Design of a Learning Management System on LTSA framework

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Abstract: In this paper, IEEE Learning Technology System Architecture (LTSA) for LMS software has been analyzed. It has been observed that LTSA is too abstract to be adapted in a uniform way by LMS developers. A high level design that satisfies the IEEE LTSA standard has been proposed for future development of efficient LMS software. A hybrid model of learning fitting into LTSA model has also been proposed while designing.

Key-Words: IEEE LTSA, e-Learning, LMS, SCROM, Hybrid Model

1. Introduction
The non-linear way of storage of information in the form of hypertext has brought a revolutionary change in the teaching-learning process [13]. In the hypertext document, links have been established in such a way that the user can explore, browse and search for not only a particular item but can also get information regarding relevant/associated issues. Cockertion and Shimell evaluated hypermedia document as a learning tool [18]. They have included graphical controls for simple interaction behavior. Vassileva and Deters designed a dynamic courseware generator tool based on AI planning techniques [14]. These works emphasize more on pedagogical and other issues rather than identification of requirements.

Keith S. Taber and his associates [15] put forward a project aimed to integrate English and Science standards using technology as a vehicle. The emphasis, however, was merely to improve the presentation of the learning material. Dr. Munro [17] also worked on identification of the requirements based on some pre-defined key issues for the effective delivery of course content. Zhang [16] has designed a computer based knowledge system for assisting persons in making decisions and predictions upon human or data-mining knowledge. However, none of these works are generic as well as tailor-made for individual learner.

While working on design of an LQ based efficient and adaptive learning system, it has been observed that a generic platform is required to design and develop an LMS with the adaptive algorithm already proposed in [4], [9] and [12]. The working group IEEE "1484 Learning Technology Standards Committee (LTSC)" has designed an architecture called Learning Technology System Architecture (LTSA) to standardize web-based content delivery for all learning technology systems [3]. We propose a high level design of the LTSA in this paper on the LQ based learning system.

The five-layered LTSA standard specifies a high level architecture for information technology-supported learning, education, and training systems. This standard is pedagogically neutral, content-neutral, culturally neutral, and platform-neutral. The layer’s specification is from abstraction towards implementation as one moves from Layer I to Layer V. The layer I is the highest level of abstraction where two entities Learner and Environment and their interactions are shown. Layer II is less abstract than Layer I and describes a generic five-step algorithm of learning technology considering the human-centered features. In layer III the system components like Learner, Evaluation, Knowledge Library, Assessment, and Learning Content are described. Layer IV specifies perspectives of different stakeholders. The final layer describes operational components like client-servers, interface protocols, name space URL etc.

Now this architecture cannot be considered as a blueprint for designing a single system, but a framework for designing a range of systems over time. Neither this framework specifies any implementation technologies. In this paper, an LQ-based design is proposed for implementing LTSA.
2. Adaptation of LTSA
The LMS software available in the markets are lacking from a common standardization of their architecture [1]. These software follow SCROM as the standard for their content management [6, 7, 8] but for the overall architecture, LTSA being so generic that it is very hard for different vendors to follow it in a universal way. Each of the market available LMS software has some merit and limitations. In Sec. 3.0 proposed modification of LTSA has been presented while section 4.0 deals with the UML design.

2.1 Market available LMS Software
Moodle [6] is one of the common names in the LMS market. In this software, course listing shows descriptions for every course on the server, including accessibility to guests. Courses can be categorized and searched - one Moodle site can support thousands of courses. A teacher has full control over all settings for a course, including restricting other teachers. Choice of course formats such as by week, by topic or a discussion-focused social format. Assignments can be specified with due dates and maximum grades. Students can upload their assignments (any file format) to the server - they are date-stamped. Teacher feedback is appended to the assignment page for each student, and notification is mailed out.

Sakai [7] is a set of software tools designed to help instructors, researchers and students to create websites on the web. For courseware, Sakai provides features to supplement and enhance teaching and learning. For collaboration, Sakai has tools to help organize communication and collaborative work on campus and around the world. Using a web browser, users choose from Sakai's tools to create a site that meets their needs, no knowledge of HTML is necessary. The powerful tools provided with Sakai are Syllabus tool, Schedule tool, Resources tool, Assignment tool, grade book tool, email archive tool, announcement tool etc [7].

Ilias [8] is a powerful Open Source Learning Management System for developing and realizing web-based e-learning. ILIAS offers multiple ways to deliver learning content. All types of document files can be uploaded; SCORM 2004, SCORM 1.2 and AICC are supported. ILIAS includes an internal authoring environment to create XML-based learning modules, that can include images, flash, applets and other web media files. ILIAS provides a "Personal Desktop" for every user with facilities like listing of selected courses, and learning resources, bookmark management, calendar, personal learning progress along with other important modules like course management, assessment, etc.

2.2 Limitations of the available software
The existing software solutions have mostly implemented the ‘Layer I’ well in their system. Moodle [6], Sakai [7] provides the scope of interaction with the teacher while learning. However, techniques to slow down the pace of learning or to explain some key words better, are not well designed in these systems. In ‘layer III’ the system components like Learning Content, Knowledge Library, Students’ performance database are covered in most of the solutions, but the approach of reusability has not been defined in any of the software. The ‘layer IV’ of LTSA architecture is well implemented in the leading software, at least three stake holders perspective student, teacher and administrator are taken care by all. Finally in ‘layer IV’ Operational components are identified by: i) Systems, e.g., clients and servers ii) Connectors (interface protocols), e.g., HTTP, PPP iii) Busses (namespaces), e.g., URLs, telephone numbers. The existing solutions have implemented some of these operational components.

3. Limitations of LTSA
Some of the functional areas not included in LTSA are identified and a brief report of the same is presented here.

a) The model does not regard the learning object designer as an integrated component in the learning process [2].
b) The students evaluation records are stored but how to use it is not specified.
c) For a distance mode learner, if the learner possess some fundamental wrong/incomplete idea and the feedback system fails to identify it, then the LTSA layer II algorithm falls under a never ending iterative cycle.
d) Students counseling is not included in the LTSA architecture. Students take on courses generally by only the name of the course. Many a times they overlook the prerequisites.
In the design we have introduced the hybrid mode of learning inside LTSA. If any learner fails to achieve the expected level of knowledge in one or multiple attempts in distance mode, there is a provision of contact classes for that learner on that subject to remove all the problems and confusions. Hybrid courses have the following inherent advantages over face-to-face teaching or totally online courses:

Convenience: Coursework accommodates students’ schedules, plus commuting time is decreased. Hybrid instructors report increased interaction and contact among students and between the instructor and the students [10].

Flexibility: Instructors can accomplish certain learning objectives more successfully than in traditional courses because of the flexibility of the Hybrid model [11].

Increased learning: Faculty almost universally reports their students learn more in the Hybrid format than they do in traditional class sections. Instructors report that students write better papers, perform better on exams, produce higher quality projects, and are capable of more meaningful discussions on course material.

Increased retention: Data from the University of Central Florida (UCF) also show that student retention in Hybrid courses is better than retention in totally online courses and equivalent to that of face-to-face courses.

In our proposed design the students evaluation records are used for the evaluation of the excellence of the course, excellence of the Instructor (for contact classes) and counseling of that student in any other course. The learner counseling is also proposed which may be conducted by taking intelligent small test on their earlier knowledge or by navigating them through the list of prerequisites for different courses. The two-mode evaluation process (online and offline) is also introduced in our design - online objective test and offline assignments.

4. Architectural Design of the Proposed Model using UML

An architectural design of a Learning Management System using UML diagrams has been presented in this section. This design consists of one use case, one sequence and one activity diagram. The basic architecture behind the design is LTSA but augmented with some added features like hybrid model of learning, two mode evaluation process, counseling etc.

![Fig. 1: Use Case Diagram of LMS](image-url)
Fig 2: Sequence Diagram of LMS

1. Counseling
2. Enrollment
3. Delivery
4. Learning
5. Participate
6. Asking help
7. Negotiating Teaching Style
8. Contributory
9. Beneficiary
10. Result
11. Record Evaluation
Fig. 3: Activity Diagram of LMS
In the use case diagram [fig 1] teacher, student and administrator are identified as the main actors and it supports both contact learning and distance learning (i.e. hybrid model). The students performance record is stored and used for counseling of the students for different courses or can be used for counseling different students on that course. Discussion forum is the place where a stakeholder like learner can change his role and can teach the other learners as per LTSA Layer IV specification. In the sequence diagram [fig 2] the link between teacher and student shows that the student can negotiate in learning style in the mid of the course with the teacher, thus satisfying the part of layer II learning cycle.

In the activity diagram [fig 3] the counseling is the first activity even before the enrolment. This design specifies the distance learning to be the next step. However the learner can negotiate with learning style while learning. The performance of the learner evaluated in two ways. One by online test, mainly objective or MCQs and are more frequent, and other by offline test mainly submission of assignments, less frequently conducted. Next if the performance is not achieved up to a desired level then contact classes are arranged for that student on that course. Thus in this design the basic learning cycle described in LTSA layer II is combined with hybrid model of learning and two mode evaluation technique.

5. Conclusion
This paper provides the designs that are based on the framework of Learning Technology System Architecture and it is expected that based on this design and its further modification, if any, more efficient and adaptive LMS software product can be developed. This proposed design adapts the advantage of both E-learning and hybrid mode learning and fits into a standard architecture.

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