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Enhancing a medical e-learning environment: The adaptive DI²@DEM approach

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Abstract. Current medical e-learning tools suffer from a variability of student user. Students are different in terms of motivations, training backgrounds, technical skills and learning objectives. It is obvious that these students do not accede relevant information if their educational resources access is misadapted. Adaptive environments propose to take the user into account in order to provide him or her with the most relevant educational resources. We present the adaptive DI²ADEM approach, which enhances the MEDIDACTE e-learning environment of the Faculty of Medicine in Marseille. DI²ADEM objective is to select the most relevant information and offer it to the user in an adaptive manner. Adaptability is based on management of knowledge regarding both the user and resources distributed. A match is made between student's profile and knowledge of resources organization and semantics.

1. Introduction

Users are different in term of motivations, training backgrounds, technical skills and learning objectives. It is obvious that they do not accede relevant information since web-based educational systems, i.e. e-learning environments, offer the same information for all. Moreover, users' variability involves different knowledge acquisition mechanisms. This results in individual attempts by the user to find suitable information him or herself. In e-learning context, classical tools improving access to information such as search engines, and specialized searching tools can prove insufficient. They do not manage user's specificities and variability, and do not take into account the pedagogical context into which resources are distributed. On the other hand, adaptive e-learning systems allow the teachers to apply their pedagogic objective and help students locate and navigate through relevant educational resources. Adaptive e-learning environment seems to be a recent research field that is both interesting and attractive [1-3].

The authors present the DI²ADEM project (Diffusion of Information with Interactive and ADaptive Environment in Medicine). DI²ADEM's objective is to take the user into account during his/her learning process and provide him or her with the most relevant information. DI²ADEM implements an adaptive and interactive model managing both a *knowledge* of the user (with user's profiles) and *knowledge* of the information distributed (with semantic relationships). DI²ADEM is currently being developed to improve the MEDIDACTE e-learning environment of the faculty of Medicine in Marseille [4,5]. The non-adaptive MEDIDACTE environment is characterized by an educational projects organization. In this system, the same resources are proposed to each category of student (1^{st}, 2^{nd} ... year of medicine) and it is up to them to make a choice regarding the consultation sequence. In order to select the most relevant educational resources and to offer those to the students in an "adaptive way", DI²ADEM implements student's profiles and enhances the educational projects organization by adding semantic relationships. In the

background section below, we present adaptive environments, recall our experience with those, and present the MEDIDACTE educational projects organization. DI²ADEM adaptive model is then presented and its adaptability management is emphasized.

2. Background

2.1. *Brief overview on adaptive environments*

Adaptive system processes a user's model to adapt page display and/or navigation between pages. *Adaptive presentation* affects the contents or display of information contained on a page. *Adaptive navigation* allows the user to find his/her way in the information hyperspace by adapting the display of links between pages. Generally, the adaptive web-based educational system groups *(i) a domain model, (ii) a user model* and *(iii) a set of techniques for adaptability* [1,2].

Domain model is usually based on a semantic network [6,7]. In the AHM project [6] the domain is organized by a set of concepts explained by documents; there are concept-concept relationships and concept-documents relationships. Considering the *user model* we must quote: the stereotype model [8] categorizing the user; the overlay model [1] considering user's knowledge as an overlay of the domain; the epistemic model with which the system assumes what the student is able to "know" or "not to know"; and the behavioral model [7] which is related to the user behavior, his/her preferences, goals, history and abilities. Satisfactory results can be achieved with a combination of the stereotype and overlay models. Considering the *adaptive techniques*, adaptive link annotation seems to be advantageous to learners who elect to accept the navigation advice [9].

2.2. *Authors experience with adaptive environments*

We initially suggested an adaptive hypermedia (AH) improving access to relevant medical information in continuing paediatric oncology education [10]. The main characteristics in this approach are *(i) user profiles* built in accordance with the stereotypes method [8], *(ii) adaptive navigation* managing semantic relationships between pages, *(iii) adaptive presentation* with typified information and the display of different types of documents. In this AH, the Unified Medical Language System (UMLS) [11] has been suggested to represent the medical domain and concepts.

2.3. *MEDIDACTE e-learning environment*

The MEDIDACTE e-learning environment is characterized by a two-level model organization (Figure 1) including the educational resources and the educational projects levels.

Educational resources level includes the educational resources suggested to the students and built by the teachers. Educational resources have several cognitive types: e.g. courseware, practical topics (virtual lab work, simulation), knowledge-evaluation (quiz) and cooperation (forum, chat).

Educational projects level contains the different educational projects. Projects are defined with their pedagogic background and the associated educational resources. Every teacher builds up an educational project specifying the different parameters included in his/her project, i.e., university administrative manager, the teacher's objectives, medical field, student audience, educational resources involved in the project. A same resource can be involved in several projects.

MEDIDACTE is well integrated in the curriculum of the Faculty of Medicine in Marseille. Teachers have no problem adopting projects and resources organization. An evaluation was made and most students were satisfied [12].

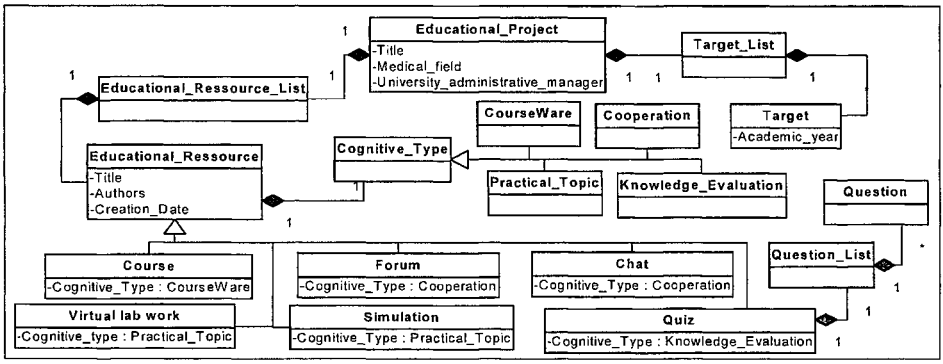

Figure 1: MEDIDACTE Server: educational projects and educational resources organization. (UML notation: Not all attributes are detailed)

3. Di²adem adaptive model

Its objective is to select the most relevant educational projects and resources to propose them to the user in an adaptive manner. DI²ADEM is conceived as a "plug-in" enhancing the MEDIDACTE two-level architecture. The DI²ADEM-MEDIDACTE association allows for an adaptive e-learning environment (Figure 2).

DI²ADEM adaptive approach characteristics are to improve the MEDIDACTE educational projects level by adding semantic relationships and to manage a user level. DI²ADEM reuses both the educational resources and educational projects levels of the MEDIDACTE e-learning environment.

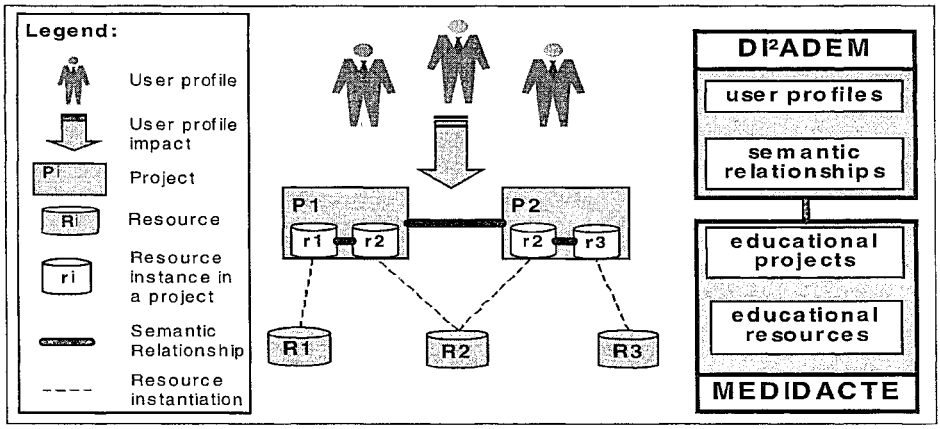

Figure 2: The DI²ADEM-MEDIDACTE association allows for an adaptive environment. DI²ADEM is designed as a "plug-in" taking MEDIDACTE two-level architecture into account. MEDIDACTE is divided into educational resources (Ri) and their instances (ri) in educational projects (Pi). DI²ADEM enhances this architecture by adding semantic relationships between projects and between resources; users are identified with user's profiles.

3.1. Semantic level

This level is composed of the MEDIDACTE educational projects level enhanced by the DI²ADEM semantic relationships. The semantic relationships help the teachers plan educational resources and projects. Semantic relationships are established between educational resources in a project or between educational projects. They are oriented, not reversible and defined as follows *(i) A is a prerequisite of B* when A is needed to understand B, *(ii) A is an aid for B* when A provides information that may help understand B, *(iii) A is an evaluation of B* when A appraises the knowledge included in B, *(iv) A is to be consulted before B* when A is scheduled prior to B, *(v) A is to be consulted after B* when A is scheduled after B, *(vi) A helps be better informed regarding B* when A provides additional data on B. Relationships within a project help schedule the resources particular to this project: it is, for instance, preferable to consult course material prior to self-evaluation. Relationships between projects help teachers link their projects with existing ones whether they are managing those or not; these complete their pedagogic projects. The student is provided with a list of scheduled projects and resources; this helps him or her select resources and improves the learning process efficiency.

3.2. User level

This level is composed of the different users' profiles. These profiles are at the root of adaptability. They have an "impact" on the semantic relationships and they contribute information regarding the appropriateness of a semantic relation for a user compared to another. These profiles are built according to the stereotype method [8] combined to a behavioural approach. This method uses information regarding the user and provides a base for action before specific knowledge is stacked up. We call student's profile the current instance for a student user. In order to manage adaptability, the student's profile is built with the following relevant attributes *(i) student's administrative identification*, *(ii) student's pedagogic identification*, *(iii) student's cognitive objective*, *(iv) student's resources access rights*, *(v) student's projects history*, *(vi) student's resources history*, *(vii) student's behavior* (Figure 3).

4. Di²adem adaptability management

The objective of adaptability management (Figure 4) is to provide the student with the most relevant educational projects and resources in an "adaptive way". Adaptability management is based on *(i) student's profile* in order to select the most relevant educational projects *(ii) semantic relationships* in order to suggest to the student the most relevant educational resources and projects to be consulted first (or priorily). This, enables resources and projects planning and we call it "adaptive planning".

Adaptability management is composed of three steps *(i) user identification*, *(ii) projects selection*, *(iii) adaptive planning*.

4.1. User identification

The objective of user identification is to collect the most relevant information regarding the student. It is based on the student's profile and is composed of two steps *(i) profile initialization*, *(ii) dynamic profile reevaluation*.

Profile initialization objective is to initialize the student's profile with enough information to activate adaptability management. The student is connected to the system and fills in an initialization questionnaire [2]. Static information, such as the student's

identification (name, first name) and pedagogic situation (university program, academic year) is obtained at this stage. The system initializes the student's profile by implementing the following attributes *(i) identification administrative* (name, first name...) and *(ii) identification pedagogic* (academic year...).

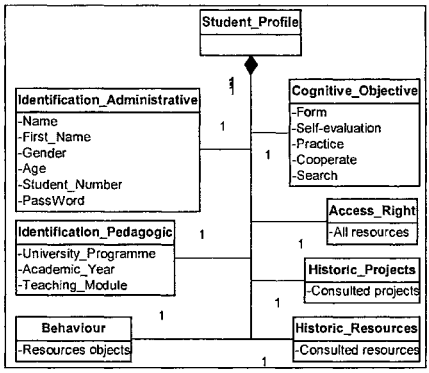

Figure 3: Student's profile representation. Relevant attributes for adaptability management are presented and detailed (UML notation).

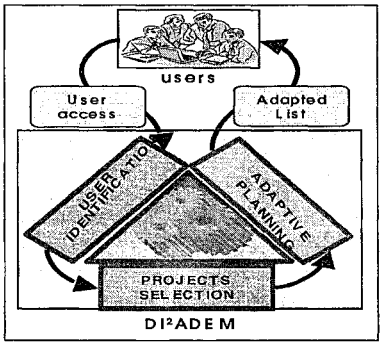

Figure 4: DI²ADEM adaptability management. The user accedes DI²ADEM and the following three steps are completed: user identification, projects selection and adaptive planning. Finally, DI²ADEM provides the user with a suitable list of relevant projects and resources.

Dynamic profile reevaluation objective is for the system to maintain and manage the student's profile by using and interpreting his/her interactions with this system [1]. It is an updated and completed profile. Dynamic information, such as behavior or history, is evaluated by the system during the user's session. The following attributes are affected by the dynamic profile reevaluation *(i) historic projects attribute, (ii) historic resources attribute, (iii) behavior attribute.*

4.2. Projects selection

Its objective is to select the most relevant educational projects according to the student's profile. DI²ADEM matches the *"academic year"* value (Figure 3) for the *pedagogic identification* profile's attribute and the *"academic year"* value (Figure 1) for the *target* property of the educational project; with the relevant educational projects, the adaptive system is able to retrieve the associated and relevant educational resources.

4.3. Adaptive planning

Its objective is to suggest to the student the most relevant educational projects or resources to consult first. We define a resources as well as projects adaptive planning.

Resources adaptive planning is based on historic resources profile's attribute and semantic relationships established by the teachers between the educational resources. Semantic relationships are interpreted in order to suggest the most relevant educational resources to consult first. The historic resources attribute contains information about the educational resources that the student consulted before. The result is that not every profile privileges the same semantic relationships [10] and, consequently, privileges the same order to consult educational resources. The semantic relationships are applied or not for each student's profiles, e.g. the "uterine MRI project" proposes a uterine MRI course and quiz. It will be useful to establish a "consult before" relationship between these two educational resources in order to suggest to the student that it is more appropriate to consult the course before consulting the self-evaluation. If the course has never been consulted before, the adaptive system will not displayed this suggestion.

Projects adaptive planning is based on historic projects profile's attribute and semantic relationships established by the teachers between the educational projects. By analogy with the resources adaptive planning mentioned above, we define the projects adaptive planning as the interpretation of the semantic relationships existing between educational projects. The educational projects that need to be consulted as a priority according to the student's profile are suggested first. The adaptive system uses the *historic projects* attribute to apply or not the relationships existing between the educational projects.

5. Discussion and conclusion

There is a will to offer an efficient e-learning environment and, the "French Virtual Medical University" (FVMU) [13] including every French university in the same virtual space is proof of this. However, e-learning could be more interesting for teachers and students if the system adapted itself [14] to the student's specifics. Thus, our objective is to propose an adaptive e-learning environment taking students and different types of educational resources into account.

In this communication we described DI²ADEM, our adaptive approach designed to improve MEDIDACTE i.e. the e-learning environment of the Faculty of Medicine in Marseille. MEDIDACTE currently represents more than 26 educational projects covering different medical disciplines (anatomy, dermatology, radiology, etc) and more than 50 educational resources. DI²ADEM proposes an adaptive planning of these educational projects and resources based on user profiles and semantic relationships between projects and resources. We are aware of the fact that this model has to be improved in the future. The next step of our research project shall attempt to optimize the dynamic re-evaluation of the profile. In the future, we could design DI²ADEM as part of an educative portal offering adaptability to students and taking pedagogic aspects into account.

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