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An ontology-based knowledge management system for Higher Education

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Abstract—The purpose of this paper is to examine the role of ontologies in knowledge management systems. At first we present the theoretical foundations of knowledge management. We also supply some aspects related to their use in the heart of knowledge management systems at the level of the representation and exploitation, level of reasoning and indexing or annotating documents. Afterward we detailed our approach of building ontology for the university system (US), using as basic tools for the construction an e-learning platform and finally we will detail the various constructive blocks of our knowledge management system.

Keywords—Knowledge management, e-learning, University organization, organizational memory, documents, Knowledge, information and communications technology

I. INTRODUCTION

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The challenge now is to develop systems capable of simulating human reasoning and enable machines to interpret the information, The ontology by its capacities of representation of the knowledge and the mechanism of reasoning and inference which he offers represents a solution to this need, thus it constitutes the main core of knowledge management systems.

Ontologies are commonly used in the process of information retrieval where the goal is twofold: "understand" the contents of the documents and "understand" the need for the user to be able to put them in relation. Indeed, Thanks to the semantics they provide, ontologies may be involved in the reformulation or the extension of user requests or in terms of indexing and annotation of documents and web resources.

This paper main objective is the proposal of a knowledge management system based on ontologies. This system has for ambition the capitalization and dissemination of knowledge in a university system. The approach presented here aims to create an organizational memory based on ontologies. The ontology produced will lead to index the documents and thus enable an extension of the classical-based meta-data to a search based on semantic criteria. The main content of this ontology result from a manual extraction of the knowledge from a number of documents resulting from the daily work of the university system actors. These documents are validated and then indexed and classified using ontology. The ontology created will be used to facilitate search and navigation within the field of knowledge capitalized.

We begin our work by presenting the theoretical foundations of our research. Part 3 will deal with some aspects of the practical design of ontologies. Part 5 demonstrate the approach to the construction of our ontology then we will show the ontology that we developed to improve the research capabilities of knowledge management systems for the university system. Finally, a conclusion will come to review the obtained results, indicating some perspectives to this work.

II. ASPECTS OF KNOWLEDGE MANAGEMENT

In the literature several definitions and visions of knowledge concept are proposed in the area of knowledge management [1], [2], [3], [4], [5]. From us, we adopt a practical and operational vision, which makes a distinction between data, information and knowledge according to a hierarchical model.

In this model, the data are considered as a raw element outside any context. The information is a set of data put in a context. Information is not knowledge, but may become so unless it is understood and assimilated by an individual to perform an action.

Note also that some authors [1], [2], [7], [8], [9] made an important distinction between tacit and explicit knowledge. In this perspective, tacit knowledge, as opposed to formal or explicit knowledge, can be integrated into people's heads, in their experience and rooted in action, in the routines in a specific context. Explicit knowledge is knowledge codified and transmitted in a formal and systematic language (documents, information systems, etc.).

Knowledge management covers all the techniques to collect, identify, analyze, organize, save the knowledge for their sharing and their effective communication between the members of organizations.

Thus, the idea of knowledge management systems is to allow stakeholders to have easy access to knowledge and information sources. This important feature reduces the learning cycles by managing the access to information by disseminating excellence in organizations by sharing best practices, capacity building for learning and innovation, and so on.

III. KNOWLEDGE MANAGEMENT SYSTEMS

KMS refers generally to a system for managing the knowledge within organizations. To build effective KMS technologies, we can say that a KMS could be any of the following:

- **Document based:** It uses technologies that enable the creation, management and sharing of documents such as the Web, distributed databases, document management features, etc;
- **Ontology based:** Knowledge is classified of a set of entities, classes, proprieties and relations. Moreover, a KMS is supporting knowledge sharing and reuse by covering semantic search methods;
- **Semantic Web rooted:** KMS is a ontology based, they can so be used to explicitly represent semantics of semi-structured and textual information on the web;
- **Based on AI technologies:** Artificial Intelligence techniques are introduced for representing and reasoning about knowledge;
- **Service based:** KMS must deploy knowledge management tools for networks of participants of a project;
- **Social computing tools** are being set up to provide an efficient and natural approach to creation of a KM system. It helps knowledge providers to explicit their implicit knowledge and to formalize knowledge in general.
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IV. ONTOLOGIES

The term ontology is used in several areas of philosophy, medicine and computer science; however, we retain the traditional definition of ontology and the most widespread that was introduced by Gruber [10]. The ontology, defines the shared vocabulary to reach a common understanding of a given area.

Retain that ontology is a set of concepts and relationships between concepts that model formally objects of a domain of knowledge so that information is interpreted as well by the men and by machines.

V. ONTOLOGIES IN PRACTICE

From a practical point of view, the primary objective of an ontology is to model knowledge as it provides the definitions of concepts and terms used to describe the Knowledge of a field of activity, the logical and semantic relations between the concepts and the terms used as well as the constraints of their use. In addition, the creation of ontology provides a unified framework to reduce, eliminate, ambiguities and conceptual and terminological confusion [11].

In the context of web applications, ontologies can greatly increase the efficiency and capacity of information systems such as search engines thanks to the semantics they provide. They allow so to solve the problems of noise and silence faced by search engines that use static methods. They guide also the query expansion by ensuring the relevance of results and formulation of new types of queries that cannot be considered from the classic documentary languages.

VI. THE ROLE OF ONTOLOGIES IN KNOWLEDGE MANAGEMENT SYSTEMS

Ontologies are currently at the heart of various applications of knowledge management. In this context, several research and work have focused on the operation and operationalization of ontologies. In what follows, we focus on the contribution of ontologies in applications such as knowledge management systems or the semantic web.

A. Knowledge Representation: Knowledge representation refers to the set of tools and processes to represent and organize knowledge to ensure its use and sharing. Ontologies, in particular, serve as a skeletal representation of knowledge, as they describe, as noted above, knowledge of a domain in the form of concepts and their properties.

The work of representation of the knowledge consists at first in building a first partially coherent modeling corresponding to a formal semi conceptualization that it is necessary to translate it into a formal and operational language.

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2) Reasoning: The reasoning process involves the exploitation of existing knowledge to generate new knowledge. To this end, several mechanisms of inference and reasoning are used such as logical reasoning, classification, filtering, inheritance or rule-based.

3) Indexing and annotation: The indexing and annotation are two techniques that are usually combined, aimed at providing the semantics of knowledge resources to facilitate their reuse. Indexing is an operation that is to describe and characterize the content of a document using keywords in order to facilitate research. The annotation is to add comments, remarks or explanations to the document to highlight certain information that seem important.

4) Exploitation of knowledge: The use of ontologies in the information search process allows the integration of both a semantic dimension and a reasoning mechanism. This is to use ontologies for query reformulation based on the extension provided by the concepts of ontology, to facilitate research in heterogeneous resources, or to remove ambiguities terminology.

VII. ONTOLOGIES IN HIGHER EDUCATION

Ontologies are currently one of the most popular and widespread means of knowledge representation and reasoning. Since the first mentioning of the term 15 years ago, Nevertheless, there is still a number of domains that are yet not formally represented and clarified. There is, however, a long history of grand classification schemes in higher education, including those of the National Center for Higher Education Management Systems (NCHEMS), the U.S. Department of Education, the National Science Foundation (NSF), and The Carnegie Foundation for the Advancement of Teaching. And

there are a variety of applications for higher education for ontologies. These include: The marketplace of institutions, Academic disciplines, The documentation of data, Metadata about learning management systems (LMS), The nature of the higher education enterprise and Online resources, such as links and training materials.

Our proposal differs from these schemes in that it deals not only a particular area such as the pedagogical side, but it is intended to be general and represent all areas of knowledge of a university system.

In what follows we are going to put into practice the concepts and the experiences clarified previously concerning the ontologies, his methodologies of construction as well as their contribution in the knowledge management systems, to build an ontology of the domain and by proposing architecture of a knowledge management system exploiting this ontology.

VIII. PROPOSED MODEL FOR KNOWLEDGE CAPITALIZATION

The phase of capitalizing knowledge uses different methodologies from the field of engineering knowledge. Among these, we can cite: the CommonKADS methodology [12], MKSM [13] and REX [14]. These methodologies have been put in place to handle the whole process of learning, from the gathering of knowledge to the development of a complete system.

In the case of University System (US) considered, we opted for a more natural option, incremental and participatory, which involves different actors in the creation of knowledge. It is actually a solution based on e-learning.

In this section, we present mainly the capitalization of the knowledge for the administration staff. Thus, the staff takes courses on the platform, answered questionnaires, file documents; make annotations to documents filed in response to individual or collaborative assignments.

A. The context

The work that we propose concerns the establishment of a resource center in a university for training and research. We chose the National School of Commerce and Management (ENCG) the first institution of the University of Agadir IBN ZOHR on which our study focused view of our membership in that institution. The ENCG is considered as a learning environment where actors (900 students, 45 teachers and 15 people with administrative, technical, and service) change with different production requirements, research and exploitation of knowledge. Knowledge generally used are distributed, heterogeneous and difficult to find, with the exception of library books and student papers. Some existing databases in each department, however, allow locating some resources.

B. The choice and description of learning content

The Moodle platform (Figure 1) is the main entry point to the knowledge of the organization concerned, but also to the information found on the web. This platform allowed the administrative teams to follow two main modules as learners and creative knowledge. Both modules have an objective to inculcate the use of ICT in the daily tasks of different actors and also to deepen their knowledge of basic computer skills. The first module includes courses on the use of the Internet, but also the Microsoft office tools (Word, Excel, FrontPage, PowerPoint). The second module focused on techniques for knowledge management. Much focuses on the production and archiving of the document. The various tools built into the ODL device (Open and Distance Learning) such as forums, chats, assignments and QCM, allowed to extract the majority of tacit and/or explicit knowledge. These are a first draft to the memory MUS (Memory of the University System).

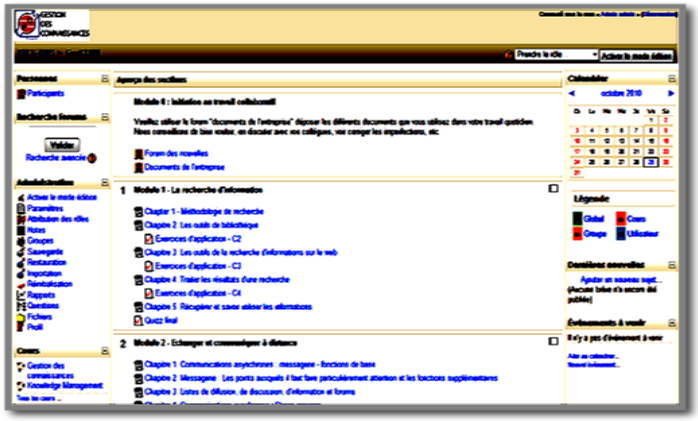

Fig. 1 Moodle Learning Portal.

IX. ONTOLOGY & ARCHITECTURE

The knowledge captured through the methodology presented above provides a resource dedicated to the representation of ontological knowledge. The ontology is used to index documents and resources, to facilitate their search and navigation between related concepts. By adding metadata to the documents capitalized through the e-learning platform, we add semantic descriptors to the organizational memory. In that case, it is possible to make complex queries and for example find documents according to their authors (name, function, etc.). Finally, another level of the semantics is developed by semantic relations between terms (working with, is connected to, is a component of, is a partner, interacts with, prerequisite for, complete, etc.). These types of relationships are used to suggest further research to the user or to perform an automatic extension of research. For example, if a learner is seeking a course, he is generally happy to know that this course requires pre-requisites, and a revised case study is linked to this course.

X. THE ARCHITECTURE OF THE SYSTEM

The architecture of the KMS (Fig. 3) is composed of five levels: exploration, capitalization, management, retrieval and knowledge base.

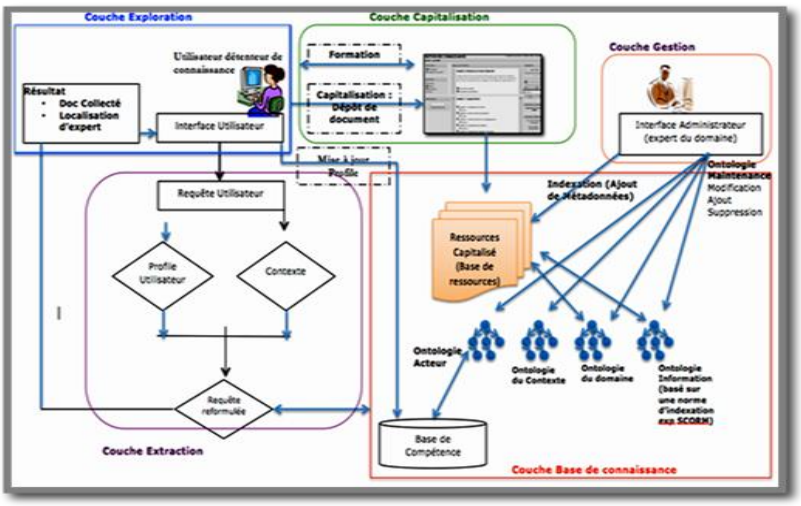

Fig. 2 Architecture of Knowledge Management System for a university system

1) Level-1 Heading: A level-1 heading must be in Small Caps, centered and numbered using uppercase Roman numerals. For example, see heading "III. Page Style" of this document. The two level-1 headings which must not be numbered are "Acknowledgment" and "References".

2) The Capitalization: This is the basis and the main core of our system, this level will provide two main tasks: staff training and subsequently the capitalization of knowledge

3) The Exploration: Exploration of the memory of the University system includes a number of services adapted to the different actors. The proposed interfaces allow users to manage their profile as well as the specification of the context of their research on the use of the platform. Profile management allows to take into account the expectations and interests of each actor according to its category (teacher, administrative or student), with some degree of specificity (doctoral student, studying in continuous training, etc.). Profile management is based on a user profile ontology. MUS memory takes into account the context of use. The definition of context based on context ontology that allows for the actor to present the knowledge required executing a given task (for a teacher for example the results of a search for the creation of a course must be different from the result for writing an article for scientific research).

4) The Management: The layer of knowledge management is responsible for put the functionalities needed for the integration of new knowledge in the system available to experts. These features allow inserting and updating the implicit knowledge. For explicit knowledge in the form of documents delivered on the platform, they are analysed by a domain expert who provides design and maintenance of the domain ontology. It also provides indexing by adding metadata for each resource capitalized.

5) The Interaction and Extraction: Layer interaction and extraction is charged after submitting a user request to reformulate it so as to take into account the user profile and context of use. With this discreet and transparent operation, data retrieved from the knowledge base will reflect the highest needs and goals of the user for a given context.

6) Level knowledge base: The layer knowledge base is built on the basis of four ontologies shown in Figure 3. It is the user profile ontology, domain ontology MUS, the ontology of context and ontology information.

XI. SOFTWARE ARCHITECTURE OF THE SYSTEM DEVELOPED

We propose to implement the system as a Web application. To be within the framework of the new generation of the Web (Semantic Web). The technologies used will be Java and Servlets that allow great flexibility and portability of the application. In the same vein we use OWL to represent the ontology developed and Jena API for handling.

This application will be for two classes of users, domain experts and the various other actors (teachers, students, administrative staff). The application will be built around several layers. This architecture will allow our application to interoperate with other programs and provides the flexibility for future developments. Figure 4 shows the software architecture of the system developed.

The lowest layer is the layer of storage objects that include content sources: different databases, documents posted on the platform. The data access layer is used to manage access to data objects; this layer will make the recovery process data independent of the nature of the objects viewed. The third layer, Description of Knowledge provides both an abstraction and specification data and knowledge resources in terms of ontologies. The fourth layer, the application layer is the base layer which consists of a task engine oriented KM. Finally, the top layer, presentation layer serves as user interface, allowing users to select and specify the information necessary for their needs and adapted to their context of use.

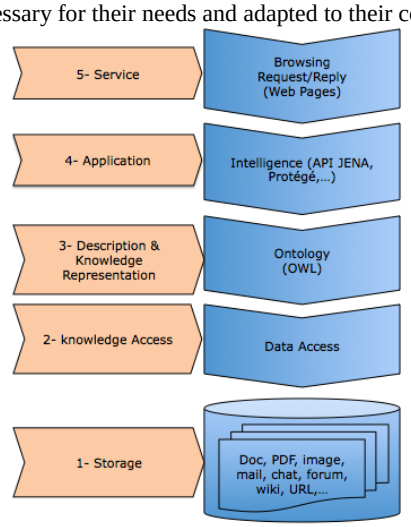

Fig. 3 An overview of the multi-tier functional architecture of the KMS info-structure.

XII. CONCLUSION

The work we have presented provides a methodology based on collaborative work for the acquisition and capitalization of part of the intellectual capital of the actors in the context of higher education. Software architecture of a management system based on knowledge ontology created is also proposed. Our research proposal is distinguished by the fact that organizational memory does not focus only on the pedagogical knowledge (courses, etc.) but extends to different pieces of knowledge used throughout the university system whether administrative, educational or technical.

In the current state, the domain ontology is functional. The objective of the next step is to develop a prototype knowledge management system adapted to the specific constraints and to the specificities of the culture of our institution and to include all the proposed ontologies and validate this function and to generalize this experience to all institutions of our universities.

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