participants who rated himself/herself as novice and the ones rated experienced ICT user were compared. According to the t test carried out on the participants' usability data, there is not a meaningful difference between the novice users' and experienced users' overall usability scores on the system, $t(32) = .232$, $p = .802$ (see Table 4.4). However, on some of the usability items the users did not validate the system features. For example;

according to the t test result (Table 4.5) users did not find the error messages on the system helpful (experienced users found the system less helpful); that may be due to simple state of the messages (because the novices found the messages helpful) or the experienced users wanted to do more on the system but the system features were not helpful. This issue will be studied in the validation study. Table 4.5 demonstrates that except on item 12, on the other seven problematic items the novices and the experienced users did not differ. Quantitative and qualitative data analysis results show that the following issues and components of the system must be revised, re-designed and validated:

- Improve warning messages about potential problems on the system,
- Enable users of the system correct their mistakes easily,
- Take the inexperienced users' needs into account at all components of the system,
- Design system features that encourage users to explore the system by trial and error,
- Use more graphics in the system,
- Change and improve current layout templates,
- Change the way users insert a flash animation, graphic and other multimedia to a topic,
- Revise the WYSIWYG (What You See Is What You Get) editor,
- Optimize overall system to improve performance.

3.4. Revisions of BU-LCMS Facilities Based On Beta Study Results

In order to increase the usability of the system the following revisions were made according to requirements of participants of the beta study. These revisions can be listed as:

- Results of the beta study show that it had to be changed the way users insert a flash animation, graphic and other multimedia to a topic. Before the revisions, users had to upload a file and selected it to insert the file. After the revisions uploaded file is automatically inserted to topic. Also, an icon about the type of the file was placed each of the file name in the file list.

- All of the texts that have been used in the system were revised in order to be clear in directions, feedbacks and error messages.

- While creating a learning unit, after saving the information about learning unit, there was an extra screen that gives feedback and the user had to click "Add Topic to Learning Unit" button. This extra screen was removed from the system (see Figure 3.9).

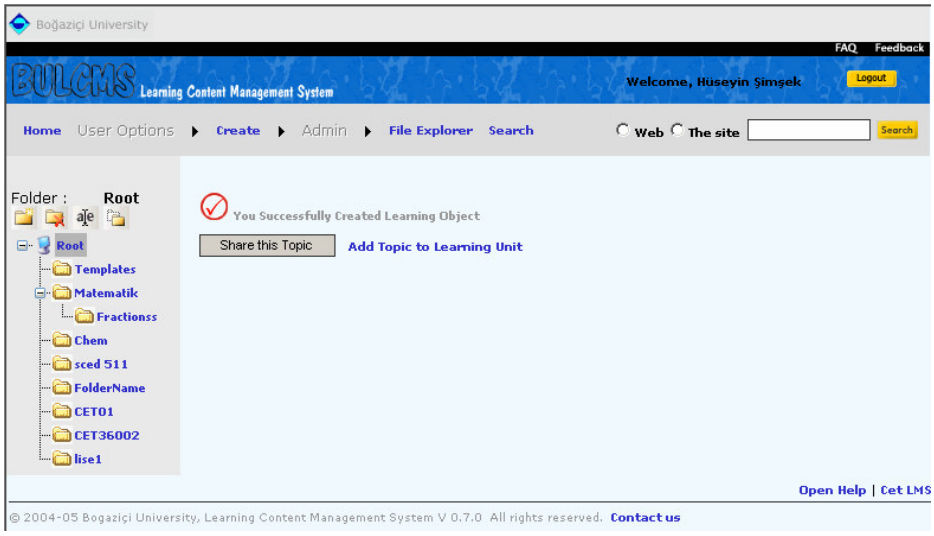

Figure 3.9. Removed screen after the revision of BU-LCMS

- Some bugs in the system resulted in asp.net error messages, which were meaningless for the users. These bugs were decreasing reliability of the system and comprehensibility of the error messages. They were fixed.

- Before the revisions, system was slow especially when more than 20 users connected simultaneously. Some optimizations were made like changing the data layer of the application, using more stored procedures.

- Results of the beta study show that using layout templates were problematic. After changing layout template, all contents of the topic were changing naturally. However, losing the content of the topics created problems for participants. A confirmation dialog was inserted in order to warn users. Also, AJAX (Asynchronous JavaScript and XML) techniques were used while changing the layout template. Before the revisions, it made post back to the server which cost the speed and performance.

- System redesigned as a multi-language application. Currently, Turkish and English language options are supported by BU-LCMS. Using Turkish characters in topics had been making problems, after publishing the learning unit. Character set of the published topics was changed to the UTF-8

- Editor that is used to create a learning unit was revised and buttons' places on the editor were re-designed.

3.5. Validation Study

Validation study was conducted at the end of the development process, after completing the revisions that beta study results emphasized. It was aimed to verify that BU-LCMS meets previously identified users needs.

3.5.1. Participants

Sample of validation study should be similar to the beta study to make meaningful comparisons to see whether the revisions made significant improvements. Thus, the sample of validation study was selected from students in Boğaziçi University Education Faculty who attended Instructional Technologies and Material Development (CET 360) course at the 2005/2006 Spring term. The validation study was conducted with 44 students. 21 of them were female and 23 of them were male. Distribution of the sample according to the department, computer skills were given in the below tables. Classification of subjects in computer skill was based on the self rated question in the usability test.

Table 3.16. Sample of students for each department

Department	**Science Education**	**Foreign Language Education**	**Pre-school Education**	**TOTAL**
Number of students	12	18	14	44

Table 3.17. Distribution of sample according to age groups

Age Group	**18-21**	**22-26**	**TOTAL**
Number of students	10	34	**44**

Table 3.18. Distribution of sample according to computer skills

Computer Skills	**Novice**	**Experienced**	**Expert**	**Total**
Number of students	10	34	0	**44**

3.5.2. Data Collection Tools

To collect data about usability of the system, the same usability test (Appendix A) used in beta study was re-used in validation study. Cronbach's Alpha reliability coefficient of the questionnaire was calculated as 0.939 in the validation study, demonstrating that items in the test consistently measure the traits the test aims.

Since beta study is more about finding out the problems with the BU-LCMS and validation study is about validating the system, screen captures were used only in the beta study and were not used in validation study.

3.5.3. Procedure

The procedure used during the validation study was similar to the beta study. Validation study of the BU-LCMS was made in two sessions which lasted 90 minutes each. Students were first provided with a username and a password to the LCMS server. Then they were taken to the same computer lab where they also take some of their information technology courses. It is also the same lab which beta study was conducted in. In the first session, researcher explained basics of BU-LCMS and demonstrated how a learning unit is created in BU-LCMS in first half of the session. In the second half of the session students were free to make observations and exercises with BU-LCMS.

In the second session, the subjects were asked to use the system facilities and to construct a series of web based course component for a chosen learning unit. They were instructed to use any sort of learning materials from video segments to static graphics, but they were free to use anything. During their usage of the system, researcher was present in the lab but did not intervene in the participants' work. After the end of second session, they were given a usability questionnaire.

3.5.4. Results of Validation Study

The participants' responses to the usability questionnaire were converted into numerical values using their rating on the scale of each question as in the beta study. Average score for each item was calculated and item-total statistics were taken. The item analysis details were given in Table 3.21. Then each participant's total usability score was computed. The mean of those scores was 166.94 where the maximum score is 220.00. A list of descriptive statistics of the usability score of each user was given in Table 3.19 and Table 3.20 shows the summary of item statistics. (For Inter-Item Correlation Matrix, see Appendix C).

Table 3.19. Descriptive statistics of usability scores

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Usability	44	149.00	216.00	177.09	18.56	344.55

Table 3.20. Summary item statistics

	Responses Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance
Item Means	4.02	3.39	4.91	1.52	1.45	.18

Data was initially analyzed using "response mean" obtained from each item of usability test in Table 3.21.

Table 3.21. Item-total statistics

Item	Mean	Item-Total Correlation	Cronbach's Alpha if Item Deleted
1) Highlighting and button actions on the screen was helpful	4.11	.473	.938
2) Reading characters on the screen was easy	4.07	.367	.939
3) The screen layouts were helpful	4.18	.610	.937
4) Arrangements of information on screen was logical	3.93	.313	.939
5) Next screen in a sequence was predictable	3.80	.514	.938
6) Sequence of screens were clear	3.89	.729	.936
7) Throughout the system terms were used consistently	4.00	.449	.938
8) The terminology used was well related to the work I was doing	3.95	.330	.939
9) Messages appearing on the screen were clear	4.09	.353	.939
10) Messages appearing on the screen were consistent	4.00	.570	.937
11) The system always kept me informed about what it was doing	3.80	.369	.939
12) Error messages on the system were helpful	3.59	.384	.939
13) Learning to navigate the system was easy	3.91	.584	.937
14) Exploration of the system features by trial and error was encouraged	3.84	.465	.938
15) Remembering names and use of commands/links was easy	4.18	.398	.938
16) Tasks can always be performed in a straight forward manner	4.05	.507	.938
17) Help messages on the screen was clear	3.77	.616	.937
18) Use of graphics in the system was sufficient	3.70	.433	.938
19) The system is reliable	3.77	.237	.940
20) Response time of the system was relatively fast enough	3.89	.526	.938
21) The system always warns the user about potential problems	3.66	.534	.938
22) Correcting my mistakes on the system was easy	3.61	.249	.940
23) Needs of inexperienced users were always taken into consideration	3.75	.255	.940
24) Creating folder was easy	4.39	.497	.938
25) Managing (editing/deleting) folders was easy	4.27	.478	.938
26) Uploading a file to the system was an easy task	4.43	.487	.938
27) Creating a learning unit was easy.	4.52	.457	.938
28) Learning unit templates was easy to use	4.20	.503	.938
29) Creating a learning topic under a learning unit was easy	4.32	.649	.937
30) Buttons to manage orders of topics of a learning unit were placed appropriately	4.07	.647	.937
31) Editing functions of a learning topic were appropriate	4.11	.780	.936
32) Editing a learning unit was easy	4.32	.626	.937
33) Publishing a learning unit was easy	4.27	.392	.939
34) Editor facilities to create a learning topic were satisfactory	4.16	.477	.938
35) Buttons on the editor were placed appropriately	3.93	.499	.938
36) Text formatting facilities of the editor was easy to use	3.98	.749	.936
37) Design templates for creating a learning topic were functional	4.11	.558	.937
38) Layout templates for creating a learning topic were functional	3.93	.621	.937
39) Inserting/editing an image to a topic was easy	4.32	.565	.937
40) Inserting/editing a flash animation to a topic was easy	3.89	.426	.938
41) Inserting multimedia to a topic was easy	3.93	.544	.937
42) Sharing a learning unit was easy.	4.16	.654	.937
43) Subject index was functional	4.05	.591	.937
44) My overall reactions to the system is satisfying	4.18	.654	.937

The usability scores obtained during the validation study were also compared for groups that differed in terms of their expertise, gender, age and department.

Initial comparisons were based on groups that differed in terms of their expertise. The participants who rated themselves as novice and the ones who rated themselves as experienced ICT user were compared. The results are presented in Table 3.22 and Table 3.23.

Table 3.22. Descriptive statistics for novice and experienced learners (total score)

Computer Skill	N	Mean	Std. Deviation	Std. Error Mean
Novice	10	172.20	15.73	4.97
Experienced	34	178.52	19.29	3.30

Table 3.23. Independent samples test for novice and experienced learners

t	df	Sig. (2-tailed)	Mean Dif.	Std. Error Dif.
-,947	42	,34	-6,32	6,68

The t-test carried out on the participants' usability data showed (Table 3.23) that there is not a meaningful difference between the novice users' (M=172.20, SD=15.73) and experienced users' (M=178.52, SD=19.29) total usability scores on the system, t(42) = -0.94, p=.34. The results indicated that the participants' average perception of the system facilities measured through each usability item of the questionnaire was received 4 out 5: The current state of the system was confirmed. Also, there is not a single item whose usability score is below 3.5, which indicates that participants' perception for each item is positive.

Further comparisons were carried out for gender, age and department groups. In order to investigate whether the usability test scores differ between genders, t-test statistics

was used. The results indicated that females' test scores (M=182.95, SD=19.06) were significantly higher than males' test scores (M= 171.74, SD=16.75), t(42) =-2.077, p=.04.

Also, the effect of age on usability scores of BU-LCMS was analyzed by conducting t-test for students. T-test results showed that usability test scores do not significantly differ among age groups, t(42)=.49, p=.62 (see Table 3.24 and Table 3.25).

Table 3.24. Descriptive statistics for different age groups (total score)

Age	Mean	Std. Deviation	N
18-21	175.13	14.82	15
22-26	178.10	20.40	29

Table 3.25. Independent samples test results for different age groups

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Dif
-.499	42	.621	-2.97	5.95

Moreover, in order to see if the students' departments account for differences in their usability scores was questioned using One-Way ANOVA test. The test scores show that usability test scores of students are not significantly different among students who study at different departments, F (2, 43) =1.781, p=.18. (See Table 3.26 and Table 3.27)

Table 3.26. Descriptive statistics for different department groups (Total Score)

Department	Mean	Std. Deviation	N
Foreign Language	176.39	24.73	18
Pre-school Education	183.79	23.31	14
Science Education	170.33	20.27	12

Table 3.27. One-Way Analysis of Variance results for department groups (total score)

Source	**SS**	**df**	**MS**	**F**
Between groups	1184.34	2	592.17	1.781
Within groups	13631.30	41	332.47	
Total	1394708.00	43		

Observations and open ended questions in the usability questionnaire were used as qualitative data. Most users did not answer open ended questions.

These findings mostly support the usability test results. Moreover, observations during the study also support previous findings quantitative statistics.

4. RESULTS

The beta-test and validation test were conducted with the similar participants. So, in order to clarify if the revisions made after the beta test was successful to increase the perception of the participants to the BU-LCMS, the usability test scores of two studies were compared by conducting a t-test. T-test scores indicate that usability scores of validation study (M=177.09, SD=18.56) were significantly higher than usability scores of beta study (M=166.94, SD=23.40), t(76)=-2.137, p=.036 (see Table 4.1 and 4.2). This can be an evidence for revisions that were made after beta study made a positive effect on participants' perception about the usability of BU-LCMS.

Table 4.1. Usability scores' means for beta and validation studies

STUDY	N	Mean	Std. Deviation	Std. Error Mean
BETA	34	166.94	23.39	4.01
VALIDATION	44	177.09	18.56	2.80

Table 4.2. Independent samples test results for beta and validation studies

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Dif
-2.137	76	.036	-10.14	4.74

Also, t-test analyses were conducted for each item in order to see the effect of the revisions. T-test analysis results can be seen in Table 4.3.

Table 4.3. Independent samples test results of each usability item for beta and validation studies

	STUDY	N	Mean	Std. Deviation	Mean Difference	t	df	Sig. (2-tailed)
I1	BETA	34	3.97	.67	-.143	-1.043	76	.300
	VALIDATION	44	4.11	.53				
I2	BETA	34	4.24	.55	.167	1.187	76	.239
	VALIDATION	44	4.07	.66				
I3	BETA	34	4.00	.65	-.182	-1.217	76	.227
	VALIDATION	44	4.18	.65				
I4	BETA	33	4.00	.79	.068	.367	75	.715
	VALIDATION	44	3.93	.81				
I5	BETA	34	3.76	.92	-.031	-.155	76	.877
	VALIDATION	44	3.80	.82				
I6	BETA	32	3.97	.82	.082	.463	74	.645
	VALIDATION	44	3.89	.72				
I7	BETA	34	3.91	.66	-.088	-.572	76	.569
	VALIDATION	44	4.00	.68				
I8	BETA	34	4.12	.72	.163	.904	76	.369
	VALIDATION	44	3.95	.83				
	BETA	34	4.00	.77	-.091	-.551	76	.583
	VALIDATION	44	4.09	.67				
I10	BETA	34	4.12	.64	.118	.714	76	.477
	VALIDATION	44	4.00	.77				
I11	BETA	34	3.79	.97	-.001	-.006	76	.995
	VALIDATION	44	3.80	.93				
I12	BETA	34	3.35	.98	-.238	-1.013	76	.314
	VALIDATION	44	3.59	1.06				
I13	BETA	34	3.62	.88	-.291	-1.417	76	.161
	VALIDATION	44	3.91	.91				
I14	**BETA**	**33**	**3.12**	**1.13**	**-.720**	**-3.159**	**75**	**.002***
	VALIDATION	**44**	**3.84**	**.86**				
I15	**BETA**	**31**	**3,77**	**,92**	**-,408**	**-2,101**	**73**	**,039***
	VALIDATION	**44**	**4,18**	**,75**				
I16	BETA	34	3,76	,85	-,281	-1,569	61,844	,122
	VALIDATION	44	4,05	,68				
I17	BETA	34	3,76	,92	-,008	-,041	76	,967
	VALIDATION	44	3,77	,80				
I18	BETA	34	3,32	,91	-,381	-1,900	76	,061
	VALIDATION	44	3,70	,85				
I19	BETA	34	3,65	1,07	-.126	-.593	76	.555
	VALIDATION	44	3.77	.80				
I20	BETA	34	3.82	1.02	-.063	-.288	76	.774
	VALIDATION	44	3.89	.89				
I21	**BETA**	**32**	**2.94**	**.80**	**-.722**	**-3.276**	**74**	**.002***
	VALIDATION	**44**	**3.66**	**1.11**				

	STUDY	N	Mean	Std. Deviation	Mean Difference	t	df	Sig. (2-tailed)
I22	BETA	33	3.18	1.23	-.432	-1.718	75	.090
	VALIDATION	44	3.61	.97				
I23	BETA	34	3.26	1.21	-.485	-1.975	57.268	.053
	VALIDATION	44	3.75	.86				
I24	BETA	34	4.29	.87	-.092	-.511	76	.611
	VALIDATION	44	4.39	.72				
I25	BETA	34	4.18	.96	-.096	-.476	76	.636
	VALIDATION	44	4.27	.81				
I26	BETA	34	4.24	1.01	-.197	-1.005	49.636	.320
	VALIDATION	44	4.43	.58				
I27	**BETA**	**34**	**4.15**	**.85**	**-.376**	**-2.290**	**76**	**.025***
	VALIDATION	**44**	**4.52**	**.59**				
I28	BETA	34	4.06	.77	-.146	-.868	76	.388
	VALIDATION	44	4.20	.70				
I29	BETA	33	4.06	.89	-.258	-1.470	75	.146
	VALIDATION	44	4.32	.63				
I30	BETA	34	3.97	1.02	-.098	-.474	76	.637
	VALIDATION	44	4.07	.78				
I31	BETA	34	3.88	.76	-.231	-1.302	76	.197
	VALIDATION	44	4.11	.78				
I32	BETA	34	4.00	1.10	-.318	-1.484	51.57	.144
	VALIDATION	44	4.32	.67				
I33	BETA	34	4.15	.82	-.126	-.700	76	.486
	VALIDATION	44	4.27	.75				
I34	**BETA**	**34**	**3.74**	**.93**	**-.424**	**-2.323**	**76**	**.023***
	VALIDATION	**44**	**4.16**	**.68**				
I35	BETA	33	4.15	.61	.220	1.437	75	.155
	VALIDATION	44	3.93	.69				
I36	BETA	34	3.97	.75	-.007	-.034	76	.973
	VALIDATION	44	3.98	.92				
I37	BETA	34	3.94	.98	-.172	-.848	76	.399
	VALIDATION	44	4.11	.81				
I38	BETA	33	3.82	.95	-.114	-.553	75	.582
	VALIDATION	44	3.93	.84				
I39	BETA	33	3.91	1.12	-.409	-1.862	75	.067
	VALIDATION	44	4.32	.80				
I40	BETA	34	3.53	1.21	-.357	-1.416	60.982	.162
	VALIDATION	44	3.89	.94				
I41	**BETA**	**34**	**3.38**	**1.12**	**-.549**	**-2.251**	**76**	**.027***
	VALIDATION	**44**	**3.93**	**1.02**				
I42	BETA	34	3.76	1.04	-.394	-1.882	76	.064
	VALIDATION	44	4.16	.80				
I43	BETA	34	3.68	1.06	-.369	-1.668	76	.099
	VALIDATION	44	4.05	.88				
I44	BETA	34	4.15	.89	-.035	-.194	76	.847
	VALIDATION	44	4.18	.69				

Comparison results indicated that the mean of 6 items (namely item 2, 4, 6, 8, 10, and 35) decreased, whereas other 38 items' scores increased. While, none of the items' usability score decreased in a statistically significant way, mean of 6 items (item 14, 15, 21, 27, 34, and 41) in validation study were significantly greater than the response mean in the beta study.

The results of the beta study had showed that some items (item 12, 14, 18, 21, 22, 23, 40, and 41) were problematic and had to be revised considering the perception of the participants. All of these items increased to an acceptable level (above 3.5 which means participants agree with the statement) in the validation study. Also, usability score of 3 items (item 14, 21 and 41) increased significantly. Item 14(Exploration of the system features by trial and error was encouraged)'s usability score significantly increased from 3.12 to 3.84, $t(76)=3.159$, $p=.002$. Item 21(The system always warns the user about potential problems)'s usability score significantly increased from 2.94 to 3.66, $t(74)=3.276$, $p=.002$. Item 41(Inserting multimedia to a topic was easy)'s usability score significantly increased 3. 38 to 3.93, $t(76) = 2.25$, $p=.027$.

4.1. Interaction Effects: Differences between Usability Scores in Beta and Validation Studies for Different User Groups:

Differences between usability scores obtained during Beta and Validation studies was further investigated for groups that differed in terms of gender, age and department. Beta and Validation Studies were taken as two distinct categories of the "study" variable. Two-Way ANOVA was conducted to determine the interaction between study (beta and validation studies) and computer skills, gender, age and department.

Changes in usability scores from Beta study to Validation study for groups that differ in terms of their expertise indicated greater changes for the experienced group. However ANOVA results indicated that the difference was not significant. Group differences and interaction effects are presented in Table 4.4 and Table 4.5.

Table 4.4. Descriptive statistics for the usability test showing interactions between study and computer skill

Computer Skill	STUDY	Mean	Std. Error
Novice	BETA	170.70	6.35
	VALIDATION	172.20	6.35
Experienced	BETA	167.65	4.19
	VALIDATION	178.53	3.44

Table 4.5. 2-Way ANOVA results for the usability test: interactions between study and computer skill

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
STUDY	561.38	1	561.38	1.389	.242
STUDY * Computer Skill	374.31	2	187.15	.463	.631
Error	29505.39	73	404.18		
Total	2347559.00	77			

While novice ICT users' usability score average increased 2 points (from 170 to 172), experienced ICT users' usability score average increased 9 points (from 167 to 178). Means of the both group in each study was given in Table 4.23. In order to investigate the interaction with computer skills of the users and change in the mean between beta and validation study, a two-factor analysis of variance analysis was conducted. The 2 x 2 ANOVA revealed that there was no significant interaction between computer skill and study, $F(2, 73) = .463$, $p = .63$.

Further analysis was carried out to question how study and gender might interact to account for changes in usability test scores. Male participants' mean was 164.2 in the beta study and 171.7 in the validation summary. Female participants' mean was 168.2 in the beta study and increased to 182.9 in the validation study as given in Table 4.6. However,

results of the two-factor analysis of variance analysis indicated that there is not significant interaction between study and gender, F (2, 74) = 1.764, p= .18 (see Table 4.7).

Table 4.6. Descriptive statistics for the usability test showing interactions between study and gender

Gender	**STUDY**	**Mean**	**Std. Error**
Male	BETA	164.27	6.21
	VALIDATION	171.74	4.29
Female	BETA	168.28	4.29
	VALIDATION	182.95	4.49

Table 4.7. 2-Way ANOVA results for the usability test: interactions between study and gender

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
STUDY	2185.97	1	2185.96	5.155	.026
STUDY * Gender	1496.03	2	748.02	1.764	.179
Error	31381.48	74	424.07		
Total	2360328.00	78			

Since there were no participants from Guidance and Psychological Counseling Program in the validation study, participants from this department also excluded from the beta study for the analysis. As shown Table 4.8, while usability score of the participants from Foreign Language and Pre-school Education departments increased, usability score of the participants from Secondary School Science and Math Education department decreased. However, results of the two way ANOVA statistics showed that there is no significant interaction between study and department of the participants, F (4, 63) = 2.168, p= .15 (see Table 4.9).

Table 4.8. Descriptive statistics for the usability test showing interactions between study and department

Department	STUDY	Mean	Std. Error
Foreign Language	BETA	160,30	6,40
	VALIDATION	176,39	4,77
Pre-School Education	BETA	162,91	6,10
	VALIDATION	183,79	5,41
Science Education	BETA	183,25	10,12
	VALIDATION	170,33	5,84

Table 4.9. 2-way ANOVA results for the usability test: Interactions between study and department

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
STUDY * Department	2785.22	4	696.30	1.700	.161
STUDY	888.09	1	888.09	2.168	.146
Error	25805.06	63	409.60		
Total	2090098.00	69			

Lastly, the interaction between study and age variable was investigated. The means of the groups were given in Table 4.10. The two-factor analysis of variance analysis was calculated and results showed that there were no significant interaction between study and age of the participants, $F(2, 71) = 1.764$, $p = .18$ (see Table 4.11).

Table 4.10. Descriptive statistics for the usability test showing interactions between study and age

Age	STUDY	Mean	Std. Error
18-21	BETA	165.60	5.36
	VALIDATION	175.13	5.36
22-26	BETA	165.19	5.19
	VALIDATION	178.10	3.86

Table 4.11. 2-Way ANOVA results for the usability test: interactions between study and age

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
STUDY	2188.17	1	2188.17	5.071	.027
STUDY * Age	88.53	2	44.27	.103	.903
Error	30636.46	71	431.50		
Total	2258557.00	75			

5. DISCUSSION

The present study aimed to develop and evaluate a SCORM-compliant Learning Content Management System (BU-LCMS) that can be used by educators who differ in terms of their background characteristics. However because making a learning object SCORM-compliant was difficult, this study, along with meeting SCORM requirements, adapted a different approach. The approach aimed eases the task of tagging learning objects with more realistic, meaningful and practical information sets.

The development of such a system was initiated in an attempt to provide teachers with a flexible platform that they could use to design instructional environments that can be adopted according to their students' as well as their own needs. Today technology provides teachers with a wide variety of resources. Web is full of materials both desired and undesired. Commercial software developers bombard teachers with a wide variety of software packages even for a single learning unit. Teachers, therefore, must be aware of potentials of presented software packages; be selective and conscious of the pedagogical value so that correct packages are chosen and used efficiently. Real classroom interaction requires the addressing of specific learning problems and customization of lessons on an on-going basis. When teachers are able to design and alter applications, they will then be better able to solve learning problems. A number of sophisticated tools have emerged for creating interactive multimedia software including commercially available products. The general purpose tools serve a variety of functions; however offer little in the way of design constraints governing the type of software which can be produced. The result is a tool supporting a broad range of possible applications, but none of which can be created with much guidance from the tool itself: Tools for the design of educational software still aim to support creation of any possible kind of instruction.

Although recent research indicates significant efforts to transfer the technology of intelligent tutoring systems and authoring tools over the Internet, the development of such educational programs is a hard task that needs much effort from domain and computer

experts. Since available courseware packages alone may not meet adaptability requirements of students in different needs and teachers may need cooperation of other teachers in coping with students' learning problems the courseware packages should count teachers' intellectual capacity and provide teachers with collaboration tools to make courseware facilities fit to individual students.

Further rationale for the development of BU-LCMS was based on a need to improve collaboration among teachers. The collaborative communities provide opportunities for teachers to reflect deeply and critically upon their own teaching practice on the content they teach and on the experiences and backgrounds of the learners in their classrooms (Putnam and Borko, 1997). Briscoe and Peters' (1997) findings further indicate that "collaboration facilitates change on teachers because it provides opportunities for teachers to learn both content and pedagogical knowledge from one another, encourages teachers to be risk takers in implementing new ideas, and supports and sustains the processes of individual change in teaching". The teacher tools designed in this study may serve the purpose as pointed out by Jauhiainen et al (2002) who reported that the courses and activities that were most valuable for day-to-day teaching were those where teachers could cooperate, reflect and plan with each other in small groups.

In a recent and more comprehensive analysis of the teacher networks, Zhao and Rop (2001) report that the teacher networks have a number of positive effects on their participants such as reduced teacher isolation, enabled curriculum development, facilitated dissemination of information, and provided easy access to curricular materials. To enable teachers to use computer mediated communication (CMC), this study showed again that not only general purpose tools like e-mail and discussion lists, but also easy-to-use content editors may be designed. Tools similar to BU-LCMS would develop teacher reflective discourse communities, because the real value of CMC may lie in information sharing around a set of materials and sharing student data which could be the focus of discussion and reflections. When similar student-facilities specific to learning tasks increase in number and quality, teachers may then enrich their reflective discourse in different learning units of varying content areas. This study will hopefully contribute to efforts of teachers.

This study outlined a web based learning content development and management system. It differed from others in terms of letting authors to bring in any type of file into the environment. That allows authors transfer their existing files and dress them with some set of standard tags, enabling authors to quickly adapt available content components. The approach this study took in developing LCMSs was to leave the sophisticated video editing and simulation editing to already existing authoring systems, but help authors to embed any authoring-package produced content into a web based course. Dynamic visualization facilities, for example, in a LCMS may be many, but these facilities are already available in authoring platforms The LCMS targeted here was not to replicate all features of commercially available authoring systems, but extend rather than replace capabilities afforded by such systems, and allow additional level of concreteness and modularization for producing a learning environment.

The BU-LCMS was developed to provide a flexible platform for all educators that could be used by as many teachers as possible. Therefore usability of the system was questioned for different groups in both the beta-study and the validation study. The evaluation of BU-LCMS was carried out to determine changes in usability scores from beta-study and the validation study. In order to understand whether the newly developed system could effectively be used by different groups, analysis of data also included comparisons of usability scores for groups who differed in terms of gender, department and expertise. The usability scores were expected to show a significant increase from beta study to validation study. Furthermore in order to show that BU-LCMS could effectively be used by different groups of educators, the mean usability scores calculated for different groups were expected to be similar.

The results of the study indicated significant changes in mean usability scores from 166.9 to 177.1 as assessed for the beta and validation study. This indicates that the assessments and revisions following the beta version were effective in improving the ease with which the system could be used.

After the revisions, participants in the validation study perceived that the BU-LCMS more encourage them to explore the system features by trial and error and they found easier to remember names and use of commands/links. Also, participant thought that the

system warned them about potential problems better than the previous version. In these improvements, revisions of the text used in BU-LCMS and fixing some bugs can become more effective in participants' perception.

Participants found easier to create a learning unit in validation study than beta study. In fact, just one extra screen was removed after creating learning unit and no more revisions were made in that point, but since their perception for the whole system was improved, they may think it is easier to create a learning unit.

Participants thought the revisions made on the editor used to create a learning topic became affective. One of the revisions was made after beta study was to change the way user insert image, flash, and multimedia. It seemed that this revision was affective; all of related items' score in the usability test were increased.

When differences in mean usability scores were considered for groups that differed in terms of their gender, department, age and expertise significant differences were observed for gender in validation study on the other hand students were not different in terms of their usability scores when grouped in terms of their department, age, and ICT expertise.

The lack of significant differences between groups that differed in terms of department, age, and ICT expertise was an expected outcome because the BU-LCMS was designed so that it could easily be used by different groups of educators.

Giving a theoretical reason for the gender differences in validation study is not possible. The system was not designed for one gender. However, it was observed that female participants' motivation to the study is higher than male participants' one. It can be a reason for this difference.

When the difference between groups was examined by 2-way ANOVA the results indicated there is no interaction between study and computer skills, gender, department, and age. This result shows that revisions made after beta study were perceived similar by

all groups. Similarity between different users was a major concern in the development of BU-LCMS. Therefore the results obtained both from the ANOVA and 2-Way ANOVA analysis indicating similarity between different groups is an expected and desired outcome for the purposes of the present study.

5.1. Limitations and Suggestions for Further Research

It is possible to put forth a number of limitations that can be considered in extended studies in order to help further revisions and improve the contribution of BU-LCMS. These limitations are briefly mentioned in the following paragraphs.

Participants were selected from prospective teachers in Boğaziçi University, Faculty of Education. There were no participants who rated themselves expert ICT users. More research should be done with teachers and trainers who will use the material developed with BU-LCMS. Also, Expert instructional designers' perception of the system should be taken into account while evaluating the BU-LCMS. Moreover, materials developed In BU-LCMS should be investigated in the view of their effectiveness and media used in the learning unit differs according to the computer skills, subject area or instructional design knowledge. Furthermore, teachers and trainers should be able to record the experiences with the prepared learning unit.

Different type of computer supported learning materials can be created by the help of the BU-LCMS such as simulation, drill, and tutorial. Then, these learning materials can be investigated in terms of their effectiveness and used assets in the learning unit.

All of the participants used the system inside the campus; system performance should be tested outside the boundaries of the university campus.

There was a time limitation. Participants can study with LCMS only four hours and it may not enough to explore all systems and use all features such as creating custom templates. Participants should study at least 6-8 weeks. Furthermore, in this study

participants worked individually with the system. Collaborative authoring facilities should also be studied.

BU-LCMS should be revised and improved. Different design may be developed for the system. In developed learning objects, in order to increase interactivity level with the students, quiz facility should be developed. By the help of these quiz facility; students can create drag and drop, matching and short answer questions as well as multiple choice questions. More templates in the BU-LCMS can be developed.

Appendix A: Usability Test

USABILITY TEST OF BU-LCMS

This questionnaire measures your satisfaction with the BU-LCMS and your evaluation of the system will greatly help us to improve the system. Please rate all items sincerely. Thank you for your contribution.

Name :..... **Your department** :.....

Sex: Male ( ) Female ( ) **Age:** 18-21 ( ) 22-26 ( ) 26-30 ( ) 31-35 ( ) 36-& over ( )

How do you rate your experience with computers?

Novice ( ) Experienced ( ) Expert ( )

Please read the following statements and rate "BU-LCMS" system by selecting appropriate slot across the statement.	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1) Highlighting and button actions on the screen was helpful	○	○	○	○	○
2) Reading characters on the screen was easy	○	○	○	○	○
3) The screen layouts were helpful	○	○	○	○	○
4) Arrangements of information on screen was logical	○	○	○	○	○
5) Next screen in a sequence was predictable	○	○	○	○	○
6) Sequence of screens were clear	○	○	○	○	○
7) Throughout the system terms were used consistently	○	○	○	○	○
8) The terminology used was well related to the work I was doing	○	○	○	○	○
9) Messages appearing on the screen were clear	○	○	○	○	○
10) Messages appearing on the screen were consistent	○	○	○	○	○
11) The system always kept me informed about what it was doing	○	○	○	○	○
12) Error messages on the system were helpful	○	○	○	○	○
13) Learning to navigate the system was easy	○	○	○	○	○
14) Exploration of the system features by trial and error was encouraged	○	○	○	○	○
15) Remembering names and use of commands/links was easy	○	○	○	○	○
16) Tasks can always be performed in a straight forward manner	○	○	○	○	○
17) Help messages on the screen was clear	○	○	○	○	○
18) Use of graphics in the system was sufficient	○	○	○	○	○
19) The system is reliable	○	○	○	○	○
20) Response time of the system was relatively fast enough	○	○	○	○	○
21) The system always warns the user about potential problems	○	○	○	○	○
22) Correcting my mistakes on the system was easy	○	○	○	○	○
23) Needs of inexperienced users were always taken into consideration	○	○	○	○	○
24) Creating folder was easy	○	○	○	○	○
25) Managing (editing/deleting) folders was easy	○	○	○	○	○
26) Uploading a file to the system was an easy task	○	○	○	○	○
27) Creating a learning unit was easy.	○	○	○	○	○
28) Learning unit templates was easy to use	○	○	○	○	○
29) Creating a learning topic under a learning unit was easy	○	○	○	○	○
30) Buttons to manage orders and hierarchy of topics of a learning unit were placed appropriately	○	○	○	○	○
31) Editing functions of a learning topic were appropriate	○	○	○	○	○
32) Editing a learning unit was easy	○	○	○	○	○
33) Publishing a learning unit was easy	○	○	○	○	○

34) Editor facilities to create a learning topic were satisfactory	○	○	○	○	○
35) Buttons on the editor were placed appropriately	○	○	○	○	○
36) Text formatting facilities of the editor was easy to use	○	○	○	○	○
37) Design templates for creating a learning topic were functional	○	○	○	○	○
38) Layout templates for creating a learning topic were functional	○	○	○	○	○
39) Inserting/editing an image to a topic was easy	○	○	○	○	○
40) Inserting/editing a flash animation to a topic was easy	○	○	○	○	○
41) Inserting multimedia to a topic was easy	○	○	○	○	○
42) Sharing a learning unit was easy.	○	○	○	○	○
43) Subject index was functional	○	○	○	○	○
44) My overall reactions to the system is satisfying	○	○	○	○	○

Please Turn Page >>

The following items are the ones I tried to do on the system but I could not succeed or the system was not able to meet requirements. (You can respond in Turkish)

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Anything you want to add about BU-LCMS (You can respond in Turkish)

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Appendix B: Inter-Item Correlation Matrix for Beta Study

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19	I20	I21	I22
I1	1.00	.363	.194	.486	.153	.387	.089	.319	.460	.447	.456	.362	.484	.189	.531	.415	.643	.371	.382	.289	.415	.036
I2	.363	1.00	.719	.333	-	.363	.219	.094	-	.423	.419	.248	.265	.107	.487	.391	.461	.263	.253	.447	.180	-
I3	.194	.719	1.00	.356	.079	.491	.274	.188	.000	.542	.462	.426	.291	.231	.538	.615	.508	.455	.366	.373	.176	-
I4	.486	.333	.356	1.00	.352	.646	.569	.125	.000	.796	.419	.585	.315	.071	.487	.225	.525	.340	.742	.332	.147	.212
I5	.153	-	.079	.352	1.00	.323	.505	.297	.250	.171	.000	.056	.230	-	.061	.417	.172	.360	.463	.177	.347	.040
I6	.387	.363	.491	.646	.323	1.00	.448	.141	-	.599	.434	.431	.314	.085	.630	.356	.478	.406	.547	.183	.212	-
I7	.089	.219	.274	.569	.505	.448	1.00	.343	-	.297	.181	.194	.199	-	.210	.160	.331	.238	.669	.340	.241	.091
I8	.319	.094	.188	.125	.297	.141	.343	1.00	.594	.204	.382	.311	.284	.335	.156	.481	.625	.458	.379	.140	.481	.204
I9	.460	-	.000	.000	.250	-	-	.594	1.00	.171	.000	.225	.230	.183	.000	.347	.345	.360	.174	-	.347	.198
I10	.447	.423	.542	.796	.171	.599	.297	.204	.171	1.00	.447	.655	.295	.235	.604	.357	.650	.335	.616	.081	.167	.245
I11	.456	.419	.462	.419	.000	.434	.181	.382	.000	.447	1.00	.637	.513	.580	.707	.466	.621	.445	.478	.541	.408	.080
I12	.362	.248	.426	.585	.056	.431	.194	.311	.225	.655	.637	1.00	.623	.455	.577	.276	.649	.404	.559	.053	.151	.219
I13	.484	.265	.291	.315	.230	.314	.199	.284	.230	.295	.513	.623	1.00	.313	.486	.338	.565	.313	.326	.108	.401	.179
I14	.189	.107	.231	.071	-	.085	-	.335	.183	.235	.580	.455	.313	1.00	.320	.345	.428	.418	.153	.086	-	.461
I15	.531	.487	.538	.487	.061	.630	.210	.156	.000	.604	.707	.577	.486	.320	1.00	.610	.667	.418	.556	.229	.273	.055
I16	.415	.391	.615	.225	.417	.356	.160	.481	.347	.357	.466	.276	.338	.345	.610	1.00	.641	.607	.459	.262	.460	.070
I17	.643	.461	.508	.525	.172	.478	.331	.625	.345	.650	.621	.649	.565	.428	.667	.641	1.00	.632	.685	.162	.385	.161
I18	.371	.263	.455	.340	.360	.406	.238	.458	.360	.335	.445	.404	.313	.418	.418	.607	.632	1.00	.626	.242	.379	.139
I19	.382	.253	.366	.742	.463	.547	.669	.379	.174	.616	.478	.559	.326	.153	.556	.459	.685	.626	1.00	.328	.266	.266
I20	.289	.447	.373	.332	.177	.183	.340	.140	-	.081	.541	.053	.108	.086	.229	.262	.162	.242	.328	1.00	.327	-
I21	.415	.180	.176	.147	.347	.212	.241	.481	.347	.167	.408	.151	.401	-	.273	.460	.385	.379	.266	.327	1.00	-
I22	.036	-	-	.212	.040	-	.091	.204	.198	.245	.080	.219	.179	.461	.055	.070	.161	.139	.266	-	-	1.00
I23	.353	-	.000	.075	.044	-	.000	.473	.309	.121	.461	.238	.426	.694	.279	.417	.467	.382	.266	.167	.270	.644
I24	.163	.469	.447	.348	.177	.503	.306	.105	.000	.485	-	.238	.284	.032	.386	.442	.447	.109	.287	-	.049	.224
I25	-	.132	.400	.133	.126	.433	.073	.188	.316	.325	.020	.383	.269	.237	.330	.466	.312	.293	.300	-	.044	.251
I26	.108	-	.149	.232	.354	.213	.204	.210	.059	.323	-	.000	.189	-	.029	.164	.244	.024	.191	-	.098	.037
I27	.156	.347	.257	.295	.135	.464	.235	.040	-	.348	.134	.106	.226	-	.090	.122	.148	.146	.196	.128	.348	.182
I28	.258	.076	.304	.237	.360	.673	.347	.309	.120	.247	.259	.306	.340	.095	.360	.389	.395	.519	.362	-	.456	-
I29	-	.244	.360	.224	.341	.519	.328	.090	.114	.312	-	.085	.061	.007	.230	.369	.218	.257	.448	-	.053	.048
I30	.378	.196	.203	.527	.161	.383	.432	.170	.107	.551	.406	.280	.225	.140	.524	.292	.397	.143	.657	.252	.173	.413
I31	.149	.167	.327	-	-	.198	-	.064	.000	.067	.272	.140	.255	.652	.379	.428	.359	.512	.187	.000	-	.311
I32	-	-	.000	-	.055	.040	-	-	-	-	.104	-	.153	.580	-	-	-	.152	-	-	-	.107
I33	.106	-	.158	.379	.188	.245	.145	.161	.063	.494	.377	.567	.256	.410	.438	.333	.299	.006	.326	-	.055	.354
I34	.186	-	.000	.322	.336	.075	.155	.186	.067	.231	.276	.191	.087	.659	-	.156	.242	.484	.296	.190	.006	.462
I35	.308	.146	.195	.109	.463	.140	.356	.367	.309	-	-	.035	.408	-	.019	.236	.230	.238	.054	.073	.236	-
I36	.228	.206	.376	.376	.297	.448	.514	.647	.149	.509	.506	.378	.080	.226	.301	.316	.557	.397	.516	.210	.316	.016
I37	.245	.177	.279	.411	.220	.676	.381	.360	.110	.472	.465	.507	.196	.216	.488	.237	.461	.447	.529	.000	.176	-
I38	.412	.254	.354	.378	.391	.520	.323	.598	.447	.383	.420	.502	.411	.327	.434	.497	.565	.644	.466	.105	.373	.071
I39	.457	-	.000	.196	.099	.043	.172	.433	.248	.341	.339	.164	.236	.042	.298	.156	.418	.061	.299	.140	.267	.168
I40	.379	-	.171	.297	.539	.106	.259	.436	.315	.170	.439	.286	.370	.212	.293	.464	.277	.319	.380	.424	.314	.168
I41	.082	-	.068	.136	.375	-	.062	.042	.054	.037	.383	.280	.299	.472	.186	.263	.029	.209	.186	.252	-	.311
I42	.365	.178	.411	.396	.487	.513	.375	.493	.433	.446	.354	.357	.240	.310	.359	.431	.390	.512	.426	.255	.371	.057
I43	.456	-	.130	.591	.563	.428	.532	.446	.410	.527	.167	.238	.114	.053	.145	.175	.325	.327	.510	.241	.346	.189
I44	.156	.009	.184	.307	.291	.645	.336	.201	.000	.349	.389	.403	.328	.261	.594	.289	.295	.194	.421	.000	.128	.131

	I23	I24	I25	I26	I27	I28	I29	I30	I31	I32	I33	I34	I35	I36	I37	I38	I39	I40	I41	I42	I43	I44
I1	.353	.163	-	.108	.156	.258	-	.378	.149	-	.106	.186	.308	.228	.245	.412	.457	.379	.082	.365	.456	.156
I2	-	.469	.132	-	.347	.076	.244	.196	.167	-	-	-	.146	.206	.177	.254	-	-	-	.178	-	.009
I3	.000	.447	.400	.149	.257	.304	.360	.203	.327	.000	.158	.000	.195	.376	.279	.354	.000	.171	.068	.411	.130	.184
I4	.075	.348	.133	.232	.295	.237	.224	.527	-	-	.379	.322	.109	.376	.411	.378	.196	.297	.136	.396	.591	.307
I5	.044	.177	.126	.354	.135	.360	.341	.161	-	.055	.188	.336	.463	.297	.220	.391	.099	.539	.375	.487	.563	.291
I6	-	.503	.433	.213	.464	.673	.519	.383	.198	.040	.245	.075	.140	.448	.676	.520	.043	.106	-	.513	.428	.645
I7	.000	.306	.073	.204	.235	.347	.328	.432	-	-	.145	.155	.356	.514	.381	.323	.172	.259	.062	.375	.532	.336
I8	.473	.105	.188	.210	.040	.309	.090	.170	.064	-	.161	.186	.367	.647	.360	.598	.433	.436	.042	.493	.446	.201
I9	.309	.000	.316	.059	-	.120	.114	.107	.000	-	.063	.067	.309	.149	.110	.447	.248	.315	.054	.433	.410	.000
I10	.121	.485	.325	.323	.348	.247	.312	.551	.067	-	.494	.231	-	.509	.472	.383	.341	.170	.037	.446	.527	.349
I11	.461	-	.020	-	.134	.259	-	.406	.272	.104	.377	.276	-	.506	.465	.420	.339	.439	.383	.354	.167	.389
I12	.238	.238	.383	.000	.106	.306	.085	.280	.140	-	.567	.191	.035	.378	.507	.502	.164	.286	.280	.357	.238	.403
I13	.426	.284	.269	.189	.226	.340	.061	.225	.255	.153	.256	.087	.408	.080	.196	.411	.236	.370	.299	.240	.114	.328
I14	.694	.032	.237	-	-	.095	.007	.140	.652	.580	.410	.659	-	.226	.216	.327	.042	.212	.472	.310	.053	.261
I15	.279	.386	.330	.029	.090	.360	.230	.524	.379	-	.438	-	.019	.301	.488	.434	.298	.293	.186	.359	.145	.594
I16	.417	.442	.466	.164	.122	.389	.369	.292	.428	-	.333	.156	.236	.316	.237	.497	.156	.464	.263	.431	.175	.289
I17	.467	.447	.312	.244	.148	.395	.218	.397	.359	-	.299	.242	.230	.557	.461	.565	.418	.277	.029	.390	.325	.295
I18	.382	.109	.293	.024	.146	.519	.257	.143	.512	.152	.006	.484	.238	.397	.447	.644	.061	.319	.209	.512	.327	.194
I19	.266	.287	.300	.191	.196	.362	.448	.657	.187	-	.326	.296	.054	.516	.529	.466	.299	.380	.186	.426	.510	.421
I20	.167	-	-	-	.128	-	-	.252	.000	-	-	.190	.073	.210	.000	.105	.140	.424	.252	.255	.241	.000
I21	.270	.049	.044	.098	.348	.456	.053	.173	-	-	.055	.006	.236	.316	.176	.373	.267	.314	-	.371	.346	.128
I22	.644	.224	.251	.037	.182	-	.048	.413	.311	.107	.354	.462	-	.016	-	.071	.168	.168	.311	.057	.189	.131
I23	1.00	.063	.246	.083	.120	.212	.040	.454	.617	.328	.376	.523	-	.158	.097	.277	.351	.461	.378	.268	.217	.308
I24	.063	1.00	.671	.250	.431	.340	.563	.227	.229	-	.310	-	.109	.105	.195	.237	-	-	-	.153	.072	.308
I25	.246	.671	1.00	.089	.317	.516	.719	.284	.433	.131	.451	-	-	.038	.327	.396	-	-	-	.356	.091	.533
I26	.083	.250	.089	1.00	.415	.226	.322	.303	.030	-	.089	.000	.073	.210	-	-	.609	.318	-	.000	.290	.137
I27	.120	.431	.317	.415	1.00	.553	.462	.362	.044	.022	.144	.055	-	.282	.291	.121	.135	-	-	.147	.264	.256
I28	.212	.340	.516	.226	.553	1.00	.510	.240	.300	.201	.311	.151	.222	.452	.661	.591	.064	.223	-	.555	.410	.652
I29	.040	.563	.719	.322	.462	.510	1.00	.471	.284	.290	.294	-	.000	.158	.326	.254	-	-	-	.378	.248	.551
I30	.454	.227	.284	.303	.362	.240	.471	1.00	.217	-	.513	.125	-	.360	.365	.144	.539	.407	.176	.340	.490	.570
I31	.617	.229	.433	.030	.044	.300	.284	.217	1.00	.548	.116	.423	-	-	.050	.173	-	.106	.189	.121	-	.269
I32	.328	-	.131	-	.022	.201	.290	-	.548	1.00	.084	.445	.017	-	.102	.049	-	-	.277	.150	-	.323
I33	.376	.310	.451	.089	.144	.311	.294	.513	.116	.084	1.00	.230	-	.310	.407	.280	.157	.381	.433	.370	.278	.649
I34	.523	-	-	.000	.055	.151	-	.125	.423	.445	.230	1.00	.041	.266	.133	.240	.071	.310	.527	.330	.431	.065
I35	-	.109	-	.073	-	.222	.000	-	-	.017	-	.041	1.00	.092	.085	.552	.000	.319	.165	.468	.348	.045
I36	.158	.105	.038	.210	.282	.452	.158	.360	-	-	.310	.266	.092	1.00	.752	.531	.433	.329	.106	.557	.568	.374
I37	.097	.195	.327	-	.291	.661	.326	.365	.050	.102	.407	.133	.085	.752	1.00	.739	.109	.193	.106	.644	.462	.688
I38	.277	.237	.396	-	.121	.591	.254	.144	.173	.049	.280	.240	.552	.531	.739	1.00	.044	.402	.239	.823	.550	.520
I39	.351	-	-	.609	.135	.064	-	.539	-	-	.157	.071	.000	.433	.109	.044	1.00	.542	.113	.115	.421	.193
I40	.461	-	-	.318	-	.223	-	.407	.106	-	.381	.310	.319	.329	.193	.402	.542	1.00	.696	.499	.531	.361
I41	.378	-	-	-	-	-	-	.176	.189	.277	.433	.527	.165	.106	.106	.239	.113	.696	1.00	.293	.183	.197
I42	.268	.153	.356	.000	.147	.555	.378	.340	.121	.150	.370	.330	.468	.557	.644	.823	.115	.499	.293	1.00	.783	.608
I43	.217	.072	.091	.290	.264	.410	.248	.490	-	-	.278	.431	.348	.568	.462	.550	.421	.531	.183	.783	1.00	.407
I44	.308	.308	.533	.137	.256	.652	.551	.570	.269	.323	.649	.065	.045	.374	.688	.520	.193	.361	.197	.608	.407	1.00

Appendix C: Inter-Item Correlation Matrix for Validation Study

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19	I20	I21
I1	1.000	.501	.335	.494	.316	.333	.317	.064	.227	.334	.466	.531	.164	.090	.062	.176	.492	.075	-.047	.317	.259
I2	.501	1.000	.239	.267	.283	.406	.361	-.079	.038	.362	.137	.140	.165	-.144	.021	.251	.249	.161	.161	.328	.315
I3	.335	.239	1.000	.500	.371	.437	.260	.525	.276	.410	.367	.209	.184	.217	.166	.189	.345	.223	.124	.313	.023
I4	.494	.267	.500	1.000	.324	.262	.083	.132	.180	.329	.318	.395	.085	.017	.058	.215	.294	.071	-.130	.180	-.077
I5	.316	.283	.371	.324	1.000	.586	.414	.257	.327	.291	.005	.141	.285	.183	.061	.308	.209	.177	-.072	.189	.200
I6	.333	.406	.437	.262	.586	1.000	.425	.223	.117	.290	.138	.150	.408	.307	.465	.626	.396	.360	.075	.411	.469
I7	.317	.361	.260	.083	.414	.425	1.000	.041	-.050	.351	.257	.192	.300	.198	.135	.251	.212	.200	.255	.114	.305
I8	.064	-.079	.525	.132	.257	.223	.041	1.000	.131	.072	.318	-.048	.209	.184	.124	.086	.193	-.118	.123	.273	.058
I9	.227	.038	.276	.180	.327	.117	-.050	.131	1.000	.443	.215	.182	.316	.345	.195	.294	.253	.209	-.090	.287	.042
I10	.334	.362	.410	.329	.291	.290	.351	.072	.443	1.000	.322	.562	.427	.208	.238	.352	.372	.351	.186	.301	.321
I11	.466	.137	.367	.318	.005	.138	.257	.318	.215	.322	1.000	.337	.307	.365	.220	-.058	.528	-.137	.061	.279	.177
I12	.531	.140	.209	.395	.141	.150	.192	-.048	.182	.562	.337	1.000	.225	.130	-.021	.091	.406	.300	-.057	.121	.368
I13	.164	.165	.184	.085	.285	.408	.300	.209	.316	.427	.307	.225	1.000	.545	.566	.270	.353	.355	.226	.330	.448
I14	.090	-.144	.217	.017	.183	.307	.198	.184	.345	.208	.365	.130	.545	1.000	.367	.171	.350	.283	.283	.248	.280
I15	.062	.021	.166	.058	.061	.465	.135	.124	.195	.238	.220	-.021	.566	.367	1.000	.436	.338	.049	.146	.341	.267
I16	.176	.251	.189	.215	.308	.626	.251	.086	.294	.352	-.058	.091	.270	.171	.436	1.000	.317	.265	.104	.429	.265
I17	.492	.249	.345	.294	.209	.396	.212	.193	.253	.372	.528	.406	.353	.350	.338	.317	1.000	.206	.170	.546	.248
I18	.075	.161	.223	.071	.177	.360	.200	-.118	.209	.351	-.137	.300	.355	.283	.049	.265	.206	1.000	.308	.230	.453
I19	-.047	.161	.124	-.130	-.072	.075	.255	.123	-.090	.186	.061	-.057	.226	.283	.146	.104	.170	.308	1.000	.287	.222
I20	.317	.328	.313	.180	.189	.411	.114	.273	.287	.301	.279	.121	.330	.248	.341	.429	.546	.230	.287	1.000	.285
I21	.259	.315	.023	-.077	.200	.469	.305	.058	.042	.321	.177	.368	.448	.280	.267	.265	.248	.453	.222	.285	1.000
I22	.265	.115	.222	-.063	-.014	.035	.176	.093	-.158	.123	.194	.384	.117	.287	-.156	-.290	.094	.337	.422	.189	.454
I23	.162	.193	.164	.238	-.139	.028	.039	.113	.040	.104	.397	.189	.059	.351	-.071	.099	.318	.118	.217	.293	.078
I24	.184	.236	.143	.006	.410	.443	.047	.146	.212	.207	-.018	.059	.408	.363	.380	.295	.275	.303	-.005	.285	.426
I25	.192	.094	.252	.028	.534	.448	.167	.326	.122	.000	-.047	.024	.253	.195	.181	.395	.238	.085	.167	.139	.282
I26	.136	.042	.214	.111	.428	.393	.174	.089	.368	.153	.038	.141	.424	.185	.239	.358	.411	.308	.016	.229	.229
I27	-.045	.145	.289	.027	.417	.470	.000	.238	.170	.101	-.140	-.022	.177	.030	.147	.403	.207	.222	-.136	.291	.311
I28	.307	.370	.170	.146	.235	.460	.146	.056	.107	.213	-.041	.177	.321	-.022	.323	.565	.497	.376	.084	.520	.328
I29	.299	.223	.469	.220	.436	.584	.267	.290	.147	.281	.347	.196	.451	.348	.311	.287	.371	.177	.099	.187	.383
I30	.365	.481	.424	.223	.165	.544	.475	.181	.075	.341	.273	.228	.235	.358	.330	.384	.429	.273	.355	.275	.553
I31	.355	.433	.546	.266	.361	.639	.304	.293	.156	.420	.320	.224	.373	.372	.318	.339	.522	.295	.301	.417	.390
I32	.411	.263	.497	.462	.455	.649	.253	.192	.241	.177	.366	.153	.238	.370	.295	.323	.437	.087	.008	.331	.209
I33	-.021	.055	.318	.405	.427	.355	.225	.094	.450	.316	.114	.084	.273	.139	.114	.291	.142	.164	-.049	.150	.085
I34	.077	.182	.246	.020	.309	.416	.401	.054	.170	.308	.016	.092	.137	.124	.169	.286	.238	.163	.068	.107	.317
I35	.208	.364	.333	.073	.341	.401	.147	.075	.112	.387	-.022	.370	.284	.059	.157	.056	.221	.279	.138	.137	.388
I36	.378	.116	.389	.274	.481	.517	.404	.209	.300	.419	.210	.486	.383	.374	.172	.444	.461	.492	.180	.417	.440
I37	.555	.245	.352	.187	.313	.339	.335	.179	.404	.662	.278	.485	.360	.159	.268	.285	.325	.184	.040	.306	.299
I38	.324	.258	.232	.060	.413	.444	.403	.259	.336	.495	.218	.278	.656	.272	.420	.450	.285	.230	.148	.297	.441
I39	.292	.222	.418	.140	.277	.507	.213	.196	.289	.262	.308	.129	.296	.278	.210	.357	.332	.073	-.102	.149	.280
I40	-.020	-.099	.484	.110	.089	.355	.072	.465	.199	.095	.158	-.024	.177	.292	.192	.334	.394	.275	.180	.287	.072
I41	.142	.007	.539	.134	.398	.494	.334	.351	.110	.205	.181	.124	.344	.358	.167	.272	.321	.378	.123	.195	.244
I42	.172	-.021	.604	.158	.436	.472	.381	.461	.186	.371	.200	.241	.306	.339	.219	.326	.309	.240	.129	.348	.242
I43	.135	.311	.584	.164	.299	.443	.269	.285	.032	.404	.181	.069	.350	.162	.265	.266	.439	.264	.243	.475	.203
I44	.381	.328	.335	.064	.271	.508	.395	.095	.263	.389	.204	.293	.470	.362	.381	.328	.286	.410	.202	.260	.623

	I23	I24	I25	I26	I27	I28	I29	I30	I31	I32	I33	I34	I35	I36	I37	I38	I39	I40	I41	I42	I43	I44
I1	,162	,184	,192	,136	-,045	,307	,299	,365	,355	,411	-,021	,077	,208	,378	,555	,324	,292	-,020	,142	,172	,135	,381
I2	,193	,236	,094	,042	,145	,370	,223	,481	,433	,263	,055	,182	,364	,116	,245	,258	,222	-,099	,007	-,021	,311	,328
I3	,164	,143	,252	,214	,289	,170	,469	,424	,546	,497	,318	,246	,333	,389	,352	,232	,418	,484	,539	,604	,584	,335
I4	,238	,006	,028	,111	,027	,146	,220	,223	,266	,462	,405	,020	,073	,274	,187	,060	,140	,110	,134	,158	,164	,064
I5	-,139	,410	,534	,428	,417	,235	,436	,165	,361	,455	,427	,309	,341	,481	,313	,413	,277	,089	,398	,436	,299	,271
I6	,028	,443	,448	,393	,470	,460	,584	,544	,639	,649	,355	,416	,401	,517	,339	,444	,507	,355	,494	,472	,443	,508
I7	,039	,047	,167	,174	,000	,146	,267	,475	,304	,253	,225	,401	,147	,404	,335	,403	,213	,072	,334	,381	,269	,395
I8	,113	,146	,326	,089	,238	,056	,290	,181	,293	,192	,094	,054	,075	,209	,179	,259	,196	,465	,351	,461	,285	,095
I9	,040	,212	,122	,368	,170	,107	,147	,075	,156	,241	,450	,170	,112	,300	,404	,336	,289	,199	,110	,186	,032	,263
I10	,104	,207	,000	,153	,101	,213	,281	,341	,420	,177	,316	,308	,387	,419	,662	,495	,262	,095	,205	,371	,404	,389
I11	,397	-,018	-,047	,038	-,140	-,041	,347	,273	,320	,366	,114	,016	-,022	,210	,278	,218	,308	,158	,181	,200	,181	,204
I12	,189	,059	,024	,141	-,022	,177	,196	,228	,224	,153	,084	,092	,370	,486	,485	,278	,129	-,024	,124	,241	,069	,293
I13	,059	,408	,253	,424	,177	,321	,451	,235	,373	,238	,273	,137	,284	,383	,360	,656	,296	,177	,344	,306	,350	,470
I14	,351	,363	,195	,185	,030	-,022	,348	,358	,372	,370	,139	,124	,059	,374	,159	,272	,278	,292	,358	,339	,162	,362
I15	-,071	,380	,181	,239	,147	,323	,311	,330	,318	,295	,114	,169	,157	,172	,268	,420	,210	,192	,167	,219	,265	,381
I16	,099	,295	,395	,358	,403	,565	,287	,384	,339	,323	,291	,286	,056	,444	,285	,450	,357	,334	,272	,326	,266	,328
I17	,318	,275	,238	,411	,207	,497	,371	,429	,522	,437	,142	,238	,221	,461	,325	,285	,332	,394	,321	,309	,439	,286
I18	,118	,303	,085	,308	,222	,376	,177	,273	,295	,087	,164	,163	,279	,492	,184	,230	,073	,275	,378	,240	,264	,410
I19	,217	-,005	,167	,016	-,136	,084	,099	,355	,301	,008	-,049	,068	,138	,180	,040	,148	-,102	,180	,123	,129	,243	,202
I20	,293	,285	,139	,229	,291	,520	,187	,275	,417	,331	,150	,107	,137	,417	,306	,297	,149	,287	,195	,348	,475	,260
I21	,078	,426	,282	,229	,311	,328	,383	,553	,390	,209	,085	,317	,388	,440	,299	,441	,280	,072	,244	,242	,203	,623
I22	,215	,118	,107	-,068	-,045	-,018	,128	,278	,243	,086	-,138	,025	,270	,274	,116	,109	-,108	-,024	,208	,259	,183	,281
I23	1,000	,195	,033	-,103	,080	,124	-,021	,264	,351	,259	,000	,148	-,068	,282	-,058	-,024	,084	,163	,191	,092	,287	,155
I24	,195	1,000	,526	,366	,552	,391	,231	,279	,496	,267	,058	,345	,424	,326	,201	,348	,144	,134	,257	,292	,407	,368
I25	,033	,526	1,000	,525	,662	,347	,498	,295	,422	,430	,140	,213	,402	,407	,162	,465	,291	,161	,329	,321	,271	,281
I26	-,103	,366	,525	1,000	,542	,402	,432	,236	,346	,233	,409	,174	,302	,446	,236	,389	,344	,342	,439	,196	,095	,375
I27	,080	,552	,662	,542	1,000	,522	,412	,221	,472	,391	,298	,309	,372	,362	,116	,259	,329	,192	,254	,310	,486	,389
I28	,124	,391	,347	,402	,522	1,000	,370	,310	,337	,351	,024	,174	,172	,508	,284	,337	,296	,281	,182	,188	,433	,401
I29	-,021	,231	,498	,432	,412	,370	1,000	,509	,530	,623	,201	,148	,469	,444	,466	,514	,707	,292	,319	,442	,343	,498
I30	,264	,279	,295	,236	,221	,310	,509	1,000	,626	,526	,124	,326	,348	,383	,277	,355	,480	,416	,381	,312	,327	,531
I31	,351	,496	,422	,346	,472	,337	,530	,626	1,000	,678	,338	,576	,484	,547	,381	,362	,497	,300	,388	,560	,694	,605
I32	,259	,267	,430	,233	,391	,351	,623	,526	,678	1,000	,418	,394	,246	,458	,187	,243	,498	,240	,336	,419	,480	,372
I33	,000	,058	,140	,409	,298	,024	,201	,124	,338	,418	1,000	,545	,257	,340	,175	,283	,313	,239	,265	,460	,223	,169
I34	,148	,345	,213	,174	,309	,174	,148	,326	,576	,394	,545	1,000	,417	,448	,303	,221	,375	,246	,284	,590	,488	,432
I35	-,068	,424	,402	,302	,372	,172	,469	,348	,484	,246	,257	,417	1,000	,286	,466	,387	,374	,129	,190	,394	,344	,365
I36	,282	,326	,407	,446	,362	,508	,444	,383	,547	,458	,340	,448	,286	1,000	,528	,531	,480	,368	,441	,628	,368	,515
I37	-,058	,201	,162	,236	,116	,284	,466	,277	,381	,187	,175	,303	,466	,528	1,000	,552	,551	,108	,094	,469	,218	,542
I38	-,024	,348	,465	,389	,259	,337	,514	,355	,362	,243	,283	,221	,387	,531	,552	1,000	,445	,135	,264	,528	,252	,379
I39	,084	,144	,291	,344	,329	,296	,707	,480	,497	,498	,313	,375	,374	,480	,551	,445	1,000	,479	,340	,461	,274	,439
I40	,163	,134	,161	,342	,192	,281	,292	,416	,300	,240	,239	,246	,129	,368	,108	,135	,479	1,000	,691	,421	,283	,068
I41	,191	,257	,329	,439	,254	,182	,319	,381	,388	,336	,265	,284	,190	,441	,094	,264	,340	,691	1,000	,438	,388	,282
I42	,092	,292	,321	,196	,310	,188	,442	,312	,560	,419	,460	,590	,394	,628	,469	,528	,461	,421	,438	1,000	,608	,323
I43	,287	,407	,271	,095	,486	,433	,343	,327	,694	,480	,223	,488	,344	,368	,218	,252	,274	,283	,388	,608	1,000	,365
I44	,155	,368	,281	,375	,389	,401	,498	,531	,605	,372	,169	,432	,365	,515	,542	,379	,439	,068	,282	,323	,365	1,000

Appendix D: Schema Files of Manifest

A1. imscp_v1p2.xsd

```
<?xml version="1.0" encoding="UTF-8" ?>
- <xs:schema xmlns="http://www.imsglobal.org/xsd/imscp_v1p1"
  targetNamespace="http://www.imsglobal.org/xsd/imscp_v1p1"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2000/10/XMLSchema-instance" version="IMS
  CP 1.2" elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:import namespace="http://www.w3.org/XML/1998/namespace"
  schemaLocation="http://www.w3.org/2001/03/xml.xsd" />
- <xs:annotation>
  <xs:documentation>XSD Data File Information ---------- Author:
  CP1P2 Project Team Date: 20th November, 2005 Version: 1.0 Status: Public
  Draft Description: This is a normative representation of the IMS CP 1.2
  Information Model for binding purposes. Read the corresponding IMS CP
  Information Model for the Platform Independent Model representation.
  History: This is version 1 of the IMS CP v1.2 XSD. It directly supercedes IMS
  CP v1.1.4 XSD. Note that the target namespace has NOT been changed. Apart
  from the functional additions, the main structural changes are: (1) All of the
  elements and attributes are defined as local to their host object; (2)
  Comments have been added to the complexType definitions. Copyright: 2005
  (c) IMS Global Learning Consortium Inc. All Rights Reserved. IMS Global
  Learning Consortium, Inc. (IMS) is publishing the information contained in
  this binding ("Specification") for purposes of scientific experimental and
  scholarly collaboration only. IMS makes no warranty or representation
  regarding the accuracy or completeness of the Specification. This material is
  provided on an "As Is" and "As Available basis". The Specification is at all
  times subject to change and revision without notice. It is your sole
  responsibility to evaluate the usefulness, accuracy and completeness of the
  Specification as it relates to you. IMS would appreciate receiving your
  comments and suggestions. Please contact IMS through our website at:
  http://www.imsglobal.org. Source XSLT File Information ----------
  ----- XSL Generator: UMLtoXSDTransformv0p7.xsl XSLT Processor: Xalan
  Release: 1.0 Beta 1 Date: 31st October, 2005 Auto-generation Tool ----------
  -------- This WSDL/XSD was auto-generated using the IMS WSDL/XSD auto-
  generation tool. While every attempt has been made to ensure that this tool
  auto-generates the XSDs correctly, users should be aware that this is an
  experimental tool. Permission is given to make use of this tool. IMS makes no
  claim on the materials created by third party users of this tool. Details on
  how to use this tool are contained in the IMS document: "IMS General Web
  Services: WSDL/XSD Binding Auto-generation" available at the IMS web-site.
  Tool Copyright: 2005 (c) IMS Global Learning Consortium Inc. All Rights
  Reserved.</xs:documentation>
  </xs:annotation>
- <!--
  Generate Global Attributes
  ********************************************************************
```

```
    -->
  - <!--
    ====================================
    -->
  - <!--
    Generate Namespaced extension Group
     ************************************************************
    -->
- <xs:group name="grp.any">
- <xs:annotation>
   <xs:documentation>Any namespaced element from any namespace may be
    included within an "any" element. The namespace for the imported element
    must be defined in the instance, and the schema must be
    imported.</xs:documentation>
    </xs:annotation>
- <xs:sequence>
     <xs:any namespace="##other" processContents="strict" minOccurs="0"
    maxOccurs="unbounded" />
    </xs:sequence>
    </xs:group>
  - <!--
    ====================================
    -->
  - <!--
    Generate the enumerated simpleType declarations
     ************************************************
    -->
  - <!--
    ====================================
    -->
  - <!--
    Generate the simpleType elements based IMS data-types
     ****************************************
    -->
  - <!--
    ====================================
    -->
  - <!--
    Generate the derived data-type elements
     ********************************************************
    -->
  - <!--
    ====================================
    -->
  - <!--
    Generate the data-type elements
     ********************************************************************
    -->
- <xs:complexType name="Manifest.Type">
- <xs:annotation>
- <xs:documentation>
    A manifest element is a container for data structures whose contents describe
    a semantically complete instance of the IMS Content Packaging Information
    Model. A manifest element may contain and reference child manifest
    elements in the same IMS Manifest document. The root manifest element
```

```
      defines an entire IMS Package. A child manifest element defines a
      semantically complete subset of that Package.
    <p>Represents a binding of the kinds of objects defined as children of ims-cp-
      imManifest : Manifest.[ ManifestMetadata, Organizations, Resources,
      Manifest, Extension ].</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
    <xs:element name="metadata" type="ManifestMetadata.Type" minOccurs="0"
      maxOccurs="1" />
    <xs:element name="organizations" type="Organizations.Type" minOccurs="1"
      maxOccurs="1" />
      <xs:element name="resources" type="Resources.Type" minOccurs="1"
      maxOccurs="1" />
        <xs:element name="manifest" type="Manifest.Type" minOccurs="0"
      maxOccurs="unbounded" />
    <xs:group ref="grp.any" />
      </xs:sequence>
    <xs:attribute name="identifier" use="required" type="xs:ID" />
    <xs:attribute name="version" use="optional" type="xs:string" />
    <xs:attribute ref="xml:base" use="optional" />
    <xs:anyAttribute namespace="##other" processContents="strict" />
      </xs:complexType>
- <xs:complexType name="Metadata.Type">
- <xs:annotation>
- <xs:documentation>
      An instance of the metadata element contains data structures that declare
      descriptive information about a metadata element's parent only. One or more
      different metadata models may be declared as child extensions of a metadata
      element.
    <p>Represents a binding of the kinds of child objects defined for ims-cp-
      imMetadata: Metadata.[ Extension ].</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
    <xs:group ref="grp.any" />
      </xs:sequence>
      </xs:complexType>
- <xs:complexType name="Organizations.Type">
- <xs:annotation>
- <xs:documentation>
      The organizations element is a container for all data structures that describe
      the way or ways that information encapsulated by its parent manifest
      element is structured.
    <p>Represents of binding of the child objects of ims-cp-imOrganizations:
      Organizations.[ Organization, Extension ].</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
    <xs:element name="organization" type="Organization.Type" minOccurs="0"
      maxOccurs="unbounded" />
    <xs:group ref="grp.any" />
      </xs:sequence>
```

```
  <xs:attribute name="default" use="optional" type="xs:IDREF" />
  <xs:anyAttribute namespace="##other" processContents="strict" />
    </xs:complexType>
- <xs:complexType name="Resources.Type">
- <xs:annotation>
- <xs:documentation>
     The Resources element is a container for data structures containing
     references to one or more assets. Asset references may be grouped within a
     containing resources element in whatever manner seems best. The scope of
     referenced assets is specific to a resources element's parent manifest
     element only.
   <p>Represents a binding of the kinds of child objects defined for ims-cp-
     imResources: Resources.[ Resource, Extension ].</p>
    </xs:documentation>
    </xs:annotation>
- <xs:sequence>
      <xs:element      name="resource"      type="Resource.Type"      minOccurs="0"
    maxOccurs="unbounded" />
  <xs:group ref="grp.any" />
    </xs:sequence>
  <xs:attribute ref="xml:base" use="optional" />
  <xs:anyAttribute namespace="##other" processContents="strict" />
    </xs:complexType>
- <xs:complexType name="Organization.Type">
- <xs:annotation>
- <xs:documentation>
     An organization element is a container for all data structures relating to a
     particular way or view that information encapsulated by a grandparent
     manifest object is structured. Multiple organization elements within the same
     parent organizations element are equivalent in purpose: Each shows a
     different way for structuring the same information declared within a
     grandparent manifest object.
   <p>Represents a binding of the kinds of child objects defined for ims-cp-
     Organization: Organization[ Title, Item, Metadata, Extension ].</p>
    </xs:documentation>
    </xs:annotation>
- <xs:sequence>
  <xs:element name="title" type="xs:string" minOccurs="0" maxOccurs="1" />
        <xs:element        name="item"        type="Item.Type"        minOccurs="1"
    maxOccurs="unbounded" />
      <xs:element      name="metadata"      type="Metadata.Type"      minOccurs="0"
    maxOccurs="1" />
  <xs:group ref="grp.any" />
    </xs:sequence>
  <xs:attribute name="identifier" use="required" type="xs:ID" />
     <xs:attribute      name="structure"      use="optional"      default="hierarchical"
    type="xs:string" />
  <xs:anyAttribute namespace="##other" processContents="strict" />
    </xs:complexType>
- <xs:complexType name="Resource.Type">
- <xs:annotation>
- <xs:documentation>
```

```
      A resource element is a container for a particular asset or collection of assets.
      A resource may contain references to assets that are all of the same type or
      different types (i.e., file formats). The scope or boundary of an IMS Package
      is defined by the asset references collected into all resources containers
      associated with the root manifest element, whether as a child, direcdt
      descendant, or externally linked descendant.
    <p>Represents a binding of the kinds of child objects defined for ims-cp-
      imResource: Resource.[ Metadata, File, Dependency, Extension ].</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
      <xs:element      name="metadata"      type="Metadata.Type"      minOccurs="0"
      maxOccurs="1" />
    <xs:element name="file" type="File.Type" minOccurs="0" maxOccurs="unbounded"
      />
      <xs:element    name="dependency"    type="Dependency.Type"    minOccurs="0"
      maxOccurs="unbounded" />
    <xs:group ref="grp.any" />
      </xs:sequence>
    <xs:attribute name="identifier" use="required" type="xs:ID" />
    <xs:attribute name="type" use="required" type="xs:string" />
    <xs:attribute ref="xml:base" use="optional" />
    <xs:attribute name="href" use="optional" type="xs:anyURI" />
    <xs:anyAttribute namespace="##other" processContents="strict" />
      </xs:complexType>
- <xs:complexType name="Item.Type">
- <xs:annotation>
- <xs:documentation>
      An item element represents a structural node in a particular organization. An
      item element may be a parent or sibling of other Item elements, each one
      representing a unique structural node. An organization has no meaning
      unless it has at least one Item element.
    <p>Represents a binding of the kinds of child objects of ims-cp-imItem: Item.[
      Title, Item, Metadata, Extension ].</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
    <xs:element name="title" type="xs:string" minOccurs="0" maxOccurs="1" />
          <xs:element      name="item"      type="Item.Type"      minOccurs="0"
      maxOccurs="unbounded" />
      <xs:element      name="metadata"      type="Metadata.Type"      minOccurs="0"
      maxOccurs="1" />
    <xs:group ref="grp.any" />
      </xs:sequence>
    <xs:attribute name="identifier" use="required" type="xs:ID" />
    <xs:attribute name="identifierref" use="optional" type="xs:string" />
    <xs:attribute name="isvisible" use="optional" type="xs:boolean" />
    <xs:attribute name="parameters" use="optional" type="xs:string" />
    <xs:anyAttribute namespace="##other" processContents="strict" />
      </xs:complexType>
- <xs:complexType name="File.Type">
- <xs:annotation>
- <xs:documentation>
```

```
      A file element declares a reference to a single asset. The reference may be
      relative to the Package containing the file element or absolute (external to
      the Package). A file element may contain child extensions declaring
      alternative references to the same asset as that referenced by the file
      element's href attribute.
    <p>Represents a binding of the kinds of child objects defined for ims-cp-imFile:
      File.[ Metadata, Extension ].</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
      <xs:element name="metadata" type="Metadata.Type" minOccurs="0"
    maxOccurs="1" />
    <xs:group ref="grp.any" />
      </xs:sequence>
    <xs:attribute name="href" use="required" type="xs:anyURI" />
    <xs:anyAttribute namespace="##other" processContents="strict" />
      </xs:complexType>
- <xs:complexType name="Dependency.Type">
- <xs:annotation>
- <xs:documentation>
      A dependency element provides a way to associate another collection of asset
      references within the scope of the dependency element's parent resource
      element. This element allows the parsimonious declaration of asset
      references. Shared asset references can be declared once and associated
      many times through a Dependency element.
    <p>Represents a binding of the kinds of child objects defined for ims-cp-
      imDependency: Dependency.[ Extension ].</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
    <xs:group ref="grp.any" />
      </xs:sequence>
    <xs:attribute name="identifierref" use="required" type="xs:string" />
    <xs:anyAttribute namespace="##other" processContents="strict" />
      </xs:complexType>
- <xs:complexType name="ManifestMetadata.Type">
- <xs:annotation>
- <xs:documentation>
      This metadata element contains data structures that declare descriptive
      information about an entire Package. One or more different metadata models
      may be declared as child extensions of a metadata element. The schema and
      schemaversion children define the kind or collection of metadata models
      being used.
    <p>Represents a binding of the kinds of child objects defined for ims-cp-
      imManifestMetadata: ManifestMetadata.[ Schema, SchemaVersion,
      MetadataModel ]..</p>
      </xs:documentation>
      </xs:annotation>
- <xs:sequence>
    <xs:element name="schema" type="xs:string" minOccurs="0" maxOccurs="1" />
      <xs:element name="schemaversion" type="xs:string" minOccurs="0"
    maxOccurs="1" />
    <xs:group ref="grp.any" />
```

```
  </xs:sequence>
  </xs:complexType>
- <!--
  ======================================
  -->
- <!--
  Declaration of the elements
   **********************************************************************
  -->
- <!--
  ======================================
  -->
- <!--
  Declaration of the root element(s)
   ************************************************************
  -->
<xs:element name="manifest" type="Manifest.Type" />
- <!--
  ======================================
  -->
  </xs:schema>
```

A.2. imscp_util.xsd

```
<?xml version="1.0" encoding="UTF-8" ?>
- <xs:schema xmlns="http://www.imsglobal.org/xsd/imscp_util"
  targetNamespace="http://www.imsglobal.org/xsd/imscp_util"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2000/10/XMLSchema-instance"
  xmlns:xlink="http://www.w3.org/1999/xlink" version="IMS Packaging Utility
  1.0" elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:import namespace="http://www.w3.org/1999/xlink"
  schemaLocation="http://www.imsglobal.org/xsd/ims_xlink.xsd" />
- <xs:annotation>
  <xs:documentation>XSD Data File Information ---------- Author:
  CP1P2 Project Team Date: 2005-11-11 Version: 1.0 Status: Public Draft - IMS
  Packaging Utility v1.0 - WD2 Description: This is a normative representation
  of the IMS Packaging Utility 1.0 Information Model for binding purposes.
  Read the corresponding IMS Packaging Utility Information Model for the
  Platform Independent Model representation. History: This is version 1 of the
  IMS Packaging Utility v1.2 XSD. It has a target namespace of
  http://www.imsglobal.org/xsd/imscp_util. This Utility uses this general
  approach to modeling: (1) All of the elements and attributes are defined as
  local to their host object; (2) There are multiple host objects; (3) Comments
  have been added to the complexType definitions. Copyright: 2005 (c) IMS
  Global Learning Consortium Inc. All Rights Reserved. IMS Global Learning
  Consortium, Inc. (IMS) is publishing the information contained in this binding
  ("Specification") for purposes of scientific experimental and scholarly
  collaboration only. IMS makes no warranty or representation regarding the
  accuracy or completeness of the Specification. This material is provided on an
  "As Is" and "As Available basis". The Specification is at all times subject to
  change and revision without notice. It is your sole responsibility to evaluate
  the usefulness, accuracy and completeness of the Specification as it relates
  to you. IMS would appreciate receiving your comments and suggestions.
  Please contact IMS through our website at: http://www.imsglobal.org.
  Source XSLT File Information ---------- XSL Generator:
  UMLtoXSDTransformv0p7.xsl XSLT Processor: Xalan Release: 1.0 Beta 1 Date:
  30th November, 2005 Auto-generation Tool ---------- This WSDL/XSD
  was auto-generated using the IMS WSDL/XSD auto-generation tool. While
  every attempt has been made to ensure that this tool auto-generates the
  XSDs correctly, users should be aware that this is an experimental tool.
  Permission is given to make use of this tool. IMS makes no claim on the
  materials created by third party users of this tool. Details on how to use this
  tool are contained in the IMS document: "IMS General Web Services:
  WSDL/XSD Binding Auto-generation" available at the IMS web-site. Tool
  Copyright: 2005 (c) IMS Global Learning Consortium Inc. All Rights
  Reserved.</xs:documentation>
  </xs:annotation>
- <!--
  Generate Global Attributes
   ************************************************************************
  -->
- <!--
  ====================================
```

```
    -->
  - <!--
    Generate Namespaced extension Group
     ************************************************************
    -->
- <xs:group name="grpStrict.any">
- <xs:annotation>
   <xs:documentation>Any namespaced element from any namespace may be
    included within an "any" element. The namespace for the imported element
    must be defined in the instance, and the schema must be imported. The
    extension has a definition of "strict" i.e. they must have their own
    namespace.</xs:documentation>
    </xs:annotation>
- <xs:sequence>
     <xs:any namespace="##other" processContents="strict" minOccurs="0"
    maxOccurs="unbounded" />
    </xs:sequence>
    </xs:group>
  - <!--
    ====================================
    -->
  - <!--
    Generate the enumerated simpleType declarations
     ************************************************
    -->
  - <!--
    ====================================
    -->
  - <!--
    Generate the simpleType elements based IMS data-types
     ****************************************
    -->
  - <!--
    ====================================
    -->
  - <!--
    Generate the derived data-type elements
     ********************************************************
    -->
  - <!--
    ====================================
    -->
  - <!--
    Generate the data-type elements
     ********************************************************************
    -->
- <xs:complexType name="IMSPointer.Type">
- <xs:annotation>
- <xs:documentation>
    A bound instance of an IMS Pointer object allows a packager to associate a
    specific XML node set in the same IMS Manifest Document that contains it or
    an XML node set in a different IMS Manifest Document instance with the
    parent object containing an IMS Pointer instance. A referenced node set must
    be a valid child of the referencing parent element, both as to kind and
    multiplicity in a referencing parent's context.
```

```
<p>Represents a binding of the kinds of objects defined as children of ims-cp-imManifest : Manifest.[ ManifestMetadata, Organizations, Resources, Manifest, Extension ].</p>
</xs:documentation>
</xs:annotation>
- <xs:sequence>
<xs:group ref="grpStrict.any" />
</xs:sequence>
<xs:attribute name="identifier" use="required" type="xs:ID" />
<xs:attribute ref="xlink:type" use="optional" default="simple" />
<xs:attribute ref="xlink:href" use="required" />
<xs:anyAttribute namespace="##other" processContents="strict" />
</xs:complexType>
- <xs:complexType name="Metadata.Type">
- <xs:annotation>
- <xs:documentation>
An instance of the metadata element contains data structures that declare descriptive information about a metadata element's parent only. One or more different metadata models may be declared as child extensions of a metadata element.
<p>Represents a binding of the kinds of child objects defined for ims-cp-imMetadata: Metadata.[ Extension ].</p>
</xs:documentation>
</xs:annotation>
- <xs:sequence>
<xs:group ref="grpStrict.any" />
</xs:sequence>
</xs:complexType>
- <xs:complexType name="Variant.Type">
- <xs:annotation>
- <xs:documentation>
A variant element is closely analogous to a resource element in the IMS Content Packaging Information Model. Variant is a container for a particular asset or collection of assets. A resource may contain references to assets that are all of the same type or different types (i.e., file formats). The Variant family of objects allows a packager to identify alternative collections of resources. Metadata is used to describe the nature of a collection of alternative assets and their intended use. Examples include, but are not limited to, use as lingual variants, visual or auditory variants, remediation variants, or platform delivery variants. The scope of referenced assets is specific to a Variant object. Their use is in the context of the parent object containing a variant instance, typically a bound instance of a Resource object from the IMS CP namespace.
<p>Represents a binding of the kinds of child objects defined for ims-cp-imResource: Resource.[ Metadata, File, Dependency, Extension ].</p>
</xs:documentation>
</xs:annotation>
- <xs:sequence>
<xs:element name="metadata" type="Metadata.Type" minOccurs="1" maxOccurs="1" />
<xs:group ref="grpStrict.any" />
</xs:sequence>
<xs:attribute name="identifier" use="required" type="xs:ID" />
```

```
<xs:attribute ref="xlink:type" use="optional" default="simple" />
<xs:attribute ref="xlink:href" use="required" />
<xs:anyAttribute namespace="##other" processContents="strict" />
  </xs:complexType>
- <!--
  ====================================
  -->
- <!--
  Declaration of the elements
   ************************************************************************
  -->
- <!--
  ====================================
  -->
- <!--
  Declaration of the root element(s)
   ************************************************************
  -->
<xs:element name="imsptr" type="IMSPointer.Type" />
<xs:element name="variant" type="Variant.Type" />
- <!--
  ====================================
  -->
  </xs:schema>
```

A.3. imsvdex_v1p0_flat.xsd

```
<?xml version="1.0" encoding="UTF-8" ?>
- <!--
Generated by Turbo XML 2.3.1.100. Conforms to w3c
  http://www.w3.org/2001/XMLSchema
  -->
- <xs:schema targetNamespace="http://www.imsglobal.org/xsd/imsvdex_v1p0"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="http://www.imsglobal.org/xsd/imsvdex_v1p0"
  elementFormDefault="qualified" attributeFormDefault="unqualified" version="1.0
  Flat Profile">
- <!--
 edited with XML Spy v4.4 U (http://www.xmlspy.com) by Adam Richard Cooper
  (FD Learning Ltd)
  -->
<xs:element name="vdex" type="vdexType" block="#all" />
<xs:element name="metadata" type="metadataType" block="#all" />
<xs:element name="langstring" type="langstringType" block="#all" />
<xs:element name="caption" type="langstringBag" block="#all" />
<xs:element name="description" type="descriptionType" block="#all" />
<xs:element name="term" type="termType" block="#all" />
 <xs:element name="mediaDescriptor" type="mediaDescriptorType" block="#all"
  />
<xs:element name="mediaLocator" type="mediaLocatorType" block="#all" />
<xs:element name="targetTerm" type="termRefType" block="#all" />
<xs:element name="sourceTerm" type="termRefType" block="#all" />
- <xs:complexType name="identifierType">
- <xs:simpleContent>
- <xs:extension base="xs:anyURI">
<xs:anyAttribute namespace="##other" processContents="lax" />
  </xs:extension>
  </xs:simpleContent>
  </xs:complexType>
- <xs:complexType name="mediaLocatorType">
- <xs:simpleContent>
- <xs:extension base="xs:anyURI">
<xs:anyAttribute namespace="##other" processContents="lax" />
  </xs:extension>
  </xs:simpleContent>
  </xs:complexType>
- <xs:complexType name="mediaDescriptorType">
- <xs:sequence>
<xs:element ref="mediaLocator" />
 <xs:element name="interpretationNote" type="descriptionType" block="#all"
  minOccurs="0" />
  <xs:any namespace="##other" processContents="strict" minOccurs="0"
  maxOccurs="unbounded" />
  </xs:sequence>
```

```
  <xs:anyAttribute namespace="##other" processContents="lax" />
    </xs:complexType>
- <xs:complexType name="termType">
- <xs:sequence>
  <xs:element name="termIdentifier" type="identifierType" block="#all" />
  <xs:element ref="caption" minOccurs="0" />
  <xs:element ref="description" minOccurs="0" />
  <xs:element ref="metadata" minOccurs="0" maxOccurs="unbounded" />
     <xs:any     namespace="##other"     processContents="strict"     minOccurs="0"
    maxOccurs="unbounded" />
    </xs:sequence>
  <xs:attribute name="validIndex" type="xs:boolean" default="true" />
  <xs:anyAttribute namespace="##other" processContents="lax" />
    </xs:complexType>
- <xs:complexType name="metadataType">
- <xs:sequence>
     <xs:any     namespace="##other"     processContents="strict"     minOccurs="0"
    maxOccurs="unbounded" />
    </xs:sequence>
  <xs:anyAttribute namespace="##other" processContents="lax" />
    </xs:complexType>
- <xs:complexType name="vdexType">
- <xs:sequence>
  <xs:element name="vocabName" type="langstringBag" block="#all" minOccurs="0"
    />
   <xs:element   name="vocabIdentifier"   type="vocabIdentifierType"   block="#all"
    minOccurs="0" />
  <xs:element ref="term" maxOccurs="unbounded" />
  <xs:element ref="metadata" minOccurs="0" maxOccurs="unbounded" />
     <xs:any     namespace="##other"     processContents="strict"     minOccurs="0"
    maxOccurs="unbounded" />
    </xs:sequence>
  <xs:attribute name="orderSignificant" type="xs:boolean" default="false" />
  <xs:attribute name="profileType" type="vdexProfilesType" use="required" />
  <xs:attribute name="language" type="xs:language" />
  <xs:anyAttribute namespace="##other" processContents="lax" />
    </xs:complexType>
- <xs:complexType name="langstringType">
- <xs:simpleContent>
- <xs:extension base="xs:string">
  <xs:attribute name="language" type="xs:language" />
  <xs:anyAttribute namespace="##other" processContents="lax" />
    </xs:extension>
    </xs:simpleContent>
    </xs:complexType>
- <xs:complexType name="langstringBag">
- <xs:sequence>
  <xs:element ref="langstring" maxOccurs="unbounded" />
    </xs:sequence>
  <xs:anyAttribute namespace="##other" processContents="lax" />
    </xs:complexType>
- <xs:complexType name="vocabType">
```

```
- <xs:simpleContent>
- <xs:extension base="xs:string">
  <xs:attribute name="source" type="xs:anyURI" use="required" />
  <xs:anyAttribute namespace="##other" processContents="lax" />
    </xs:extension>
    </xs:simpleContent>
    </xs:complexType>
- <xs:complexType name="descriptionType">
- <xs:complexContent>
  <xs:extension base="langstringBag" />
    </xs:complexContent>
    </xs:complexType>
- <xs:complexType name="vocabIdentifierType">
- <xs:simpleContent>
- <xs:extension base="identifierType">
  <xs:attribute name="isRegistered" type="xs:boolean" default="false" />
    </xs:extension>
    </xs:simpleContent>
    </xs:complexType>
- <xs:complexType name="termRefType">
- <xs:simpleContent>
- <xs:extension base="identifierType">
  <xs:attribute name="vocabularyIdentifier" type="xs:anyURI" />
    </xs:extension>
    </xs:simpleContent>
    </xs:complexType>
- <xs:simpleType name="vdexProfilesType">
- <xs:restriction base="xs:string">
  <xs:enumeration value="flatTokenTerms" />
    </xs:restriction>
    </xs:simpleType>
    </xs:schema>
```

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