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SCORM/AICC Compliance in Learning Management System and e-Learning: A Survey

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***Abstract*— Learning Management System (LMS) is a software application for administration, delivering, tracking and reporting on e-learning (electronic learning) courses to various organizations, educational institutes, and online websites. LMS launches e-learning courseware and deliver it with flexibility. LMS balances between functionality and ease of use. LMS provides the user with simple and modern user interface. Most organization uses different LMS for launching new training courseware to their employee from a central server and it is easy to track the employee understanding of the course at the end of the training by an online assessments. LMS uses AICC and SCORM standards for tracking the e-learning courses. The standards depend on the development of the course ware. In this paper, the detailed survey about the AICC and SCORM used in LMS are discussed.**

Keywords—LMS; e-Learning; AICC; SCORM; Survey

I. INTRODUCTION

LMS is a software application or Web-based technology used for administration, delivering, tracking and reporting of e-Learning courses to various organizations, educational institutes, and online websites. A LMS gives access to an instructor to create his own content, launch the course, monitor student/employee participation, and assess student/employee performance. A LMS also provides the student/employee with interactive discussions, video conferencing and discussion forums. LMS systems are web-based systems. So the students can access the course material "anytime, anywhere".

LMS has different features. Some features are common to all LMS. Creation of course list, registration process and creating waiting list are the basic features of LMS. Uploading and management of documents containing content, Course content delivery in web, interaction between students by email and messaging, assessment or Quiz at the end of the courseware and tracking of the user course completing status are the other features.

LMS used in corporate system have additional functionalities. Automatic enrollment of courseware for some specific cadre when new course are launched is done in corporate system. Also integration with the appraisal links when an employee finishes a course is enabled in this system.

The Learning Management System currently used by many organizations gives lot of benefits to the company. The LMS can be easily adaptable and reuse course materials over time. The learning in the LMS is more effective, thus this increases the profitability of the organization. The tracking of the user completion status is quick and accurate. So automatically increases the evaluation reporting for the corporates. Lot of new technologies and new software can be used for the development of e-learning course. This can improve content delivery and more choice is there for the development. All the data resides in one database. So it will be increase efficiency of administration in an organization.

LMS launches e–learning courses. E-learning is a computer based educational system that enables us to learn anywhere and at any time. Nowadays, e-learning is widely delivered through the web. In earlier days it was delivered as computer-based methods like CD_ROMs. Since web technology has grown fast, the user feels like he/she is in the classroom. Also the web materials can be shared via all formats.

In the fast-moving world of e-learning there are lots of new technologies available in the market. So the course existing always changes and course content should be updated quickly to give the students latest information. When a technology keeps on changing, it is responsibility for the organization to change the material faster and need to keep up-to-date information in the e-learning training. This is also the reasons why many businesses are now offering training via e-learning; the course material can be changed easily.

Technical standards are there for communication between e-learning content and LMS. These standards provide interoperability. Course developed by these standards are easy to integrate in LMSs that are compliance with the same standards. AICC (Aviation Industry CBT (Computer-Based Technology) Committee) and SCORM (Sharable Content Object Reference Model) are the two standards used by LMS.

The Aviation Industry Computer-Based Training Committee (AICC) existed from 1988 to 2014. It created

learning technology specifications used widely in the eLearning industry [1]. ADL (Advanced Distributed Learning) has recently inherited CMI-5 and the other work formerly done by AICC and fully supports the direction of this profile of xAPI.

The Department of Defense (DOD) started the ADL initiative in 1999. The ADL was developed to join the power of learning and information technologies and to standardize and modernize, improvise education and training [2]. This ADL developed SCORM compliance.

This paper is organized as follows: Section II describes the literature review about AICC/SCORM Compliance in LMS and e-leaning. Section III describes the AICC Compliant. Section IV describes the SCORM Compliant. Section V describes the comparison between AICC and SCORM. Section VI concludes this paper.

II. Literature Review

Gustavo Soares Santos and Joaquim Jorge, in their work proposed an approach for the development of interoperable e-learning standards. In their approach they developed an atomic tutoring system. For their approach they used SCORM compliance for developing [3].

Oliver Bohl, Dr. Jörg Schellhase, Ruth Sengler, Prof. Dr. Udo Winand, in their work the SCORM benefits and advantages are studied. Also they studied about the SCORM SCOs in detail. The quality of the WBT mainly depends on the SCOs [4].

III. AICC Compliant

On developing online course the standards specified by AICC need to be used. AICC was first used by the aviation industry, and then adopted by all the industry for e-learning course ware development. The term "AICC Compliance" is that the courseware/training product fulfills with one or more of the 9 AICC Guidelines & Recommendations (AGR's). The AICC documents AGR-006 (File-based CMI Systems) or AGR-010 (Web-based CMI Systems) are the most common meaning of "AICC compliance" is compliance [5]. The communication between the LMS and the courseware is defined by the AGRs. AICC's has CMI (Computer-Managed Instruction) which is used for the interoperability between e-learning and LMS. CMI are described in different documents. This document provides a set of recommendations and guidelines for achieving interoperability between different CMI systems and between CMI systems and computer-based training (CBT) applications.

E-Learning courses using AICC Complaint have two components: instructional elements and structure. The instructional elements contain the lessons, tests, and other assignable units (AUs) in the course. The structure is defined as the developer frequently groups lessons for assignment. By using standard mechanism for developing course as content and structure, enables CMI systems to "ingest" a new course with minimal manual effort.

CBT lessons can only be entered by one entry point. The lessons i.e. the internal structure are not standardized and hence the lessons will have only one entry point. For this reason lessons are also called assignable units (A.U) by AICC [6].

The CMI uses a standard approach to lesson initiation for the interoperability between CBT system and CMI. Standard types of data need to be passed between CBT and CMI. The data needed are, for a CBT lesson to start, data from the CMI need to be passed into the CBT system, CMI $\Leftrightarrow$ CBT; second is recording student performance by receiving data from CBT system to CMI, CMI $\Rightarrow$ CMI; and the third major one is the data needed for evaluation of a lesson such as item response data, CMI $\Rightarrow$ Lesson- evaluation [6]. Table 1 gives different groups used in data flow.

Table 1. Data Flow [6]

S. No.	Data Flow	Group Names and Keywords	Function of Group
1	CMI to CBT Lesson	Student_ID Student_Name Output_File CreditLesson_Location Lesson_Status Path Score Time Lesson_Mode	Information required to be providing by all CMI systems. What are all lessons may depend upon at start up, from any AICC compliance CMI system. Optional item
2	CBT Lesson to CMI	Lesson_Location Lesson_Status Score Time	Information required by the CMI system to function.
3	Error and Default Conditions	(i) File Creation, File Read, and File Write Errors (ii) Data and File Format Errors (iii) CBT and CMI System Mismatch Errors	Error

For each lesson there are 5 possible statuses, explicitly identified as 2. Completed status can be tracked as “Passed” or “Completed”. Incomplete status can be tracked as “Failed” or “Not Attempted” or “Incomplete”.

AICC uses HTTP (Hyper Text Transfer Protocol) for communication. HTTP is used for launching, controlling, and data transport for AICC/CMI systems and AICC/CBT Assignable Units. This communication is termed as HACP (HTTP AICC CMI Protocol).

HTTP Protocol was selected as basic transport mechanism for the following three reasons [6]. First reason is the course material delivery is based on both HTTP web Servers and HTTP web browsers. As HTTP protocol is independent of hardware platform, this is used. Last reason is that the security firewalls allow HTTP Request/Response inside the networks.

IV. SCORM Compliant

The Sharable Content Object Reference Model (SCORM) combines a set of related technical standards, specifications, and guidelines designed to meet requirements including accessibility, interoperability, durability, reusability and portability of content and systems.

Accessibility: The content must be possible found in a repository. For this requirement some standard need to be followed for the classification of data. For delivering this type of content to a learner, the SCORM defines minimum conformance requirements for system.

Interoperability: Whatever may be the environment the content should work same in all.

Durability: Content should be usable as long it is relevant and worth for the money used to develop it.

Reusability: The content must be reusable as it can be reused by other communities. For this the content need to build in small modules, which can be combined at later times.

Portability: The content need to be transferred easily between delivery environments. The content need to work same in all environments without modification, as long as the delivery environment includes a web browser.

As of now, there are three released versions of SCORM [7].

SCORM 1.1: The first version and based on AICC specification used a Course Structure Format XML file to describe content structure. This version lacked a robust packaging manifest and support for metadata.

SCORM 1.2: The widely adopted version and is still supported by most Learning Management Systems.

SCORM 2004: This the latest release. Various conformance requirements and some new conformance requirements are introduced to improve interoperability and also added the sequencing and navigation (S&N) specification. Vendor can specify behavior of SCOs within them as well as between them is allowed by S&N. This makes the content considerably richer in interactions and huge increases in the reuse of SCOs. SCORM has documents like CAM, S&N, RTE.

A Sharable Content Object (SCO) is the most important training part in a SCORM. As per SCORM, SCO is the smallest part of content, which can be both reusable and independent. As per LMS, this item is viewed separately in the course table of contents and tracked separately from other items. SCO is designed in such a way that it can contain each user's bookmark, score, and completion status.

The SCORM Content Aggregation Model (CAM) is a document specifies how the resources are aggregated with one or more activity tree.

The SCORM Runtime Environment (RTE) is a document defines how a content object is launched, and how it can communicate tracking data to the runtime environment.

The SCORM Sequencing and Navigation (SN) document defines which sequencing rules can be added, and the behaviors that should occur at runtime when sequencing rules exist in the package.

After developing the content, the next is packaging. The package has an XML file named "imsmanifest". This is the core file in SCORM packaging. This file contains required information for the LMS to import and launch the content without the help of human. The manifest file is the file describes the structure of the course (from learner's perspective as well as physical file system).

A SCORM package contains a manifest file contains the information for course launching from the LMS, and knows the content of the package and specifies how the content is organized.

Next the package contains metadata. Metadata, if not included inline in the manifest. Metadata describes the package; it has at least one organization element that specifies an activity tree for the use of the content of the package. The package must need all the files required to launch the content. The package must have a collection of one or more resource elements that specify launchable content objects.

Run-time communication specifies the communication between the LMS and the e-learning content dynamically. This is also the part of delivery and tracking. First, the content finds the LMS. Once the content has found LMS, the communication is done by through a series of "get" and "set" calls and an associated vocabulary. By availing SCORM vocabulary, many rich interactive experiences can be transferred to the LMS [8].

When a learner is interacting with a SCO in LMS, the communication is standardized by using the SCORM API method. There is a specific set of information the SCO can set or retrieve.

An international standard IEEE 1484.11.2: ECMAScript API is used by the SCORM to communicate between a SCO and the runtime environment. SCORM content uses the following Table 2 API methods for communication.

Table 2. API Methods

S. No.	API methods	Functions
1	LMSInitialize ("")	Opens communication session
2	LMSSetValue ("name", "value")	Sets a value to the API
3	LMSGetValue("name")	Retrieves data from the API
4	LMSCommit("")	Sends data from API to LMS
5	LMSFinish("")	Commits data and closes communication session
6	LMSGetLastError("")	Retrieves error code for last API call
7	LMSGetErrorString(code)	Retrieves error text
8	LMSGetDiagnostic(code)	Retrieves LMS-specific description

V. AICC/SCORM COMPARISON

This section describes the comparison between AICC and SCORM [9].

A. Communication:

AICC uses the HACP to make communication between the course content and the LMS.

SCORM uses API to communicate between the course content and the LMS.

B. Data Retrieval:

In AICC, content developer needs to write all of the functionalities for communication. Data organization is more complicated and multiple functions are required by the server to remove unwanted string as a part of the response it received.

SCORM uses a standard set of functions to send and retrieve information. Data organization is easy.

C. Cross Browsing:

In AICC, content can reside in separate server and information can be transferred through HTTPS.

In SCORM, there are some issues with cross-browser scripting. The content and LMS must be on the same server.

D. Software:

Almost all the software like Lectora, Articulate, and Flash can be used for both AICC and SCORM complaint.

VI. CONCLUSION

A detailed study about LMS and e-learning are done. LMS and e-learning uses the standards for communication. The AICC and SCORM complaint are the standards used by the LMS and e-learning for content specification and communication. A survey of this compliance is done and also a comparison study on this compliance is done.

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