Using Semantic Web Technologies For E-Learning System In Higher Education: Case Of Scheduling Of Upgrade Trainings

Hanaa EL FAZAZI, Mohammed QBADOU, Khalifa MANSOURI
Laboratory Signals, distributed systems and artificial intelligence
ENSET, University Hassan II, Mohammedia, Morocco
elfazazi.hanaa@gmail.com, qbmedn7@gmail.com, khmansouri@hotmail.com

Abstract— Elaborate efficient educational programs and precisely adapted to the student's needs and profiles is a major challenge which education makers have always tried to find solutions. This challenge has a much greater extent in online learning context through e-learning platforms. Indeed these platforms must offer adapted training courses and scalable according to the expectations and preferences of each student. To address the challenge of producing and managing customized adaptive education courses, it is imperative to develop an expert system software able to mimic the abilities of the human expert in the educational field. Based on advanced web technologies, such a system should allow rapid and massive distribution online training courses with appropriate content and educationally valid and effective learning paths.

In this paper, we used semantic web technologies and educational data mining tools for proposal an adaptive e-learning platform that provides a digital space dedicated for higher education and scientific research to the institutions of universities. This platform based on consistent semantic models, will allow students to take appropriate placement tests according to their specialties. The detailed results of these tests are then analyzed using classification algorithms based on decision trees and relevant educational criteria. This allows precisely defining the membership class for each student. This profiling will allow, for each identified weakness of the student and according to its pedagogical preferences, to propose an efficient upgrading path through the development of a pedagogical heuristic based on the ant colony algorithm.

Keywords adaptive e-learning, semantic web, ontology, student classification, decision tree, ant colony optimization

I. INTRODUCTION
The vision of the semantic web is to help machines to interpret information to support humans in carrying out their various tasks with the web. Many of the semantic web technologies provide us with tools for describing and annotating resources on the web in a standard ways, a key feature is the shared understanding based on an ontology skeleton. Ontology enables the organization of learning materials around small pieces of semantically annotated learning objects.

The Semantic Web gives information an explicit meaning there by facilitating the processing machines and the integration of information on the Web [1], [2]. The Semantic Web will be built on the ability to define custom XML markup schemes and flexibility of RDF approach to represent the data. If the machines are supposed to make useful reasoning tasks on these documents, the language must go beyond the basic semantics of RDF Schema. OWL has been designed to meet this need for an ontology language for the Web. OWL is a portion of scalable battery W3C recommendations relative to the Semantic Web.

The e-Learning material is semantically annotated and for new applications, it can be easily combined into a new learning course. In this way a user can easily find the useful learning content according to his preferences. The process is based on Semantic Web query and browsing through the learning material activated by an ontological background. Thus, the Semantic Web can be treated as a suitable platform for implementing an e Learning system, as long as it provides all means for the development of ontology, ontology-based annotation learning materials, their composition in courses and active courses delivered through learning portals.

In this context, many studies [3] [4] showed that the integration of semantic web technologies in teaching and education has a great benefit for all actors of the domain: students, teachers and administrative. This integration will be even more useful for an academic institution that’s have some difficulties like a poor monitoring for their students, a high failure rate, and a small production of scientific research. This integration is initially made at the school management then extending this to the teaching process and his pedagogical and didactical aspects.
II. PROPOSED E-LEARNING ENVIRONMENTS USING SEMANTIC WEB TECHNOLOGY

In the following subsections, we describe our proposition of an e-learning model based on Semantic Web technologies and e-learning standards.

A. System Functions

Besides the functions offered by the existing open source platforms such as Moodle, Olat, Chamilo and Claroline, the proposed platform will allow two new functions marked in the following figures 1 and 2 with red bold line.

- The first function allows to the new students to pass a pre-assessment, according to their results, the students will be classified into homogenous classes with the same discipline. This module will also enable the suggestion, monitoring and evaluation on line of an upgrading training adapted to various classes.

- The second function allows an automatic post-assessment in the end of the training due to the implementation of the multi-dimensional analysis techniques applied in track of data.

B. System’s architectural schema

The originality of our e-learning platform is the integration of semantic models in the form of domain ontologies and acquired data mining related to classification and planning techniques. Figure 2 illustrates the overall architectural diagram of our platform in fourth layers: The first layer that allows the storage of all educational data and metadata. The second layer is for processing and data analysis. The third layer represents the web portal presentation, and a last layer is dedicated to interoperability and the integration of data exchanged with other heterogeneous external systems.

C. Functional specification of educational paths planning based student classes.

The specific contribution offered by our platform is the module of teaching programs and assessment management, that’s propose an automatic pre-assessment solution and automatic planning of upgrading training for the new students. Our solution is illustrated in figure 3.
the platform to fill them. On the other hand, teachers will have a better visibility of student groups they teach.

Classification: The student is going to take at first a test of upgrade. The questions are generated according to the level and the discipline of students and classified by orders of difficulty. The obtained results will be treated in an algorithm of classification wish allow us to know level of a student and affect him afterward to a class according to his level.

Upgrading training generator: The information obtained during the classification is going to allow the system to generate training to the student according to the obtained level. The system will be able to supervise the training progress and can also propose in an intelligent way the next course to take by using the ant colony optimization algorithm.

III. SEMANTIC MODELS FOR EDUCATIONAL PATH

PLANNING AND ANALYTICS

To set up an adaptation strategy training according to learner profiles, our platform is based on the Semantic Web. In this framework, we have developed meta-models as ontologies to describe entities learner, tutor, educational content and learning process. To define the concept of learning object, we carried out a comparative study on the major standards of metadata (LOM, SCROM, and EML). Each model defines the learning object differently [5][6][7].

LOM and SCORM is primarily focused on content and promote a learning mode based on the structuring of this content into lessons, courses, modules and monitoring focused on the consultation of educational resources. No place is reserved for more constructive learning approaches in terms of monitoring and evaluation taking into account the interaction between learners. The LEM model moves from a conception of teaching in a learning design by offering to structure learning situations “Learning Unit” (courses, lessons, case studies, practical work, ...). It puts the educational activity center and favors the relationship with the learner.

To combine the advantages of these standards, we opted for structured educational entities in three classes:

- Learning units to structure training and organization in space and time;
- Educational activities that define the precise terms of acquisition, validation and communication of one or more knowledge;
- Learning resources, physical or digital, necessary for the implementation of activities.

A. Building an educational ontology

It has been well recognized in the Semantic Web community that ontologies play a key role in the delivery of the Semantic Web by facilitating information sharing between communities of humans and software agents [6, 7].

Ontologies are used primarily to describe the sense of shared vocabulary. Thus, ontology forced all possible correspondences between the symbols and their meaning. The common understanding problem in eLearning occurs on several orthogonal levels that describe different aspects of the use of documents. There exist some university domain ontologies that can be qualified as good representations with regard to aspect, such as: correctness of syntax language, satisfactory coverage degree of university domain, and there is many studies about how to build an ontology in education domain [8]-[9].

Figure 4 shows a focus on LearningObject class which shows the different classes are associated with it. Figure 5 the ontograf for test class.

IV. STUDENT’S CLASSIFICATION ALGORITHM

Our algorithm for student’s classification is based on educational data mining to predict the homogeneous sub classes of students according to their previous results in several assessments that are designed in a relevant and simple educational approach. This approach is tested for the field of software engineering on the staff of competence computer engineer. Applying the principle of divide and conquer, this domain of competence is divided into four subdomains: the analytical capacity subdomain, solutions design capability subdomain, the subdomain on the mastery of technical architectures for the implementation of solutions and at the end the subdomain on the mastery test techniques of implemented solutions.

A. Detailed Schema of student classification

Figure 6 shows the detailed schema to illustrate our implemented solution to perform the students classifier based on decision tree. To assess the quality of decision tree generated, we have used the indicator based on the calculation of the information gained by selecting an attribute A to
partition the data. This indicator is given by the difference of the training dataset entropy and the entropy of the attribute A.

![Diagram](image)

**Figure 6: Schema of student classification algorithm based on decision trees**

**B. Attributes used in classification and their values**

The following table shows the four factors that we have identified to assess the ability of students to follow the cycle of courses in software engineering for engineering grade. For each factor a weight is chosen to reflect its impact.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Weight (%)</th>
<th>Attribute values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis ability</td>
<td>20%</td>
<td>Very Good</td>
</tr>
<tr>
<td>Designing ability</td>
<td>40%</td>
<td>Good</td>
</tr>
<tr>
<td>Implementation ability</td>
<td>25%</td>
<td>Average</td>
</tr>
<tr>
<td>solutions test capacity</td>
<td>15%</td>
<td>Poor</td>
</tr>
</tbody>
</table>

**Table 1: List of considered factors and their weight**

Attribute values are defined based on the range of total scores obtained by a student in assessments in relation to each factor as indicated in the following table:

<table>
<thead>
<tr>
<th>Range in [0..20]</th>
<th>Attribute value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;16</td>
<td>Very Good</td>
</tr>
<tr>
<td>&gt;14</td>
<td>Good</td>
</tr>
<tr>
<td>&gt;10</td>
<td>Average</td>
</tr>
<tr>
<td>&gt;6</td>
<td>Poor</td>
</tr>
<tr>
<td>&lt;6</td>
<td>Very Poor</td>
</tr>
</tbody>
</table>

**Table 2: Attribute values based on the range of total scores.**

**V. PATH PLANNING ALGORITHM**

After students classification results, the system will propose for the students with an invalid profile an upgrade training. To generate this training, we opted for The Ant Colony System Algorithm.

The Ant Colony System Algorithm is divided into three main steps. In beginning all ants will try to build their tours applying a probabilistic transition. After this step, ants will apply the local pheromone update to increase the amount of pheromone on each visited edge. Thereafter the system will calculate the best shortest tour and choose the best solutions. At the end, the best ants are able to add more pheromone on their tours by applying the global pheromone update on edges that are part of the best solution. The whole procedure repeats until the finished condition is met. For more details, in Figure 7 we show pseudo code of the Ant Colony System algorithm.

![Figure 7](image)

**Figure 7: Pseudo code of ACS Algorithm**

**Conclusion**

The proposed platform provides good support to teachers and students, its offers an effective solution for all evaluations, positioning tests and pre-assessment. The future work is to implement the rest of the functions and test the entire platform.

However this solution is far from complete. Indeed to fill a larger role, many improvements are needed the most important are:

- Approaching the actual conditions of learning for active-face learning (psychomotor activities) using virtualization and interactive simulation techniques,
- Fleshing warehouse courses and tests covered by the platform to cover more student profiles (humanities, economic sciences, legal sciences, engineering sciences, ...)

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• Strengthen the traceability of the activities of students, but also in relation to educational entities,
• Provide trace analysis module based on data mining techniques,
• Improve the adaptability of the platform to better align with the needs of students and teachers.

In the same context and in order to develop the learning process our future work will be oriented to a new approach about student learning styles and adapting the training content with different styles which will allow teachers having a clear idea about the achievement and success of the learning process and also helps them to ensure a good perception on the behavior of their students and identify their best learning styles

References