A MODELING LEARNER APPROACH IN A COMPUTING ENVIRONMENT FOR HUMAN LEARNING BASED ON ONTOLOGY

Adil KORCHI
Laboratory of Signals, Systems and Components
Faculty of Science and Technology,
University Sidi Mohamed Ben Abdellah, Fez, Morocco

Najiba EL AMRANI EL IDRISSI
Professor in Laboratory of Signals, Systems and Components
Faculty of Science and Technology,
University Sidi Mohamed Ben Abdellah, Fez, Morocco

Adil JEGHAL
LIIAN, Department of Informatics
Faculty of Science Dhar-Mahraz
University Sidi Mohamed Ben Abdellah,
P.B 1796 Atlas-Fez, Morocco

Lahcen OUGHDIR
LIMAO, Department of Mathematics, Physics and Informatics
Polydisciplinary Faculty -Taza
University of Sidi Mohamed Ben Abdellah, Faculty of Taza, Morocco

Fayçal MESSAOUDI
Laboratory of research and Management,
Université Sidi Mohamed Ben Abdellah, Fez, Morocco
Laboratory of Mathématiques, Signals and computer.
University of Sidi Mohamed Ben Abdellah, Fez, Morocco

ABSTRACT
This work is in the field of technology for computing environment for human learning (CEHL). The inflexible nature of these environments must be adapted to learners and their profiles in order to gain suppleness, adaptation and individualization of learning. So they can be an effective tool for representation and consideration of the learner’s knowledge and skills. This new learning technique imposes new requirements and constraints to establish representations through which learner modeling becomes possible. We present our learner modeling approach built
upon an ontology. It is based on an accurate description of learners and their profiles made of their behaviors, knowledge, skills, interactions and designs.

**Key words:** CEHL, Ontology, Learner, learner profile, pedagogical scenario, pedagogical activity.


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1. INTRODUCTION

CEHL is a computer environment designed to promote human learning, that is to say the construction of learner’s knowledge.

The learner must be placed at the heart of the educational situation to facilitate his integration into the learning process. To get there, the CEHL must focus more on the learner’s profile which consists of a set of information interpreted and which concerned the learner himself/herself and are collected from several activities related to very specific learning scenarios. Several studies [1], [2], [3] were conducted to propose models for representing information concerning the learner such as: knowledge, design, skills, behavior, interactions

With the emergence of the Semantic Web, the CEHL researchers began using ontologies in their research to master the learning-environment relationship. [4, 5, 6]

In this article we aim to define the terms related to learner’s modeling to describe the proposed learning ontology which includes all the modeling elements. This ontology is characterized by a structured set of terms, concepts, sub concepts, semantic relationships and instances representing the learner’s area to reach a design that can allow us to model the "learner's profile" whatever his/her tendencies and preferences are.

2. STATE OF THE ART

2.1. Ontology in CEHL

The use of ontology in the model of e-learning system is an interesting solution. An ontology gathers concepts that represent the knowledge of a field in a formal and explicit specification.

SNAE [7] introduces an ontology for e-learning process from the construction of learning objects online for administration tasks.

Gasevic and Hatala [8] allow users to formulate queries to retrieve specific pedagogical resources. Moreover, they respect the LOM norm on the annotation and indexing pedagogical resources within their ontology called "target ontology."

You can use the ontology to represent people (learners, tutors, ..) or pedagogical resources. It can even be used to represent the concepts of a learning situation.

2.1. Ontologies and knowledge representation

"Ontology is an explicit specification of a conceptualization" [Gruber 93].

Building an ontology can be done after the phase of conceptualization which consist of identifying, within a corpus, specific knowledge to the field of knowledge to represent. N. Guarino [9] considers ontologies as partial and formal specification of a conceptualization.

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Therefore it is necessary to be able to build a first semi-formal modeling, partially coherent, corresponding to a semi formalized conceptualization. This is called conceptual ontology, semi-formal, and the specification process is called ontologization.

In all cases, it is necessary to translate this ontology in a formal and operational language of knowledge representation in order to use it in a computer.

The target language must allow the representation of different types of knowledge (knowledge terminology, facts, rules and constraints) and the manipulation of this knowledge through appropriate mechanisms to the operational objective of the designed system. This translation process is called operationalization. A knowledge base contains knowledge used in a system knowledge base. This knowledge is formalized and mechanisms allow to manage the knowledge base to view or to add.[10]

The need to have a learner knowledge representation has led researchers to attempt to induce a model of learner dynamically built and based on a set of learner data such as behavior. To do this, various problems are to be solved: First, the problem of choosing a representation to store data of the learner, constituting his/her knowledge model then, the realization of mechanism to initialize and update this model throughout the interaction with the system, and finally the implementation of the interpretation process of this model to guide the related decision-making procedures and the solution adopted for one determines very significantly how to handle the other two. [Bruillard, 1997]

2.3. Modeling learner

To be effective, it is essential that computer human learning environments have sufficient information about the learner, in particular learning abilities, knowledge, gaps, etc. This approach is called "The learner model".

The purpose of the learner model is to provide a complete description of all the aspects of the learner's behavior.

So modeling the learner is to structure his/her data that represents the state of his knowledge in a given field.

Hazardous models have been developed in order to get good predictions on the performance of learners on certain tasks, but they did not provide the knowledge state of the model learner. Modeling is the process that not only analyses the learner-information but also his/her exchanges with the learning environment to estimate their level of knowledge in a given field.

This modeling can be achieved without problems. According to several researchers, the constraints of modeling learner are mainly related to collecting precise information of the learner that we want to model. There was then, the step of choosing a relevant formalism of representation of this information. Finally, we must develop processes that build model learner. [11]

Modeling systems are distinguished by the following criteria: [12]

- The means used to store information on the learner,
- Construction methods applied in preparing the learner model,
- The use made of this information.

Synthetically, modeling the learning means to:

Know information about its courses.
Gather information about his/her knowledge, skill, behavior and interaction.
A Modeling Learner Approach In A Computing Environment For Human Learning Based On Ontology

Indeed, when a learner is in a learning situation in an online environment, it must have sufficient data of this actor to be able to guide him effectively in their learning situation because the learner plays a central role in the learning process.

In this article, we use the two terms “The Learning Model” and “The learner’s profile” to refer to the information we have about the learner when modeling him/her.

The learner model shows how we can represent the knowledge of the learner. The learner profile is composed of the following:

- Learning who is no other than the user using a learning system to learn.
- Profile is the set of information about a given individual in a given context.

We will be interested first in the "Learning Profile". In our article, we define it as a set of information relevant to adapt learning to behavior, knowledge, skills, interactions, and to the learner conception. In our schema, the profile will be considered as concept that will be semantically related to the following three concepts: Learning - Educational Activities – Educational Assistance. These three concepts will be developed in order to get all their sub concepts, semantic relations and their instances that will be integrated in the proposed ontology.

3. DESCRIPTION OF THE PROPOSED LEARNER ONTOLOGY

Ontology is originally a specialty of philosophy. This term is entered in the vocabulary of cognitive science for engineering which means "an explicit specification of a conceptualization." Sander et al. show how an ontological modeling facilitates the transmission of knowledge through a conceptual model. The assumption of these authors is robust. The acquisition of the domain of knowledge passes through the construction of a conceptual model at the learner which turns to ontology [13].

Developing an ontology means that we must define a set of data and their structure so that they will be used by other programs. Ontologies and knowledge bases (developed using ontologies) are used as data by problem solving methods, domains independent applications and software manufacturers. For example, in this article we develop the learner ontology, learner profiles and educational contents. This ontology can be used as the basis for a range of applications for effective online learning.

Building ontology is characterized by five elements: Concepts, Relations, the functions, and Axioms Instances. We describe in this section the aspects related to the implementation of our ontological model:

3.1. The Learner

We have developed a learner model according to the Capacity that can develop the learner and his/her cognitive level in the CEHL systems.

Figure 1 outlines the proposed learner model, it consists of:
3.1.1. The personal data
Is a part of the Learner concept. They contain general information about the learner, such as name, surname, age, gender.

3.1.2. Type
It is a data which provides information about the type of learner: Divergent, Convergent, Assimilator or Running. Many researchers focused on learners and styles with which they wish to learn. This research has shown that we tend to teach based on our own learning style. But, if the learner has a different learning style than ours, he/she will have difficulty receiving information.

The diverge learner has a keen sense of observation: he/she is clever to perceive an object or problem from different angles so that the convergent learner prefers to practice his/her ideas and theories, solve problems and make decisions.

The assimilative learner is qualified to reorganize logically varied information. He prefers the theory on practice while the executive learner is concrete, active, methodical, realistic and implements practical experience and is personally involved in new experiences with a challenge.

3.1.3. The cognitive level of the learner
It is connected by a semantic relation to the concept "Learner" and generates the three levels namely; beginner, intermediate and advanced.

The beginner learner always needs to understand what is expected from him to resolve the problem. For a student with an average level of knowledge, only the accompaniment and guidance are enough for him (in case of error) to find the solution himself/herself, whereas the advanced learner can find the solution to problems presented to him by himself/herself.

3.1.4. The Degree setting
The Degree setting which is a property in this part of the ontology in «Level-Learner» concept. It tells us about the level of the learner.

![Developed learner ontology](http://www.iaeme.com/IJCIET/index.asp)
In our ontology, a beginner learner has three levels namely; Level 1, Level 2 and Level 3. It is the same for intermediate and advanced levels.

Indeed, a beginner learner can have a general knowledge in a given field (for example in geometry). If the test proposed by our ontology detects that the learner is a beginner, he will be classed in one of the three proposed levels of the beginning level.

### 3.2. Learner Profile

Learners profiles allow to provide the learning system pertinent information about the learner.

These profiles have a very important role in all CEHL. Our learner profiling process consists of five key components that are semantically related to the learner profile, which are:

- **Behavior**: It is the relationship that the learner must develop with his/her environment for the success of his/her pedagogical activities. Behavior in our case concerns the motivation, autonomy, attention, responsibility, mind-opening and curiosity of the learner.

- **Knowledge**: This is the cognitive background of the learner. It can be general, theoretical or practical.

- **Skills**: Each learner admits strengths related to his/her skills. This may affect the sense of contact, creativity, speed and logic of understanding and problem solving.

- **Interaction**: The learner is an integral part of the interaction, otherwise he would not be a learner. It is the exchange that can have a learner with a learning environment. It may be long, medium or fast.

- **Conception**: Learning is not a process of transmission but question’s transformation of initial ideas, the usual ways of learners thinking. In this transformation process, our proposal on the learner’s conception may be limited or incorrect to reach a new concept of learning.
3.3. Pedagogical activity

Before starting a pedagogical activity, a test is required to evaluate the knowledge level of the learner. In this context, and as a first step, we propose a set of questions related to knowledge of the desired activity. Then, a level check is established in order to offer the learner a suitable activity according to his/her level and profile in the learning process.

The pretest of the concept "Pedagogical Activity" brings us directly to the sub-Level “Learner level” of the concept “Learner”.

Once the level of the learner is validated, various learning methods will be proposed to him/her such as:

- Learning with lessons, tutorials, directed works, construction works, projects realization.
- Learning with demonstrative or interactive video lessons.

The variable "Type" refers to the method of learning which can be "free or assisted"

For example: the learner may be assisted in a practical works sequence or can achieve it himself/herself.

3.4. Pedagogical Assistance

Figure 4 gives an overview. The aim of this concept is to provide pedagogical assistance adapted in a CEHL related to pedagogical content chosen by the learner. Those involved in
this operation are: the tutors and pedagogical content that has a direct connection into our ontology with the “Pedagogical Activity” concept, where each pedagogical activity is assisted by a tutor who can be an assistant, a doctor, a trainer or a supervisor.

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![Developed ontology of pedagogical assistance](image)

**Figure 4** Developed ontology of pedagogical assistance

The educational content is linked to the concept-pedagogical activity by a semantic relationship to facilitate the use and access to our ontology.

**FULL DIAGRAM OF THE PROPOSED ONTOLOGY**

Our ontology consists of 4 concepts that give rise to sub concepts and semantic relations as shown in figure 5.
Figure 5 Developed learner ontologie
4. CONCLUSION AND PROSPECT

Access to relevant information tailored to the needs and context of the learner is a real challenge. New learner modeling approaches, based on ontology, will know without doubt a better impact than expert systems because of the detailed description of learner profiles.

Our work contributes to the learners modeling of in a CEHL based on ontology. A modelization that is essential to design a new generation of CEHL that may evolve by placing the learner at the heart of the pedagogical situation in accordance with his/her behavior, knowledge, skills etc.

This preliminary work has helped to build a learner ontology that will later incorporate a CEHL to concretize the design of computer applications using ontologies that supports learners in all their states in the areas of learning within the CEHL.

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