E-LEARNING SYSTEM CONTENT AND ARCHITECTURE EVOLUTION

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Abstract. Along with the development of technologies, we face new opportunities and offers to improve the process of learning – rapid expansion of knowledge as well as increase in number of fields of interest etc. Significant factors are quality, form and availability of education. Therefore this article will discuss e-learning via agile e-learning information system which has two perspectives. The first is agile content and system structure and the second is agile infrastructure architecture.

Keywords: E-learning; Agile; Cloud computing; Ontology

1 Introduction

E-learning is based on use of educational materials (such as audio and video records, photos, different maps, documents, presentations, etc.). These materials are called Learning objects. Learning objects are described with the Learning object metadata. There are several standards that could be used. At the moment the most widespread systems of e-learning are individual (unrelated to other learning systems); they only store the learning materials (learning objects) that are input (are stored in a database called learning object repository) and they do not collaborate with any external systems.

Adaptive e-learning algorithm considers all the information from a student model and according to it provides one or other learning object [1]. The adaptation is organized in two levels – to a group of students and to an individual student according to his/her model. [2] It is possible to achieve this adaptability not only by introducing the possibility to operate with the parameters of texts and learning processes but also in an architectural level. The way of putting the adaptability into effect through usage of the cloud computing will be described in this case.

Main question for this research is how to make learning content available, agile and adaptive by using intelligent tutoring system and latest technologies. How to connect agile learning content with agile systems?

The research goal is to develop intellectual tutoring system based on agile structure and architecture. Major research in this field is made on systems that concentrate on learners testing and static learning content publishing in e-environment. Completion of tests and *.pdf file publishing doesn't solve the problem concerning processing and presentation of rapidly changing information. Therefore it is necessary to adjust the resources of those who educate and maximize efficiency of the education process.

Research is in its initial stage, therefore additional guidelines and aspects are being developed in order to create a real agile e-learning system. This system is going to ensure that learning materials would be reusable and system's technological resources – used dynamically, by using cloud technology. The efficiency of completed system will be shown by indices of use of technological resources, costs and results given by learners after acquisition of learning objects.

So, the organization of this paper is as follows. The following section briefly reviews the curriculum content management for agile e-learning content. After describing e-learning systems architecture concepts in Section 3, the agile principles will be review in Section 4. The final section provides a short description and a conclusion for our work - agility in curriculum content management.

2 Agile e-learning system structure

The agile e-learning system is a system that has adaptable, reusable and easy changeable content. We offer systems content adaptability describe using ontology, i.e., defining rules or statements, learning objects metadata and build simple reasoning mechanism for linking information (retrieval of information) -that has been described within curriculum and learning objects repository (see Figure 1). These rules have been given in OWL language (Web Ontology Language), OWL is the most recent development in standard ontology languages, endorsed by the World Wide Web Consortium (W3C) to promote the Semantic Web vision.

In the system, there is a service that makes the defined business processes work and also keeps track of the operations with objects performed by users, and Artificial Intelligence search inquiries. To achieve load changes of the operations in case of a rapid increase in the number of users exploiting several forms of demanding resources, a part of resources is moved to Cloud.

The academic staff should observe the main condition – to precisely define all parameters of object metadata and, if necessary, supplement the already existing object metadata with new parameters. Defining of LO (learning objects) parameters is established by Draft Standard for Learning Object Metadata which determines the parameters of metadata.

To provide the interaction between topic and learning objects, the OWL Ontology is used in description of links (see Figure 2). The ontology approach is a powerful modeling approach; however, it without domain analysis for particular types of applications, the ontology approach remains a virtual philosophy [8]. Ontology uses the metadata of curriculum to create semantic web or theme and the web of learning objects. This approach describes rules that are taken into account when all the learning objects and metadata added to the learning object repository are further headed to the web of links.

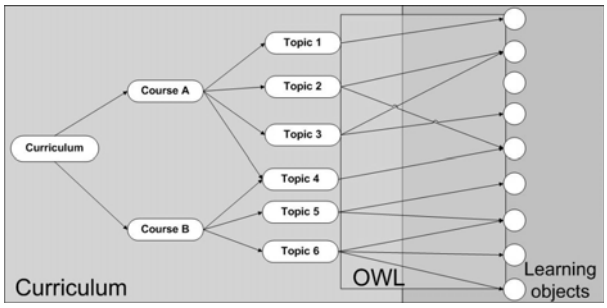

Figure 1. Curriculum structure

When changes are made, one of the rules generating links between the objects and the topics, new information structure is created. Also if the changes are made in the metadata of the learning object, a different information structure is created (see Figure 1).

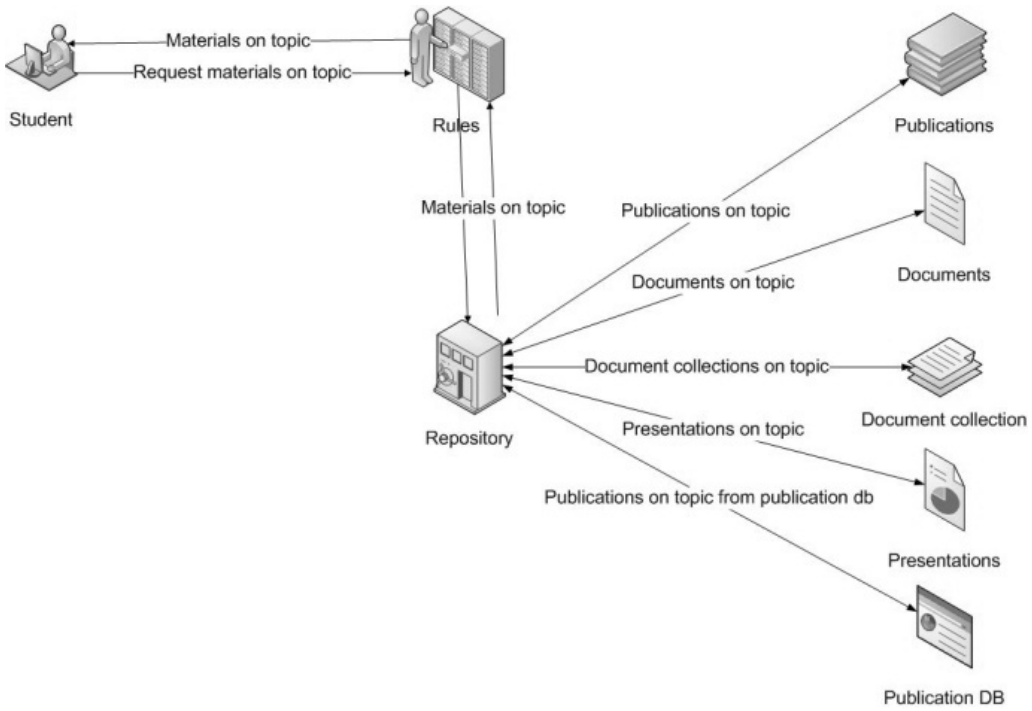

Figure 2. Learning objects retrival schema

3 Architecture of e-learning systems

All components, what we discuss in first sections (flexibility, adaptability, robustness, agility and changeability) are found in all of architectures and physical levels. The agility is in organizational level (object metadata) and in technological (Cloud) level too.

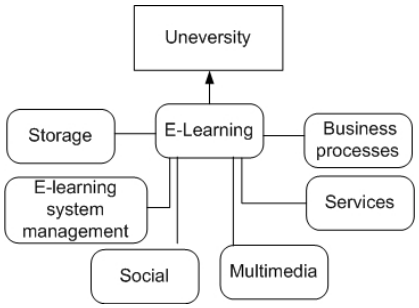

Figure 3. Typical e-learning system architecture

There are several projects and researches on this topic, but it doesn't cover our idea for 100%. As one of examples is Yu-Liang Chi "Ontology-based curriculum content sequencing system with semantic rules" where is analyzed ontology based curriculum content sequencing and E. Kontopoulos *, D. Vrakas, F. Kokkoras, N. Bassiliades, I. Vlahavas "An ontology-based planning system for e-course generation", where also we can found some common ideas and approaches. Our goal is to develop agile e-learning system with agile architecture, adaptable resource consumption and adaptable learning content.

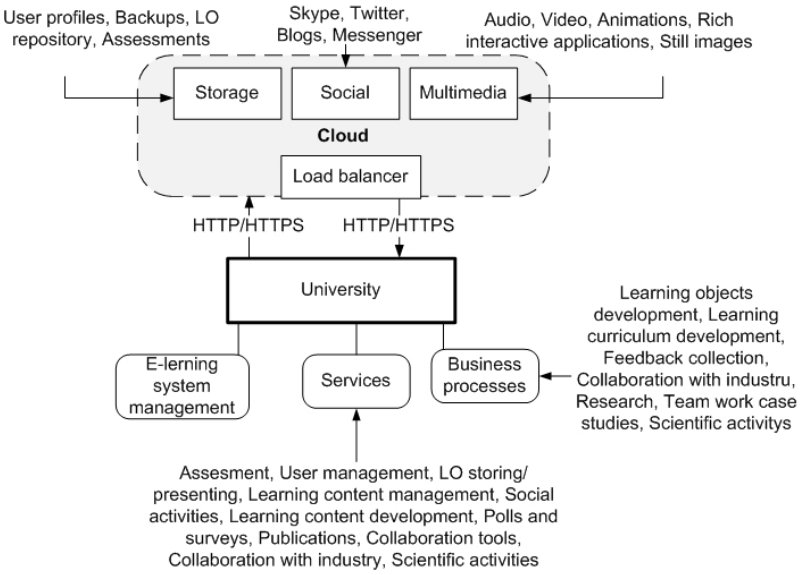

Figure 4. Adaptive E-learning system

The classical architecture (see Figure 3) of an e-learning system shows that all objects are stored in resources that are accommodated by the university. Exceptions are those cases when third parties or other companies are the providers of the e-learning system. The university system provides all the services, processes and, of course, the technical resources. E-learning system set is constant at the beginning; in case of expansion, new equipment (servers, network connection systems), services (faster Internet access), staff (information system administrators) are introduced to level the expansion with the current load. It is possible to estimate the growth of technical demand in advance by following the statistics of the load.

Indicators of the user load can change. In case when rapid increase in the load indicators is followed by a fail, system downtime occurs. It occurs because the demand for the resources is smaller than the offer. It means that all available resources are not used, but we still need to maintain them [7]. The system results in losses.

Systems that change the architecture (see Figure 4) by acquiring a part of their resources from the Cloud, allow us to adjust the available resources in accordance with the indicators of the load. These changes imply partial assignation of the business processes and storage of relevant information to the management of the system holder – the university. Learning materials, backups and all the information of dynamic character is held on the Cloud. This collaboration between the resources of the university and the possibilities offered by the Cloud provides the adaptability of the system in a more effective way; information contained by Cloud can be accessed much faster, volume of the resources can change dynamically and the access is permanent.

4 Agile principles in content structuring and system architecture

One of the most unpleasant factors regarding the information systems is that in case of introduction of changes these systems have to be modified or created anew. It leads to consumption great amount of time, human and financial resources. One of the ways of solving these problems is creation of agile IS [3]. These systems are of dynamic character – the provided aggregate of their options can be altered in a fast and simple way. A basic rule has to be followed – we have to take into consideration agile organization, because the technology cannot manage the agile organization processes without an overall unified plan of the action.

What basically is the agile IS (information system)? The definition of these systems still has not been worked out. Several authors/specialists have various views on what is agile IS and how it differs from the notion of IS that is familiar to us. For example, Steven Alter (1999a) has defined IS [3] as "special case of work system". Agile IS are characterized as organizations good organization: "…if the information system is under agile, the organization cannot respond to market opportunities of face challenges in a timely manner."[5] This need for agility in academic level we can characterized as the same – if academic environment don't work in a timely manner, the result (students knowledge) will go down. The definitions of the notion agility also differ, for example, it is described as swift initiative or rapidity and astonishment. Agile systems are dynamic enough to change in an organic way and are based on interactive and enterprising bottom-up concepts. There are cases when agile organization and agile IS are looked upon as the same concept; however, this article describes agile IS that operates in accordance with agile organization [4].

Manifesto for Agile Software Development [6]:

- Individuals and interactions over processes and tools;
- Working software over comprehensive documentation;
- Responding to change over following a plan.

The notion of agility can be described as robustness, adaptability and flexibility. All these factors by interacting with each other provide the changeability of the system. Agile IS can be described with the notion of Changeability [8]. Changeability is created by taking into account four factors that must be provided in systems. These aspects can be implemented in the e-learning by foreseeing algorithms that operate with the parameters defined for the objects and by mutually linking these objects and also by using key-words or other metadata element or combination of elements. Automatization of the linking as well as maintaining the automatization in case of deleting links or changing the number of the parameters. Thus we create agility in the link structures and object parameters.

The emphasis in such system is to put on dynamic links and parameters. Linking of the objects can be implemented by the key-words that create a mutual net of the objects, i.e. the united net of objects will contain only the objects that are marked by the same key-words. Though we have to take into account that a single object can represent web of several objects; it depends on the added parameters. When adding a new object, it is important to enter its metadata correctly, and it will adapt itself in the overall structure. It is important while adding a new learning object to learning objects repository to fill its metadata correctly, then the new learning object will adapt itself in the overall learning objects structure automatically. The benefits of such approach are the following: economy of time, because we do not have to define the link to the object (feature of Moodle); structuring of the curriculum allows us to plan the topics of the course more effectively and therefore allows to provide comprehensive and detailed layout of the course.

Users of the system do not have to perform manual linking by adding or deleting objects and their parameters. The search system depends only on the entered parameters; the search services will indicate and connect the inquiry with the objects available.

5 Conclusion

Modern e-learning systems mainly concentrate on student testing and static learning content presenting. Development of reusable learning content provides opportunity to develop dynamic curriculum exposition. Such approach connected with student model provides foundation for adaptive learning. It is important to present the right knowledge on the right context on the right time – it improves the quality and the theoretical knowledge of the learning. To solve context problem semantic web and ontology should be used. Question for further research is how to implement curriculum topic map structure with metadata and semantic connections of the learning objects, to show the predictable context.

The processing and interpretation of the learning objects is only one of the ways – in future it will be possible to process the test system and the active learning in the same way. These are the opportunities and future work agile IS is one of the vital turns in the future (and in present), because in the business or any other field the ability to change is very important; the slower changes are been made the more resources are being wasted, and it puts us in the losing position. To implement enterprise agility, you need to start with the agile organization and the simplest process of simplification. The Cloud Computing paradigm secures that agile IS can provide the dynamics and the economy of resources from the point of view of finance as well as human resources. As it is known, saved

resources always give a positive boost and open new opportunities for successful further development. Modern technologies along with up-to-date approaches to the development and exploitation of IS, open the way to development and exploitation of agile IS.

The dynamic aspect in the development of the agile IS structures is achieved largely due to the ontology and rules defined in OWL language. Previously made rules (rule based systems) allow us to reduce the time used for the system exploitation and let the modeling rules to be interpreted in the format of OWL rules, thus developing possibilities of the learning as a set of business processes.

Cloud Computing combined with learning rooted in the rules is the future-way of dynamic e-learning development.

In the future it is required to study the boundaries of the system dynamics, as at the moment it is only possible to identify the dynamics in certain borders, i.e., it is possible to predict the amount and the architecture of certain changes.

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