ONTOLOGY-BASED MODEL FOR E-LEARNING MANAGEMENT SYSTEM (O-BMEMS)

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ABSTRACT

E-Learning is a process in which the electronic medium is used to access the defined set of applications and processes. With its increasing identification and recognition in academic and corporate world, a unique model or framework is required. E-Learning is a critical support mechanism for educational institutions to grow the performance of their students, teachers, as well as useful for organizations to enhance the performance of their employees. Semantic web represents a potential technology for realizing e-Learning requirements, ranging from virtual classrooms to remote courses or distance learning. However, studies show that more effective approach to e-learning is required. Ontology is a specification of conceptualization; the object, process, and other entities that are involved in making of the framework for E-learning. This study presents the ontology for E-learning process, such as course syllabus, teaching methods, learning activities, learning styles and also prevent student from skipping prerequisite courses. The study presents the research design that gathers the information from academia, which serves as the bases for the implementation of this Ontology-Based Model for E-learning Management System (O-BMEMS)

1. INTRODUCTION

It is commonly thought that new technologies can strongly help in education. In young ages especially, children can use the huge interactivity of new media, and develop their skills, knowledge, perception of the world, under their parents monitoring. In no way can traditional education be replaced, but in this era of fast technological advancement and minimization of distance through the use of the Internet, everyone must be equipped with basic knowledge in technology, as well as use it as a medium to reach a particular goal.

E-learning courses have to serve very different learner groups and can be presented in many different forms. There are novice learners, intermediate and advanced up to experienced students. Furthermore, e-learning courses can be attended by dependent or independent learners who study full-time or part-time. On the other hand e-learning is based on certain prerequisites, such as management, culture, and IT (Chakkrit and Michael, 2007). E-learning has proven to be useful in tertiary education, e.g. universities, and in companies where life-long learning is a must. Contents of e-learning range from technical knowledge to soft skills, like social behaviour. Nevertheless, classroom training can never be completely removed by e-learning (Bachman, 1999). There are several forms of teaching e-learning courses, such as Computer- Based Training (CBT), where the learners execute customized software on a stand-alone or networked computer, or Blended Learning Classes, where e-learning works hand in hand with other educational resources.

Ontology can be defined as a set of representational primitives with which to model a domain of knowledge or discourse. The representational primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members). The definitions of the representational primitives include information about their meaning and constraints on their logically consistent application.

Ontology describes basic concepts in a domain and defines relations among them. Basic building blocks of ontology design include: classes or concepts, properties of each concept, describing various features and attributes of the concept, and restrictions on slots (facets).

A relation is used to describe a relationship among two or more terms. If a relation represents a relationship between only two terms, it is called a slot or a binary relation. If the relation describes a relationship among n terms such that there is a unique nth term corresponding to any set of the first n-1 terms, then the relation is called a function.

Examples of binary relations include: subclass-of and connected-to. If relationships are introduce to ontology, then the simple and well-designed hierarchy structure becomes complex and significantly more difficult to interpret manually. It is not difficult to understand why an entity that is described as 'part of' another entity might also be 'part of' a third entity. Consequently, entities may have more than one parent. As well as the standard is-a and part-of relationships, ontologies often include additional types of relation that further refine the semantics been modelled model. These relations are often domain-specific and are used to answer particular type of questions. The is-a relationship can be used to inherit attributes and semantic relationships. This is very similar to inheritance in Object Oriented Databases such as C++5.

In the context of database systems, ontology can be viewed as a level of abstraction of data models, analogous to hierarchical and relational models, but intended for modelling knowledge about individuals, their attributes, and their relationships to other individuals

2. RELATED RESEARCH

The motivation for this research was gotten from the study reported by Tiffany and Godon (2005) on Web-based adaptive learning system, whereby the delivery learning material is personalised according to the learner model. However the materials recommended to the learners are prior determined by the system designer/tutor. It was this limitation that lead to the objective of this paper, where learning materials are automatically found on the web and integrated into the system based on users' interactions with the system. Although users do not have direct interaction with the open Web, new or different learning materials in the open Web can enrich their learning experiences through personalized paper recommendations.

The methodology used was a critical studied of how Web-based adaptive learning system worked and some other related papers were also reviewed. These are how the two systems worked. The former had two kinds of collaboration in the system. One is the collaboration between the system and the user; another is the collaboration between the system and the open Web.

The objective of this paper is to make basic learning materials fixed for the leaner and what keeps changing is the collection of papers to be recommended to the learners. The novelty with respect to the proposed system lies in its evolving paper repository and its ability to make smart, adaptive recommendations based on the system's observations of learners' activities throughout their learning, and the accumulated ratings given by the learners. Each paper is tagged based on its content and technical aspects. Learners are required to give feedback (ratings) towards the papers recommended to them. Therefore, according to both the usage and ratings of a paper, the system will adaptively change a paper's tags, and determine whether or not the paper should be kept, deleted or put into a backup list.

The limitation of this research was that the material recommended keep changing anytime the learner want to learn on the network without considering if the learner is done with the recommended material or not.

Aleksandra et. al (2011) presented E-Learning personalization based on hybrid recommendation strategy and learning style identification**.** Personalized learning occurs when e-learning systems make deliberate efforts to design educational experiences that fit the needs, goals, talents, and interests of their learners. In this, paper, a recommendation module of a programming tutoring system – Protus was used, which can automatically adapt to the interests and knowledge levels of learners.

The objective of this research is for a system to recognize different patterns of learning style and learners' habits through testing the learning styles of learners and mining their server logs. Firstly, it processes the clusters based on different learning styles, then, it analyzes the habits and the interests of the learners through mining the frequent sequences. Finally, this system completes personalized recommendation of the learning content according to the ratings of these frequent sequences, provided by the Protus system. The Methodology used was the AprioriAll algorithm to analyze the habits and the interests of the learner through mining the frequent sequences. Some experiments were carried out with two real groups of learners: the experimental and the control group. Learners of the control group learned in a normal way and did not receive any recommendation or guidance through the course, while the students of the experimental group were required to use the Protus system. The results show suitability of using the recommendation model, for online learning activities to learners based on their learning style, knowledge and preferences. The limitation of this research was that, the learning materials that can be suggested to the learners may not suit the interest of the learners, therefore this makes learning not interesting.

Lian et al. (2012) attempt to look at the problem being encountered when learners are looking for words of the same meaning but different spellings, and also the problem encountered when they need information about their history on the network or learning site because of the loss of memory on what they have done in the past on that site.

This study proposed the ontology based personalized recommendation model for learning objects with an objectives to: increase the reusability of the learning objects, the model will assist the users to select the best fit learning objects by referring to their preference history. The search keywords inputted by the users will be processed and the semantic similar terms of the keywords will be captured from WordNet. The recommendation

model will rank the learning objects based on the user's preference history and similar users' preference history. The target users are considered as similar users of the user if they are having similar preference history with the user.
The methodology used to achieve this was the review of past related papers on ontology and e-learning, and the recommendation was based on the metadata files of the LOs (Leaning Objects). The metadata files are normally created under Learning Object Metadata (LOM) standards. In this model, the metadata are stored in Metadata database while physical LOs are stored in Learning Objects database. And this enables It is to make the recommendation process to be fast.
The limitation of this study was that when the same time was assigned to different topics without considering the complexity of each topic, the recommendation results were not analyzed; statistical data were not collected after examining the model with the learning objects.
Amorim et al, (2006) worked on Learning design Ontology, based on the IMS Specification. The study focused on the representational issues of learning design, which describes the method that enables the learners to achieve the learning objectives after carrying out a set of activities, using the resources of an environment. The motivation relied on the expressive limitations found on current XML-Schema Implementations of the IMS learning design conceptual model (IMS LD). In order to solve these limitations, an ontology using Protege at the knowledge level was developed. In addition, an implementation in OWL was provided. In order to develop the Learning Design ontology concept, a taxonomy was created, which describes the elements of the IMS LD conceptual model and the IMS LD information model. This is a set of axioms, which formally constraint the semantics of the concept taxonomy on the basis of the explanations formulated in natural language in both information and behavioural model. The limitation of the work was that the XML-Schema Language does not represent all the knowledge complied in the three models of the IMS LD specification.

Abel et al. (2004) wrote that E-learning leads to evolutions in the way of designing a course. Diffused through the web, the course content cannot be the direct transcription of face to face course content. A course can be seen as an organization in which different actors are involved. These actors produce documents, information and knowledge that they often share. In the study, ontology-based document-driven memory was presented which is particularly adapted to an e-learning situation. The utility of a shared memory is reinforced in this kind of situation, because the interactions do not usually occur in the same place and on the same time. Firstly actors needed were analyzed. Then the main features of learning organizational memory were presented and the ontologies on which it is based were focused. Two kinds of ontologies were considered: the first one is generic and concerns the domain of training; the second one is related to the application domain and is specific to a particular training program. Approach for building these ontologies was presented and how they can be merged was also showed.
The objective is to provide users with content and more precisely pedagogical content. This pedagogical content is composed of the notions to acquire, the links between these notions and the resources they index. Notions are not only chosen because they are related to the course unit, they are also the result of a reflection on the course itself. A pedagogical work has to be done. It also aims at facilitating knowledge organization and management for a given course or training, and at clarifying competencies it allows to acquire. Another objective is that it focuses on the learner, giving learner the means to be active, to make learner understand the resources that are at his/her disposal and to teach learner how to search and to use them.
The Methodology used was related the conception of e-learning to a scenario and followed by the of notion of, "learning organizational memory" and this was enabled by the use of two application ontologies (i.e algorithms and statistics) which was originally based on the experience of two courses: "Algorithms and Programming Pascal" it was observed that it is necessary to merge application ontology into domain ontology and the way it is concretely possible. Finally, the use of the memory through a prototype developed and still maintain was illustrated.
The limitation is that the notion used requires specific ontologies that allowed organizing knowledge element and index resources, also two courses were not enough to get the desired and satisfactory result needed.

3. SYSTEM DESIGN

In the present study, the details of the O-BEMS design and requirements are presented. In order to provide the details of the structures of reusable e-learning processes , a standard meta data is required. The rules must fulfil the requirements of the application and they are selected according to the extent and the environment. Various organizations have developed their own vocabulary for metadata standard according to their particular requirements, but not all standards are compatible, and the common understanding between different metadatas vocabularies is not good, and this leads to the use of ontology as a conceptualization of e-learning structure. (Figure 1) shows an overview of the fundamental components of the system and their relations

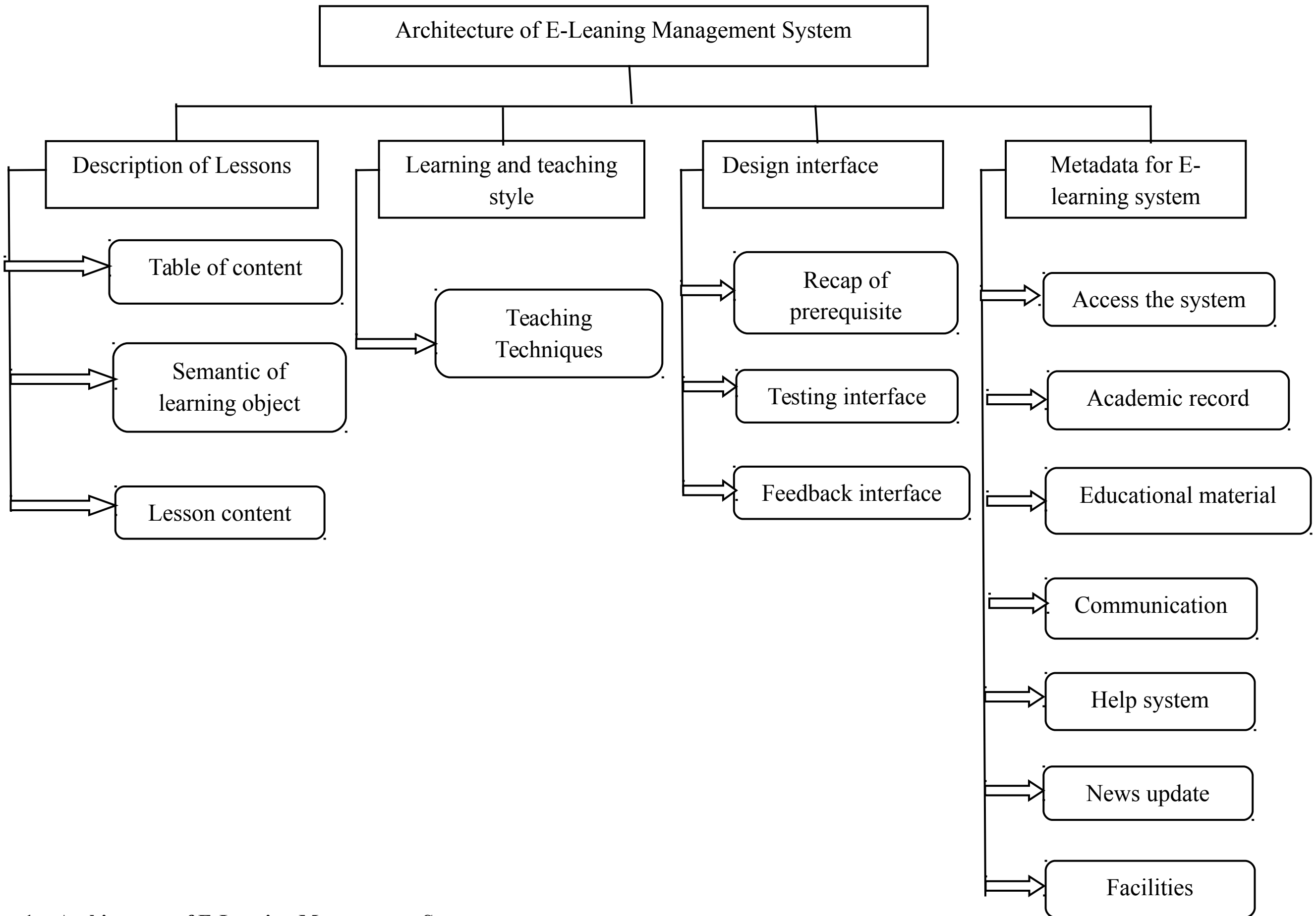

Figure 1: Architecture of E-Leaning Management System

3.1: Ontology based E-learning Management system's framework

Based on the gathered information through our research methodology, it can be seen that the main challenge of e-Learning systems are efficiency and relevancy of the results. To meet these challenges, this section presents "Ontology-based e-Learning management system's Framework (O-BEMS)". It has been developed using web services, an ontology and agent components. In the following subsections, based on e-learning standards we describe our proposed e-learning model, illustrated in Figure 2. The heart of the O-BEMS is presented below, an architecture overview of our approach that focuses on the definition of abstract services, web services instances, LOM, XML, RDF, OWL and the user's expected goals. While developing protocols within such architecture, promotes interoperability there is a chance that these protocols will not always be understood. O-BEMS defines three main layers interface, service integration and management. The aim of the framework is to provide an integration service platform that offers learner-centric support for web-based learning, which will improve the efficiency of the e-Learning applications and as well the relevancy of the search results. O-BEMS has proposed using web services, an ontology and agent components.

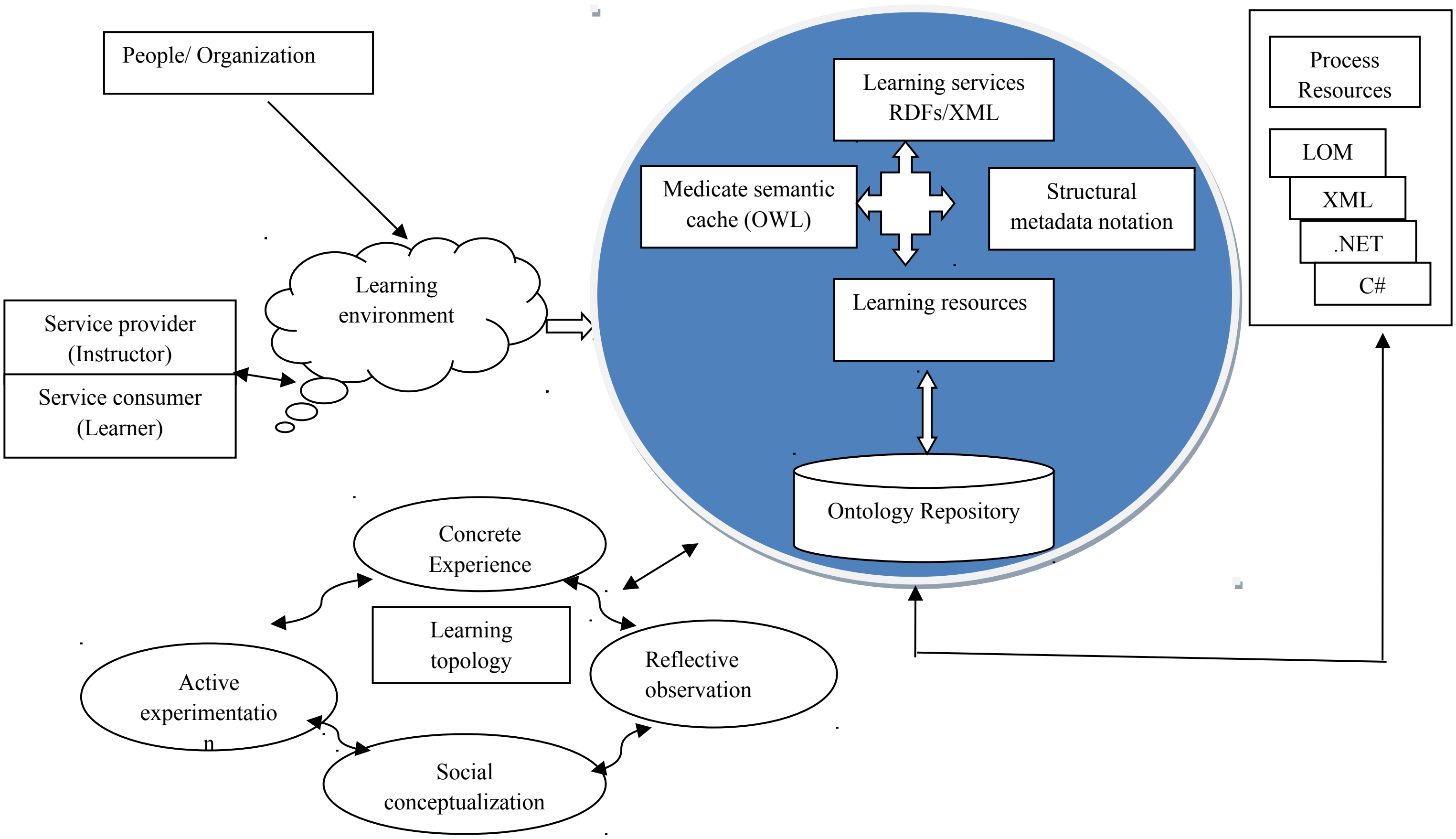

Figure 2: Ontology based e-learning management system's framework (Hafiz, 2009)

The e-learning management system using learner or instructor system, designed as a web-based data transmission system. In learning system a learner has to perform different functions when he tries to access the system. First of all a learner need to log in the system if he is already a member of the system otherwise he need to register in the system to fill the information about him so that he can access the system next time. A learner has to select the course to learn. Take the quiz and get marks on it, and the mark determines if to continue with the course or prerequisite course is to be recommended. Log out the system if the learner wants to exit the system.

The instructor side uploads the information such as to add the new courses, course outline, quizzes and exams. Admin side keeps the student record in his database and can edit the data if required.

3.2 Metadata for E-learning Management System

Here is an overview of the metadata used to create e-learning system. The main points of the system are access the system, academic record, educational materials, learning assessment, communication between teachers and students, news updates and some other facilities such as help system for teachers and students if they face any kind of problem. Metadata for e-Learning Management System defines the handling process of management system for e-learning. Here we implement ontology on learning objects and management system. It creates a rich description of each object. This strategy includes the selection, assembly, integration and evaluation of educational materials, and an assessment of needs, weaknesses and learning behaviours.

3.3 Ontology for Metadata

E-learning management system has different data points. There are ontology of metadata with several points in the field of educational. The most general point is Educational Material. Educational Material has two subtypes: Course Material and Examination Material. Examination Material can be further specialized to Project Task, Exam Task, and Exam. The Exam can consist of the Exam Task-s. Course Material can be further specialized into Lecture, Example, Lecture Note, Course, Exercise, and Project Assignment. The metadata roles represent the planned usage of the data in general. When ontology for any metadata is structured it is already understood whether it will be a Lecture, Example and so on and it

One of the important concepts of the ontology is the "Relation" concept. With it, we can connect learning Object with other in terms of versioning, belonging, requirements and other useful relationships. We use only an explicit part of a learning object and it's depending on requirement, rather than to learn or use whole learning object in a specific e-learning system. To use this ontology to facilitate e-learning with a semantic construction, ontology, as it provides a clear definition of a common domain. Ontology gives vocabulary to describe the conditions of a substance, as well as logical statements that describe what the case is, how the components and context may or may not be classified and related with each other.

Example of Learning Ontology: The ontology of a service called Learning material Search is specified using OWL-S. The service takes inputs Course and Examination materials, and Education material. Figure above shows the Education definition. The Education material has two subclasses including Course and Examination. Course material has four subclasses Example, Lecture notes, Study materials and Lectures, Examination material has three subclasses. The Education material has a property which can have only three values: For Student, For Teacher and For Management. In addition, Education material has the following constraints:

i. Material for Education is those with student or management i.e., Material for Education ≡ (Education ∩ has Material (Student ∪ Management)).

ii. Examination material is those with Exam Task and Exam i.e., Campground (Education material ∩ has relation (Examination material)).

iii. Course material are those with Lectures notes and study materials, i.e., Course material (Educational material has ∩ Relation (Course material)).

hardly fits to another function. In addition to the ontology roles, we identify metadata types as well. Metadata represent different context of a data. It means that we can distinguish at least between examination and study material.

The O-BEMS is best system with a structured learning environment that is transparent and accessible via the Web. The system allows reuse of learning materials. In addition to presentation of knowledge in various courses will be distributed to the appropriate instructor. We implement an educational system that focuses on the special needs of students learning style as a group, association, visually oriented. The system contributes to development, learning and assessment of skills of the students.

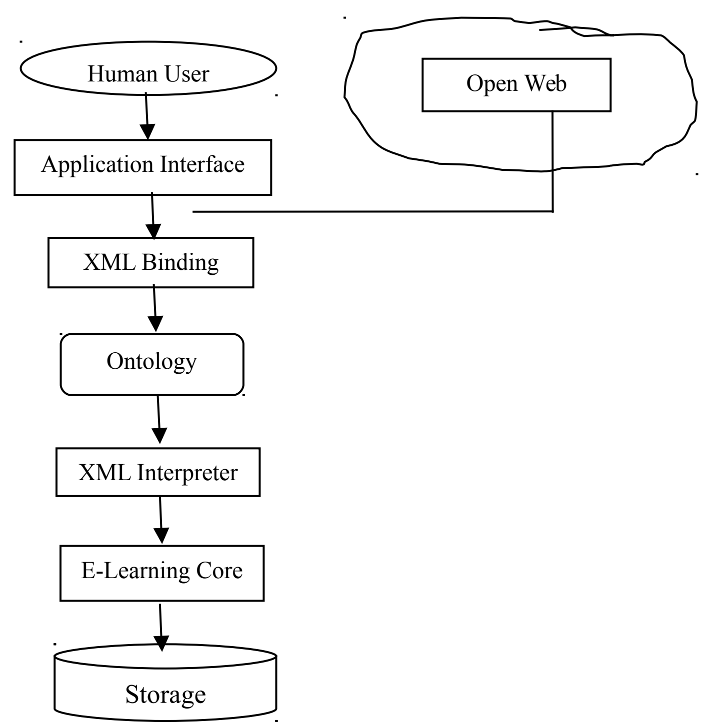

Figure 4: Architecture of the ontology recommendation system

The diagram below is a step by step in realizing the research, it has different modules which are: Log in/Registration, Course selection, Course Recap, Pre-Evaluation, Recommender, Learning core, Fixed Materials, Recommended Materials, Feedback, Post-Evaluation

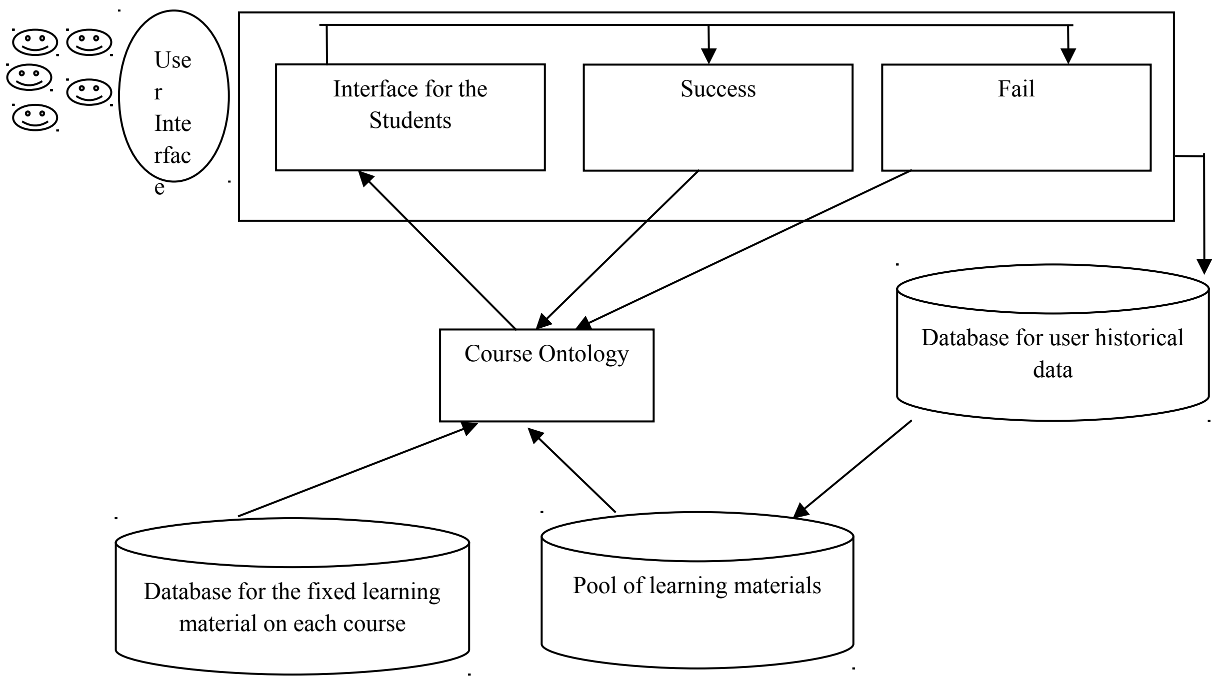

Figure 5: Model of the ontology system

The ontology-based model for e-learning management system was divided into two parts. The first part prevents learners from skipping prerequisites of courses with prerequisites. This was achieved by allowing a learner to choose a course to learn. The summary of the prerequisite will be provided as a recap for the learner after which a small test shall be written by the learner to determine if the learner can proceed with the selected course or be denied from the selected course and a prerequisite course will be recommended for the learner to learn as represented below.

If $X >= M_n$

$L_c = S_c$

Else

$L_c = P_c$

where X, M_n, P_c, S_c, L_c are mark scored, cut-off mark, prerequisite course, selected course, and learned course respectively. The second part recommends learning materials for learners. The learning materials to be recommended are being determined by the learning objects (features) extracted from the learner during interaction with the system. Equation 3.1 shows the features that would be extracted

$$f_i = \{f_1, f_2, f_3, f_4, f_5, \ldots, f_n\} \quad 3.1$$

where f_i are features like title, keyword, score, time spent with system, feedback, and n is number of features. The f_i's are used to search for matched objects with learning objects stored in the set of matchedObjects(l) database. From this the user's preference scores (Pscore) is calculated using equation 3.2.

$$Pscore(matchedObject_i(l)) = \left(\sum_{j=1}^{n} \frac{\sum_{x=1}^{max(x)} (matchedObject_i^j(l) \text{ exists in } UsedObject_x^j(l))}{\text{number of } usedObject(l)} \right) \quad 3.2$$

where j represent order of features

i = features itself

n = number of extracted features

l = user ID

x represent number of similar used learning object respectively. Assuming a user A has similarity feature with user B, the similarity degree counts the percentage of learning objects that are used by user (l) which is calculated using equation 3.3.

$$sim(l, sl) = \frac{\sum_{x=1}^{max(x)} (UserObject_x(l))\, existin\, LPH_{sl}}{number\ of\ UsedObject(l)} \quad 3.3$$

where sl, and LPH represent similar users and Learner Preference History respectively. If the similarity degree is over a particular variable, then the user is considered as similar user. For every similar user, their used objects will be extracted and the matched objects will be found. The similarity user preference score (Sscore) will be calculated using equation 3.4.

$$Sscore(matchedObject_i(l)) = \left(\sum_{j=1}^{n} \frac{\sum_{x=1}^{max(x)} (matchedObject_i^j(l)\, exists\ in\ UsedObject_x^j(sl))}{number\ of\ usedObject(sl)} \right) \quad 3.4$$

The line graphs below differentiate between student "A" that did not skip class and student "B" that skipped class.

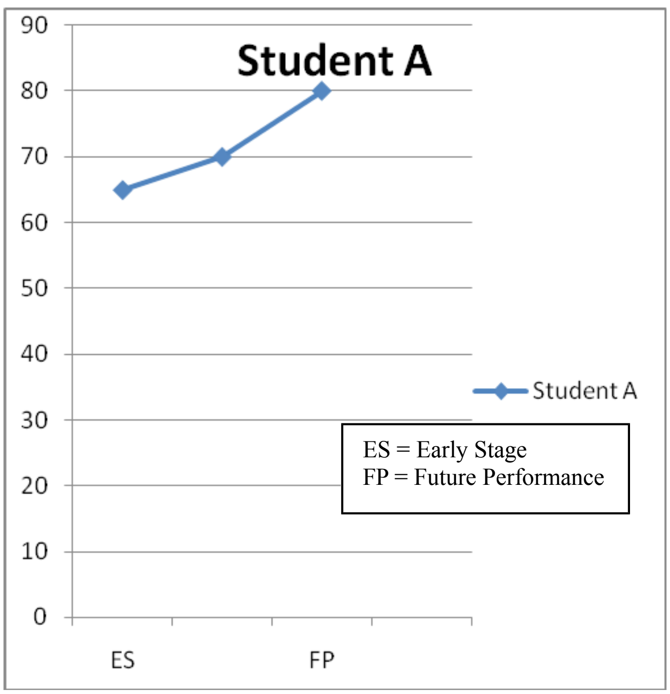

Figure: Performance of student A

The performance of student A will be increasing as the student is developing because of the full understanding of the basic knowledge; this will also boost the performance of the student in future. The performance at the early stage of learning was high (65%), but since the student passed through all the recommended topics, the performance was higher (80%) later in future performance.

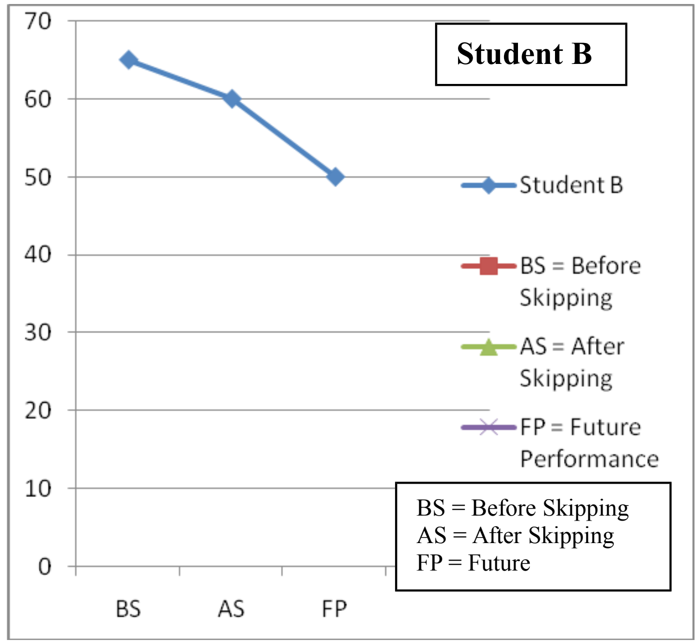

Figure: Performance of student B

The performance of student B was high (65%) before skipping a class, skipping a class now reduce the performance to 60% which results from the lack of basic knowledge of what suppose to have been known and the greatest disadvantage of it is, it affects the future performance of the student by reducing his performance to 50%. This has turn a brilliant student to an average student

CONCLUSION

After the study, it is clear that Semantic Web leaves its impact on information technology and different research areas such as Knowledge Engineering / Management, Software Agents and Web Services. An important objective of the Semantic Web is to hand over most of the information to software agents that is been done on the web these days. Although the Semantic Web has achieved many milestones, but still it faces many challenges in the form of a vision to reality. This report used the combined qualitative and quantitative research methodology to find out the specific requirements of academia with respect to e-Learning. In order to gather the data collection, researchers used the case studies with observation in academia. All the steps are detailed for the case studies including background, related work, research questions, procedures, data collection, data analysis and expected outcome. The outcome of the qualitative study shows that academia needs an efficient e-Learning framework, which gives relevant results. After gathering the requirements, research proposed an Ontology-Based Model for E-Learning Management System (O-BMEMS), whose basic objective is efficiency and relevancy. After proposing O-BMEMS, researchers developed software using C sharp and SQL server, which is based on O-BMEMS .Researchers conduct an experiment with academia. Subjects for that experiment are taken from the academia. All the steps are detailed for the experiment including definition, hypothesis formulation, variable selection, subject's selection, experiment design, execution plan, validity evaluation etc.

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