Analysis of Learning Management Systems features and future development challenges in modern cloud environment

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Abstract - Learning Management Systems (LMS) are commonly used for management of online learning activities inside single or many courses. Usually they are rich with different tools and options in order to enable modern interactive learning environment. But from their early beginnings, before migration on web, LMS were designed as closed systems in order to serve single institution learning content. Such development hindered LMS for proper integrations with other systems and brought many challenges which are present up to this date in many LMS solutions. This research explains why some of the most used LMS in the world today are not able to properly integrate in modern cloud environment. Analysis of core functionalities of most used LMS are explained with propositions for improvement and future development.

I. INTRODUCTION

Sharing and collaboration on creating knowledge should be main feature in any e-learning system. Unfortunately those activities are frequently being hindered by systems which supposed to support them. LMS and similar e-learning systems are designed to structure learning procedures, tools and information but they are often not enabling effective sharing and creation of content in easy to use collaborative environment. Educators are reaching for other services and solutions in order to create, share and collaborate on creation of educational content which, on the end, is being offered to students inside LMS.

This paper explains why LMS are inherently closed systems and proposes open architecture for sharing and reusing learning objects (LO) with explanation of main benefits of such approach. Integration capabilities and challenges for successful integration of current LMS solutions are analyzed from perspective of two most commonly used LMS solutions - Blackboard and Moodle. General proposition for LMS open architecture is given with explanations of communication inside proposed learning network. Special attention is given to analysis and proposition of LO since they are in the core of learning network. In the end, this research brings possible future development based on proposed architecture.

II. CURRENT RESEARCH

Researchers exploring possible integrations of various learning systems and learning repositories have successfully created different solutions which are implemented in government and e-learning networks. Those repositories and services allows creation of easily accessible resources [1]. Extensively mentioned OER (Open Educational Resources) are in focus of various other researchers with aim to facilitate integration of learning resources [2]. Therefore similar solutions for integrated LO search tools or networks already exist as demonstrated in [3], [4], [5], [6] and [7]. However, existing federated LO search engines produced through such research are rarely used. Educators are mainly using dedicated individual sources like professional literature resources with readymade materials or LO which are available through various OER portals. Poor usage comes from fact that majority of high quality LOs are not present in OERs or any other learning repositories but inside LMS. Other researchers explored options for personalization of learning objects in virtual learning environments [7] or gave practice-oriented review of LO which emphasizes need for better management of LO in any learning information system [8]. But majority of research is focused on integration problems in some limited environment [9] or on need for upgrading LMS as individual system [7] without taking into consideration global scope of the problem.

III. ASSESMENT OF CURRENT LMS INTEGRATION CAPABILITIES

LMS integration services should allow educators and students to collaborate not only on institutional level but also with other institutions. LMS integration with other systems like SIS (Student Information System) has been standard way of integration. It is usually fairly limited type of integration for accessing basic information in SIS (about students, professors, departments, courses) in order to replicate same state inside LMS. Blackboard and Moodle, as most used LMS, are following IMS Global standard for LTI (Learning Tools Interoperability [10]) in order to integrate content from providers like McGraw and Pearson [11] or to allow access to full courses and activities from

remote systems (other LMS installations or any other LMS LTI consumer compliant software). LTI is standard way of integrating rich learning applications (often remotely hosted and provided through third-party services) with platforms like LMS, web portals, or other educational information systems [12]. This is also powerful way to integrate LMS with cloud services in order to achieve collaborative and interactive features that often lack inside LMS environment. Integration with Google Docs is good example of that [13]. API (Application Programming Interface) on LMS is offering access to content and tools inside LMS environment and API is usually used to create plugins (in Moodle [14]) or building blocks (in Blackboard [15]) environment which are extending standard functionalities. These are usually ways LMS can be extended but this does not mean they are offering ideal modern e-learning environment. We must keep on mind that e-learning is continuously evolving and learning systems must be ready to integrate new paradigms that consider student as the center of the learning process [16, 17]. This shift will mean changing the tools currently used and giving way to new tools for easy integration of new services and resources which are frequently emerging [18]. Web carries large variety of new kinds of tools and services and many educators are adopting new approach from the closed LMS course space towards Personal Learning Environments (PLE) [19]. PLE's are characterized by its absence of structure, just what is provided by open standards and mashup techniques which are becoming more and more important because they allow effective integration of content or service in modern web environment [20]. Unfortunately integration options like that are either not supported or they are very limited in current mainstream LMS. LMS APIs that should enable described integration are falling short in enabling such dynamic environment inside LMS courses.

A. Metadata problems

Valuable resources like LO have to be discoverable in networked educational environment and with proper metadata automatically defined. Unfortunately LMS is not storing LO with metadata options and usually they have quite week capabilities regarding metadata management in general. Content features do allow easy input of data on course, for example with Moodle you can easily just drag and drop new content in certain content holder areas inside courses. Question is – how is document metadata stored? In usual scenario users will not have option for filling metadata fields and there is no automated mechanisms that are doing that instead of user. Convenient circumstance is that LMS already holds majority of information which can be assigned as metadata or it can be easily fetched from SIS. Problem is that there is no usual workflow that implements this important aspect [21]. Metadata already present in LMS is:

- User information about teachers and students – fetch from authorization system or SIS of the institution,
- Course and department data – is already stored in structure of the LMS while courses are opened, structured and classified.

With such a rich sources of metadata any LO generated in LMS environment could be described with all

information that can be fetched from LMS or any other institutional system. It's worth noting that SaaS (Software as a service) LMS solutions are becoming more and more popular [22, 23]. They are usually modern cloud based software created on SOA (Service Oriented Architecture) principals and therefore very flexible, easily scalable and customizable with better pricing systems which is appealing to management of institutions [24]. SaaS LMS features SIS integration but custom integrations are not fully supported [25].

IV. CHALLENGES FOR SUCCESSFUL LMS-CLOUD INTEGRATION

Many proposals tried to demonstrate integration of learning activities in cloud environment [26]. Main challenges in the way are:

- Successful integration with existing learning and other supporting information systems.

We have seen proposed architectures that are giving complete road map on how to migrate existing services into cloud environment but transition in reality cannot easily follow that pattern. There are many legacy systems (not only LMS) that needs to be taken into consideration. SIS is starting point of integration - allowing authorization and data acquisition from cloud applications as well as better integration with LMS.

- Supportive cloud environment with adept tools for educational purposes of different types.

Different cloud platforms are recently launched with "education" emphasis [27]. They usually provide good foundation for creation of new generation of educational cloud content services because they provide stable storage with powerful collaboration features, event management features, email integration on institution level and similar services. What is missing are instructions, case scenarios, tools, additional APIs and examples on how to build and integrate cloud applications with different types of existing standardized infrastructures; LMS and SIS in first place.

- Advanced adaptive schemas for semantics and ontology.

Educational services on the web use different ways of naming various types of data for internal handling and also for communications with other systems. Some are standardized according to SCORM [28] but in many cases situation is still quite challenging since there is no standardized procedure for all activities [29] in formal or informal learning on the web. Therefore problems are present in service communication with any standardized LMS. Procedures, data types and APIs should be defined with agreements between key organizations on how to implement them.

- Tracking, assessment and collaboration.

Implementing ways to assess and track learners' progress during formal and informal learning in PLE is imperative. There has been good attempts recently to assess those activities [30] but we are far away from standardized procedures. We need to be able to preserve learners' privacy and still track activities across web with customizable tools for measuring quantity and quality of learners' contributions across wide variety of tools and services on the web and not only inside LSM. Learning is

happening more frequently on the web than in LMS. Measurement are not enough in this situation since we also need ways to link them with rubrics and assessment procedures in LMS that will allow us to give students feedback. Gamification tools that recently emerged in LMS tools are promising but much needs to be done so we could effectively integrate them with third party tools [31].

V. PROPOSITION FOR LMS OPEN ARCHITECTURE

There is obvious need for better collaboration among institutions for enabling support for teachers' and students' needs in learning environment. Open architecture for connected learning has to support unprecedented agility, flexibility, and personalization in order to fulfil those requirements. Agility, in the IT context, means a focus on applications so that instructors can mix and match tools from a wide array of sources (i.e., traditional vendors, instructors, institutions, open sources) to best support their pedagogical goals [32]. Figure 1. shows schema for institutional collaboration integrated in existing LMS environment. Idea is not to abandon currently used LMS but enrich them with collaborative options which educators from various institutions can use in order to create, share and reuse educational material. LMS directory service could enable discovery of learning materials and activities across many institutions.
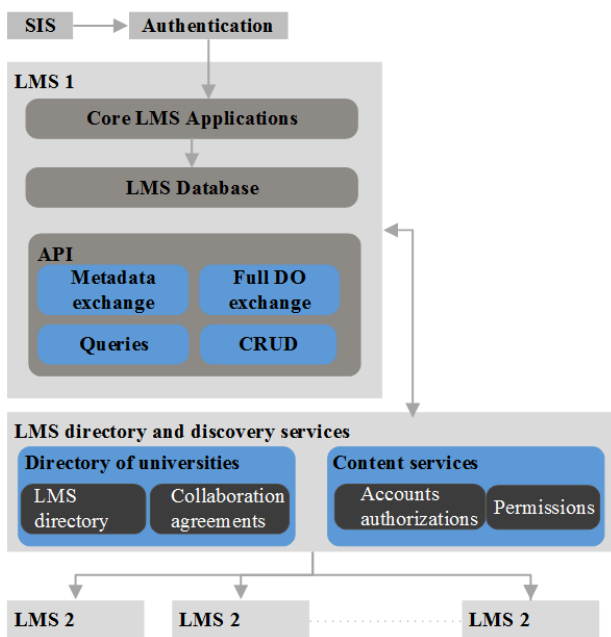

Figure 1. Simplified schema of Open Architecture for LMS network

Based on their learning affiliation, content and activities, institutions could automatically initiate collaboration intention and simplify various agreements based on them. After agreement has been officially signed collaboration can start. So this will enable customizable network of resources built with affiliated partners. This proposed solution brings down many barriers that educators are facing today and could enable richer learning experience for students and educators as well [33].

VI. LMS COMMUNICATION INSIDE PROPOSED LEARNING NETWORK

In order to facilitate communication with proposed LMS learning network, institutions has to be able to discover, describe and open their own resources to learning network in controlled way. We have to keep on mind that any scientific publication system or library information system could as well be part of this network. Figure 2. shows proposed Learning Directory Service for harvesting and discovery of learning resources on own private network with primary focus on LMS and other internal information systems with educational content and services. Such service also has to be able to integrate 3rd party content and service from other LMS or other external repositories.
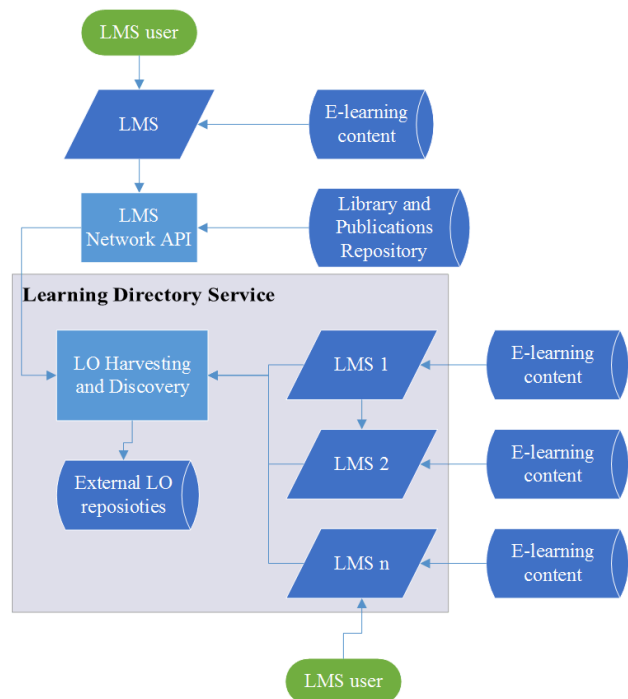

Figure 2. Learning Directory Service

In extended form, this service should be able to expand own API in order to successful integrate various types of services and content providers. But in that case data model should be very flexible and in same time no information should be omitted while communicating with rest of the learning network. Idea is to integrate heterogeneous sources and properly enable technology enhanced learning ecosystem [34]. In order to achieve that we need far better architecture of LO.

VII. LEARNING OBJECT AS CORE OF SERVICE ORIENTED E-ARCHITECTURE

Proposed data model of LO is in the heart of architecture shown on Figure 3. Figure shows proposed Extended Learning Object Architecture. LO core components define its ID, properties, description, relations to other object (in case if it's part of some complex object), his internal structure (in case it is itself complex object), API implementations automatically defined by type of resources that object is consisted of, core datastreams (local or remote) and places where object is integrated

(information systems, local or remote which are using object). Such LO structure enables sustainability, reusability, tracking and versioning supported by corresponding APIs. Also any missing service could be easily integrated since custom API for that specific LO could be easily build. Any object editing could create new versions and any citation or reusing of object would create new record in objects Resource Map [35].
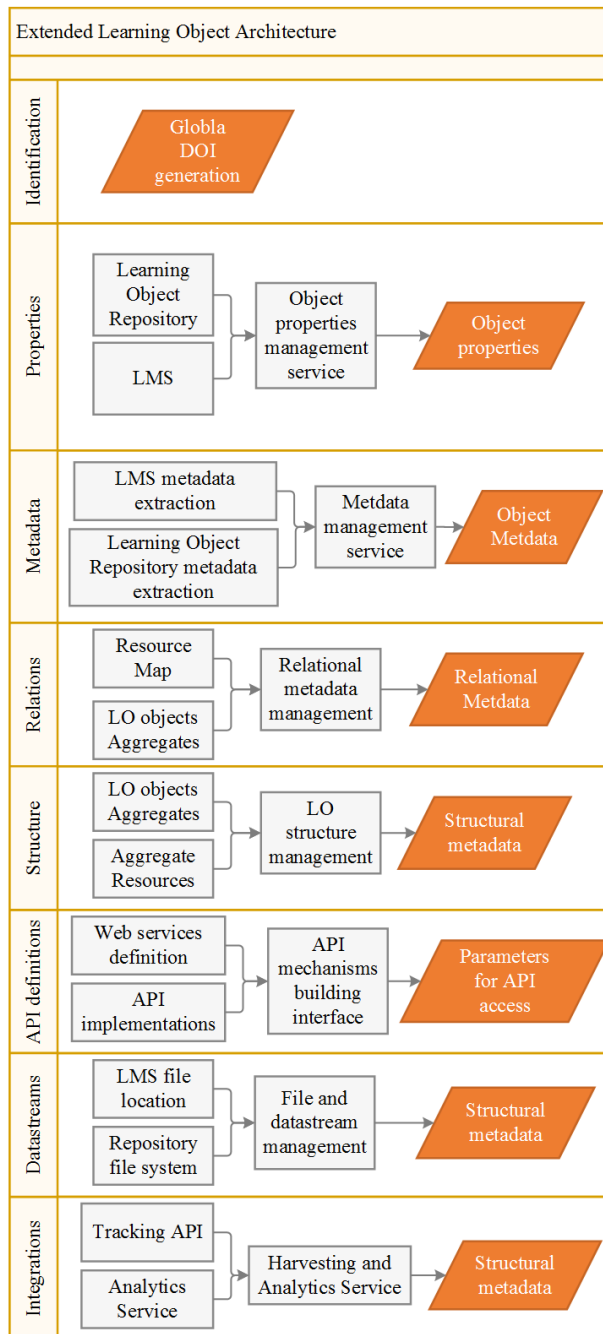

Figure 3. Schematics of proposed Extended Learning Object Architecture

The Service Oriented Architecture approach is applied in form of application of protocols like OAI-ORE (Open Archives Initiative Object Reuse and Exchange) which gives thorough guidelines on how to enable such proposition in own environment [36, 37]. Just like every SCORM compatible LO could be reused in LMS SCORM

supporting system in same way proposed extended LO could be reused everywhere through its extensive APIs (including SCORM supported LMSs).

Purpose of proposed framework would be enabling of advanced features and integrating them in existing learning environment. Examples of new features are:

- enhanced application for collaboration

This would enable creation of customized web environments. Specialized collaboration apps could allow researchers and students collaboration while writing: essays, project, and scientific articles from online apps which would be integrated with enhanced learning content tools and references. Users would be able to collaborate on joint projects inside its own cloud environment or in collaboration with other educational institutions. Integration for other recognized third party service (e.g. Google Docs through Google Docs API) would be enabled with various options like tracking of user contributions, versioning and content integration on courses.

- enhanced existing learning content tools and references

Bookmarked sites, custom libraries, annotations, commenting and highlighting tools, custom web scrapping and other web objects, personal learning objects library etc. , are all cloud tools and services that could be integrated with cloud core storage engine together with custom search. This would allow learners to search their storage, their college resource, college partners' resources and also school library and scientific databases on which school bought access - all from single location.

- educational internal social network

Service integration would allow creation of social-like news feeds where students could see contributions of their project groups or class participants in internal or external learning apps from their own institution or with users from other institutions. This would be enabled since this approach would literally wipe LMS borders allowing direct communication among groups. Instead of just programmatically support various platforms, web services mechanism builder (under API definitions) from Figure 3. could provide interface for less knowledgeable users for visual creation of applications. Apps could harvest types of data records from knows services and then allow users to build custom applications with available building blocks and integrate in them various data sources (users and objects from other LMS or Repository services).

A. Example of learning activity in proposed system

In this chapter we'll give example how proposed architecture could be used to asses learners' informal activities on the web and integrated it in LMS.

Computer science students are learning about web server administration. Group have to set up their own web server with custom features and create comparison between few open source applications using open source

931

performance benchmark testing tools. While they run into several problem professor is giving them just few guidelines and directing them to post question on Stack Exchange portal [38]. They start using schools LMS account and log with it on Stack Exchange portal. Professor initiates cloud application for Stack Exchange inside LMS which allows professor tracking of students' contributions on Stack Exchange from LMS. Users' contributions and results of tested solutions are recorded as well as user communication.

In this case no special application permissions are required since application only needs to harvest data which is already publicly available on the web site of the service. Additional service is needed to support representation of students' activities in overall grading schema in LMS. This is just matter integrating cloud services with its corresponding building block. That part could be easily developed since interface for such applications is supported in standard way in all major LMS since same interface is used for building plugins in LMS.

This is just one simple lesson in which third party professional questions and answers portal is used for learning activity and in same time students are using professional services for building their reputation in professional environment.

CONCLUSION

Modern cloud environment in combination with SOA principles and proper cross repository data model for e-learning offer new and exciting options for educators. Many project in area offered similar solutions but key for future success is agreement of various parties. E-learning standard makers should be able to understand problematics of closed LMS and needs of users which are frequently frustrated with LMSs' closed environment. Future development should in first place work on bringing together e-learning standard makers, LMS producers and content and repository providers. Goal is to bridge gaps between institutional collaboration and define standardized ways for sharing, creating and reusing e-learning content.

Besides, as we mentioned before, learning is frequently happening outside LMS environment and teaching stuff has no control over it. Far better mentoring procedures could be created if teaching staff had better control over informal learning of their own students.

Migration from traditional platforms is happening slowly but biggest problems are not migration in cloud itself, which is already under way, but effectiveness of integrations of learning activities in cloud environment. Cloud environment offers many advantages but if used with inflexible traditional mind-set it will only be recreation of linear activities taken from LMS to cloud. This will not significantly enrich current learning activities. Advancements in that part greatly depend on teaching staff and institutional stand towards such approach.

We have to truly grasp idea that student's learning already did become ubiquitous and then we'll be able to support it effectively and build form there onwards.

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