Adaptation of learning resources based on the MBTI theory of psychological types

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Abstract

Today, the resources available on the web increases significantly. The motivation for the dissemination of knowledge and their acquisition by learners is central to learning. However, learners show differences between the ways of learning that suits them best.

The objective of the work presented in this paper is to study how it is possible to integrate models from cognitive theories and ontologies for the adaptation of educational resources. The goal is to provide the system capabilities to conduct reasoning on descriptions obtained in order to automatically adapt the resources to the learner according to his preferences. We rely on the model MBTI (Myers-Briggs Type Indicator) for the consideration of learning styles of learners as a criterion for adaptation.

Keywords: *Learner modeling,* learning style*, MBTI,* adaptive learning*, knowledge engineering, semantic web, ontology.*

1. Introduction

The use of information technology and communication has greatly improved the way we read and learn. These advances are revolutionizing our way of learning by facilitating access to content and services. A large amount of educational resources is produced continuously on the Web. Given the cost of production of these resources and the expertise to produce them, it is essential to make them easily accessible, usable and reusable.

Students can learn, communicate and collaborate by means of Learning Management Systems (LMS) such as Blackboard [1], Moodle [2] or ATutor [3]. The problem is that LMS doesn't offer personalized services, all the students being given access to the same set of educational resources and tools, without taking into account the differences in knowledge level, interests, motivations and goals.

In fact, we are aware that any adaptation process is based on a model of users. The adaptation necessitates enough knowledge of the users (capacity, objectives, learning preferences, history). People have different personalities, which affect their daily activities, emotions, the ways they interact, and how they learn. In the initial stage of the research, we intended to generate a framework to understand how we could review the effectiveness of the adaptive hypermedia systems. Identifying each student's learning preferences style was considered. To deal with this aspect, Myers-Briggs Type Indicator (MBTI) questionnaire test was employed. The MBTI test was originally developed to measure people's personalities type [4]; however, it has also been used for developing different teaching methods that meet different students' learning styles. Of course, MBTI cannot be used to stigmatize each person as a particular personality type, but it has demonstrated many useful tips to improve learners' communication style with tutors through constructive use of differences [5]. In particular, the education domain has used it to develop different teaching methods that meet different students' learning styles.

Our aim is to try to apply this model in the learning context and to study the advantages of learners' styles of learning as a criterion for adaptation.

In this research paper, we will introduce our new approach of modeling that based on ontologies. A learner's ontology based on the theory MBTI. Our aim, here, is to describe and analyze the preferential needs of learning process. Besides, a simple ontology related to the field of knowledge supported with resources is put forwards. This is carefully structured using the concepts and relations. Finally, the adaptation model will be carefully elaborated by applying norms of adaptation selection and, also,

presentation. To support our proposal, we will, ultimately present a prototype and a conclusion of our whole work.

2. Learning style

Learning style can be defined as "attitudes and behaviors that determine the preferred way of a person to learn" [6]. We can say that learning style is the way a person perceives and organizes information. An overview of the literature quickly show the plurality and diversity of learning style models. These models are grouped into three types:
- Models of learning style preferences are interested in the conditions of teaching and learning.
- Models of learning style with an interest in how the learner processes information in terms of preferred means
- Models of learning styles that address the personality of the learner. Example: Myers and Briggs [7].

As part of our approach, we examined the model Myers-Briggs Type Indicator (MBTI).

2.1 MBTI model

The MBTI is based on the work of Carl Gustav Jung and the authors of the instrument, Isabel Briggs Myers and her mother, Katharine Cook Briggs. [8]. His work led in turn to Myers Briggs Type Indicator or MBTI. The MBTI is a tool that allows an individual to be aware of his own behavioral preferences. According to this theory, each has a natural preference. When a person uses his favorite pole, it generally succeeds better and feel more competent, natural and dynamic.
This indicator was used for many years in the Anglo-Saxon countries, including the army and in schools to lead students to the university that will fit best their profile [9]
The MBTI is based on the principle that the differences in behavior from one person to another can be expressed in terms of preferences between the polarities. Four bipolar oppositions thus define four main dimensions of psychic life:
I: Introversion (Introvert) **E**: Extraversion (Extrovert)
The scale E / I shows preference to direct his attention to the outer world of people and things (E) or to the inner world of ideas (I).
S: Sensation (Sensing) **N**: intuition (intuitive)
The scale S / N indicates the preference of the perception of things, events or details of the present moment (S) or the possibilities, the intuitions of the future (N).
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T: thinking (Thinking) **F**: feeling (Feeling)
The scale T / F indicates the preference of the rational decision is based on an objective analysis and logic (T) or on subjective values (F).
J: Judgement (Judging) **P**: Perception (perceiving)
The scale J / P indicates the preference for the organization and control of external events (J) or for the observation and understanding of these events (P).
The various combinations of these preferences result in a total of 16 personality types and are typically denoted by four letters to represent a person's tendencies on the four scales as shown in Table 1.

Table 1: The 16 MBTI types

ISTJ	ISFJ	INFJ	INTJ
ISTP	ISFP	INFP	INTP
ESTP	ESFP	ENFP	ENTP
ESTJ	ESFJ	ENFJ	ENTJ

For example, ENFP stands for Extraversion, iNtuition, Feeling, and Perception. This does not mean that the person has only four preferences, but that the four preferences show a greater presence than their counterparts. There are questionnaires to determine the personality type of a person.

3. Learner model

The focus of our research is on the learning style as the adaptation criterion, since it is one of the individual differences that play an important role in learning, according to educational psychologists. Learning style refers to the individual manner in which a person approaches a learning task. Research in this area began relatively recently and only a few systems that attempt to adapt learning styles have been developed.
Several works have proposed solutions based on ontologies to describe learner's profile. [10], [11], [12] have developed models for the representation of learners in order to monitor and control their activities.
Our modeling approach is based on the findings of works on cognitive theory for the description of learner's profile and more specifically for the representation of styles (preferences for learning).
We suggested that the learner's model is defined as an ontology comprising the diverse qualities and characteristics of the user according to special concepts and relations between them. We would like to introduce a learner's description according to four facets (see Fig. 1). These latters are considered as abstract notions, in our ontology.

The first facet called "**Identity**" is used to represent information about a particular learner. It is composed of predefined attributes that are essential and common to all users: name, surname, login, language, media type ... and it is modeled as a set of attribute-value pairs.

The second facet called "**Preferences**" predefined attributes that are prerequisite and common for all learning preferences. This component is directly based on the theory of psychological types of MBTI (Myers-Briggs Type Indicator). According to this theory, everyone has a natural preference. We have also used it for developing different teaching methods that meet different students' learning styles. The individuals show differences in the ways of learning as follows:

- Some prefer basic, complete instruction: (T);
- Some prefer to start directly learning about the task: (F);
- Some prefer to get through the subject first before the following: (J);
- Some need flexibility, opportunities for exploration: (P);
- Some need space and time to learn (L);
- Finally, some assimilate faster in learning: (R)

This component is modeled as a conceptual vector Vp= (P_I, P_E, P_S P_N, P_T, P_F, P_J, P_P) this vector enables us to specify MBTI the characteristics of the psychological style of the learner and, hence, find out more about his preferences in the learning process. There are questionnaires which determine the psychological type of a person. For example, the types of psychological types of a learner A1 are described as follows: Vp= (I:2%, **E**:18%, **S**:20%, N:6%, **T**:25%, F:5%, **J**:20%, P:4%). A learner A1 has the type **ESTJ** so he is a learner who prefers to finish his task before moving on to the next aspect that emphasizes the well-structured, etc.

The third facet which is referred to as "**Capacity**" is introduced to represent and measure the degree of a learner's understanding of a concept. This perception is represented by a stereotype (class or category of individuals) this can be achieved with "quiz" test. The stereotype model eases the categorization of perception in a given group: the learner is classified with a particular category, acquiring his specificity and adaptability feature provided by the mentioned stereotype. The possible observations are: very low, low, medium, good, excellent. This scale of evaluation provides more precision.

The fourth facet called "**History**" is supposed to record everything about the learner memorization of navigation and resources in the documents read. This recording gives exact information like: the length of a resource or the navigational course.

Both the third and the fourth aspects develop automatically and dynamically while the learner is acquiring new concepts.

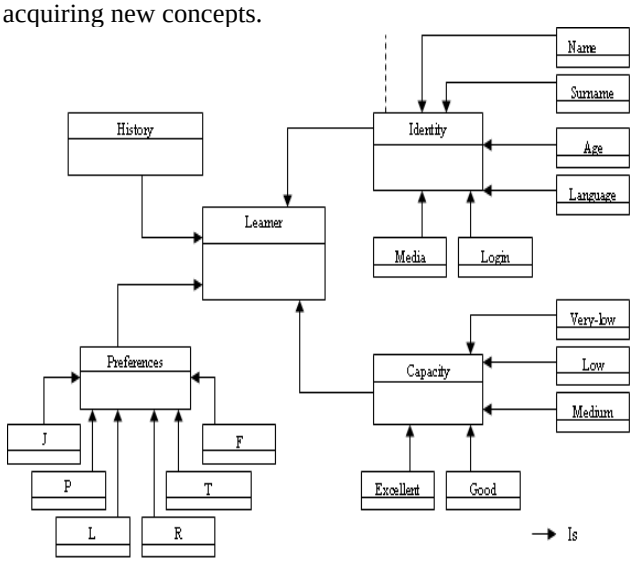

Fig. 1 Learner ontology.

4. Domain model

Works in semantic web [13], [14] and [15] Endeavor to render the content of resources accessible by using the adaptive hypermedia systems. The semantic web uses "engineering knowledge" as effective means of representation of knowledge. The main characteristics of the structure of the "semantic web" (common meaning, metadata processed by machines) seem very effective to resolve the problem of searching for pertinent information.

In this context, a pedagogical resource is pedagogical, atomic unity representing a physical entity (text, picture, sound...) belonging to a given category (definition, example, illustration exercise....) corresponding to a particular notion. These resources are represented as XML fragments, carefully arranged together to form hypermedia pages. To represent a pedagogical resource, we can take into consideration different information. Information about the resource itself (Norm LOM) [16], information about the notion covered by the resource, knowledge of the resource category, and information about the learning style of the resource. All this knowledge is represented by using ontologies. The aim is to add semantic annotations to the pedagogical resource content to make them easily found and adapt them to the different learners' profiles.

Many facets are suggested for the description of a resource. A complete ontological model containing different representation aspects is illustrated in (see Fig. 2).

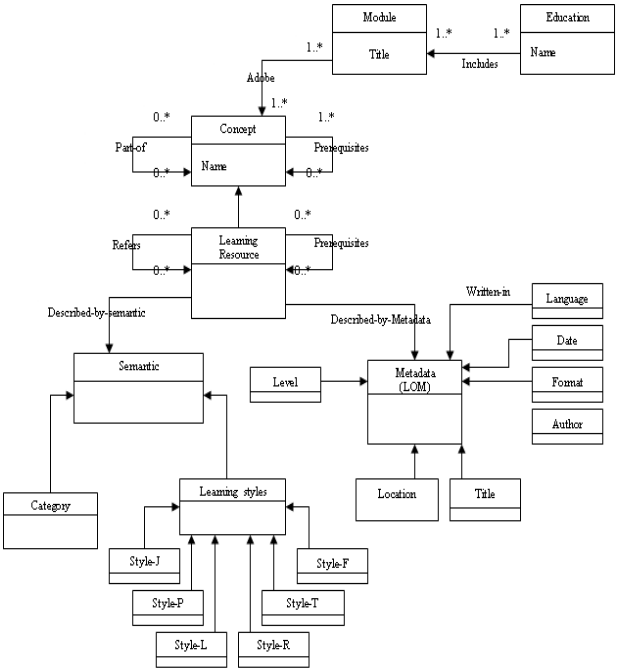

Fig. 2. Complete ontological model for representing a learning resource

The "**Thematic**" facet helps to represent the pedagogical resources according to the themes they deal with in the form of different modules. Each module covers one or many notions. A particular notion of the domain (data base, network...) represented with a name, is an abstract representation of a finite set of pedagogical resource. These concepts to be exploited are described with a graph in which the nodes are the concepts and the arcs are the semantic relationships between them. This graph is conceived by the system administrator. It is obvious that this task is not easy in case the domain covered is vast. However, there exist similar ontologies (not forcibly with the same semantic relations).The different type's definite relations between concepts are:

- Prerequisite: concept X is the prerequisite of the concept Y if the learning of Y requires the knowledge of X.
- Part of: X part of Y if X is a concept belonging to Y.

The relations between the concepts influence the adaptation of the hypermedia, for example, certain resources cannot be added to a page because their concepts have prerequisites that have not yet been acquired by the learner. The link "Part of" is, also, very useful for the adaptation. We can, for example, divide a concept into simple concepts and introduce less complex pedagogical resources to the learner that are adapted to his knowledge. Choosing a course then a module among many via a list of choice is done by choosing and visualizing the "OWL" ontology that describes the concepts of a particular domain. This enables a learner to specify his knowledge (already acquired, and to be acquired) relative to a domain.

The second facet "**Metadata LOM**" ensures the description of a pedagogical resource by using Metadata (author, title, date, language, media, location.....) this part is similar to Metadata described in LOM norm. But to meet the needs of our application, and to make the analysis easier, we have established a set of vocabulary. Let's, for example, consider R1= <language, {"French"}>, <media, {"text", "video", "picture"}>, <author, {"behaz", "djoudi"}>

A LOM description is attached to each pedagogical resource. This description is illustrated in figure 2. The associated Metadata provides précis's and well classifies information about each learning resource rendering the ulterior researches more effective.

The different types of relations between the resources are:

- Prerequisites: if the reading of the resource A necessitates the reading of the resource B: "an exercise" requires the knowledge of a "definition" first.
- Cite: the resource A cites the B if A contains a reference or a link towards B.

Or, the representation suggested in the norm is not sufficient for accessibility and adaptation in a hypermedia system. We complete it with a semantic representation of contents.

The third facet "**Category**" helps to classify the pedagogical resources under different categories (introduction, example, definition, illustration, exercise....) depending on their contents.

The fourth facet "**Learning styles**" enables to take into account the different learning styles of a pedagogical resource. This facet, which helps to specify the content of a resource, is adapted to a learning style seen as psychological MBTI. For example, the resource R1 has the conceptual vector Vs = (I: 4%, **E**: 16%, **S**: 22%, N: 4% **T**: 20%, F: 10%, **J**: 18%, P: 6%), indicates that this object is most suitable for a MBTI type **ESTJ** indicates that this resource is more adapted to the profile of a leaner who prefers to finish his task before going on to the following one (style-T: 20%) that prefers the well structured aspect (style-J: 18%) which assimilates long (style-S: 22%). The operation of the resource parameters is ensured by the designer (or an annotator) about the content and the possible usage. This operation is realised via an ergonomic interface (forms, questionnaires.....etc.) hiding the

technical details during the creation of a pedagogical resource. After that, the value of a usage vector Vs of a resource can be modified (or adjusted) manually by the designer of the resource, or automatically by the system. This modification is based on the ulterior traces of usage of that resource through the different learners' profiles.

5. Adaptation model

The adaptation model is used to generate personalized content from the information space of the model learning and applying the rules of structure and presentation. There are many approaches to model adaptation using logic Woukeu [17] Stash [18], which are often based on the use of rules. In our case, after identifying the learning styles of learners. The adaptation process takes place as it follows:

- Research : Identification of resources to the concept
- Selection: the choice of adequate resources in the best model of the learner (media favorite, level, style, ...).

5.1 Research of resources

When the learner has defined the concept on which it wants to work, There will be a process of research resources. The identification of resources relevant to a concept is based on the learner model and domain model knowledge. The proposed annotation resources systematically connects resources to their concepts. The system builds a request to the resource base. This returns the resource identifiers corresponding to the concept. To improve the process of finding an inference engine is built. This is mainly based on semantic links between the learning resources in the ontology and the inference rules.

5.2 Resource Selection

The result of the previous step is a list of resources found explicitly or implicitly inferred. This list is subject to another module that compares the semantic usage of each resource in the list with a description of the learning preferences of the learner.
This comparison is performed for using a distance D which calculates the distance (as defined vector), it returns a semantic and a measure of geometric distance. Given the two vectors, Vp= (P_I, P_E, P_S P_N, P_T, $P_{F,}$ P_J, P_P) describing the learning preferences of the learner A_i and the vector Vs= (S_I, S_E, S_S, S_N, S_T, S_F, S_J, S_P) describing the styles of the resource. The measure of similarity is the calculation of distance between vectors (the vector of preferences of the learner Vp and the vector of styles Vs of educational resources found in the previous step) Various measures can be used. We have used the cosine measure.

$$D = Cos\ (Vp_{Ai}, Vs_{Re}) = \frac{\sum_{i=1}^{8} P_i \sum_{i=1}^{8} S_i}{\sqrt{\sum_{i=1}^{8} P_i^2 \sum_{i=1}^{8} S_i^2}} \quad (1)$$

Another list of resources is then proposed to the learner. This set is closest to the learning preferences of the learner. This therefore ensures better assimilation of knowledge and capabilities to the rhythm of understanding of each learner.

6. Implementation

We implemented the system as a Web application. For this we used the Java and Servlets that allow great flexibility and portability of the application. It is within the scope of the new generation of Web (Semantic Web). In fact we used the OWL ontology to represent the developed and the Jena API for handling. Figure 3 shows the software architecture of the system developed.
A prototype is still at an experimental stage at the University of Batna. We confirm the large number of educational resources involved to qualify a system that actually adapts to the learner. An important advantage is the fine descriptions of available resources, we facilitated access. Also, the inclusion of styles (preferences) learning as a criterion of adaptation has facilitated the acquisition of knowledge.

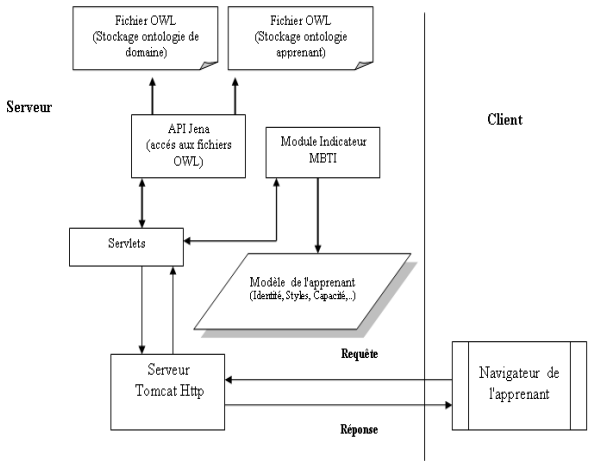

Fig. 3 Software architecture of the system developed.

When registering a new learner, a questionnaire is proposed to determine the psychological type (see Figure 4). Once completed and validated, the system calculates and stores the result in the learner profile.

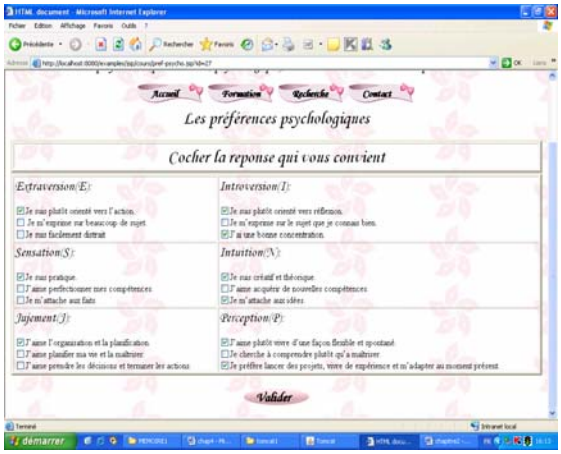

Fig. 4 Indicator MBTI.

A learner, connects to the system via an interface to describe the request. Choose a module is to choose and view the OWL ontology that describes the concepts of a particular domain.

Figure 5 shows a description of a given resource. In the left side you can see the concepts of a particular area here it is the field of computer module "Network Architecture". In the right side can see the descriptions for a given resource (LOM metadata) extracted from the ontology.

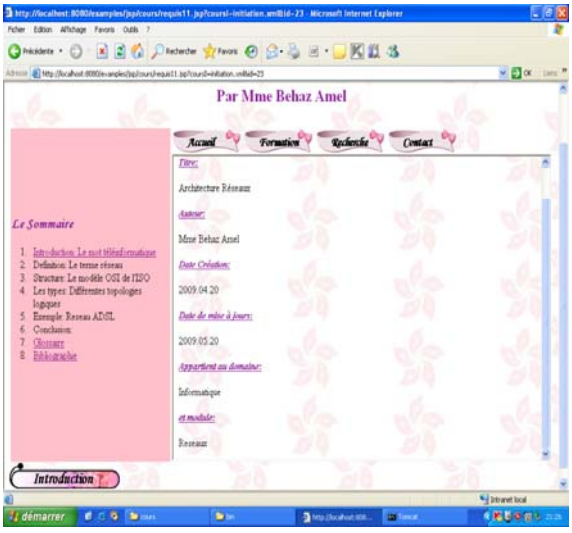

Fig. 5 Description of the resource "Architecture Networks"

In Figures (6 and 7) a dynamic generation of the same concept "Network Architecture" presented to two learners of different profiles. A learner of a medium level of knowledge that prefers to complete its task before moving on to the next, which favors the appearance well structured (style-J) another learner of excellent level needs flexibility, opportunities for exploration (style-P). We note the content which is generated differently, more details to a medium learner and less details for an excellent student.

Fig.6 Resource for a Medium learner and style -J

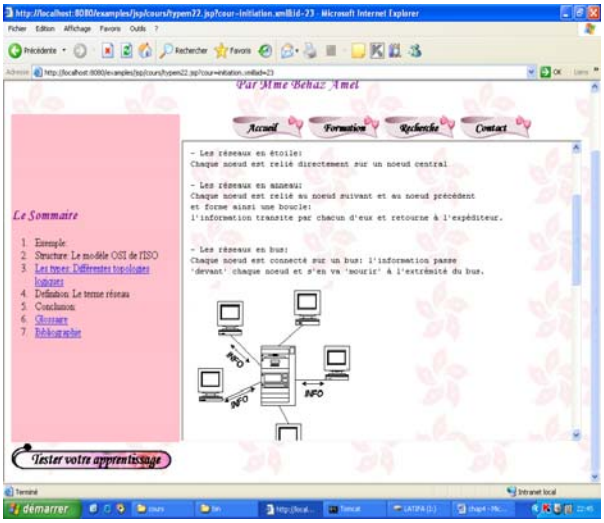

Fig.7 Resource for a Excellent learner and style -P

4. Conclusions

Personalized e-learning implementation is recognized one of the most interesting research areas in the distance web-based education. We conducted a research on the effects

of student's psychology to improve their learning performance.

We have introduced a new modeling adaptive system for the e-learning. A learning ontology based on the findings of works on cognitive theories for the description of learner's profiles, specifically for the representation of learning preferences. A simple domain ontology covered by resources. Finally, the adaptation model is described in using the research and selection resources.

We introduce the resources with metadata to detect them easily. We use indexation techniques of pedagogical resources. a prototype was developed; it represents the advantages of our project: easing the acquisitions of concepts by introducing the resources compatible with the learner's profiles.

We do not claim to have solved the problem of learning style modeling and adaptation. We do however hope to have shed light on some aspects and filled in some of the gaps. Further research is of course needed to clarify the remaining and newly raised issues.

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