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A MODEL ADAPTING DYNAMICALLY AN ONLINE HYPERMEDIA LEARNING

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Abstract

For a few years, the concept of hypermedia has become closely related to the eLearning thanks to its important contribution covering informational, navigational and interactional dimensions. However, the various studies and experiments carried out recently made it possible to identify certain possibilities for improvements being able to be beneficial with the process of learning. One of these improvements in which we are interested in this work is the adaptability. Indeed, the difference existing between the various learner profiles requires going beyond the educational hypermedia, having static and identical contents for all learners, to adaptive educational hypermedia, whose contents are created dynamically by taking account of the characteristics of each learner. Thus, our objective through this research task is to develop a model of educational adaptive dynamic hypermedia. With this intention we have, first, studied the concepts on which our work is based such as the eLearning, educational hypermedia as well as the various techniques and methods employed to ensure the adaptability. Secondly we proposed a model specifying teaching document structure, learner's profile representation and the different learning steps. Finally we applied the proposed model using a static online course in the NetUniversité platform as an input.

Keywords: Hypermedia, adapting, dynamic, elearning.

1 CONTEXT

The development known by information technologies during these last decades as well as the importance attached to knowledge collection in all its forms everywhere in the world, are the two principal factors responsible for the appearance of a new form of learning; the eLearning. Indeed, we can classify technological progress which served the eLearning in two shutters: the first shutter relates to the development of the communication networks and especially Internet, which allowed a fast exchange of all kinds of data at very wide distances and accessible cost. The second shutter relates to the progress of hypermedia, on this subject we notice the migration of traditional systems hypertexts towards more ergonomic hypermedia systems offering better possibilities of interactivity. Consequently, eLearning becomes a solution increasingly requested in educational establishments and companies. However, the various experiments during which this new form of learning was adopted revealed that the educational hypermedia systems, conceived and brought into eLearning service currently, are still too much limited in order to be able to replace the traditional mode of learning.

One of the principal problems of Learning with which scientific research is confronted is the difference which exists between learners. Indeed, each learner has his own characteristics which differentiate him from the other learners. Consequently, the relation between the learner and the hypermedia is not any more the same one for all learners. Note on this subject that the page contents can appear complicated for a novice, which is not the case for an expert on the field. The learning capacity also varies from one learner to another, thus a learning rhythm will be appropriate for the learner X but rather will be much accelerated for the learner Y. According to (Brusilovsky, 1998) and (Ognian and Al, 2004) this difference between learners covers four different levels: (1) Learner objectives, (2) Learner knowledge and his familiarity with the field, (3) Learner capacities and his experiment in the hyperspace and (4) Learner personal preferences which cover the visual aspects, navigation practices, course organization, etc.

In this context our research task has as objective to design an educational adaptive hypermedia model. This model must be able to identify the various profiles of learners and to dynamically build teaching documents specific to each profile.

2 IMS LEARNING DESIGN SPECIFICATION

The IMS Learning Design (IMS-LD) is one of the specifications the most sought in the field of the eLearning. It distinguishes itself with regard to the other specifications especially by its capacity to align itself with a big variety of educational methods, as the other specifications are characterized by their aspect directed to a specific educational method. This flexibility is du to the implemented of a generic language developed by Open University of the Netherlands (OUNL) and which was the result of evaluation studies and comparison of various educational approaches and the learning activities which compose them.

The specification IMS LD consists of three levels of representation linked by the relation of the following inclusion: the level A (statics) is included in the level B (dynamics) which is included in his turn in the level C (based on events).

- Level A: it is the base level, it allows a static description of the learning scenario evoking the various activities composing the lesson, the various roles (learner, teacher, etc.) which participate in the activities of learning and organize the interaction and the distribution of the roles between them.
- Level B: besides the components of the level A, this level adds the properties and the conditions: the properties serve for storing and for updating certain information concerning the lesson or the participating persons in this lesson, whereas the conditions serve for starting actions (show or mask an activity, change the value of a property, etc.) and this, further to the satisfaction of a

specific condition. So, this level B makes possible the adaptability of the contents of the lesson with regard to the learner profile and allows a dynamic generation of the various educational activities composing it.

- Level C: thanks to the announcements which it adds to the level B, This level allows the exchange of messages between the various roles as well as the addition of new activities roles during the learning process.

3 TEACHING DOCUMENT MODEL

In order to have an adaptive system hypermedia able to adapt the contents of the documents according to a learner profile, the model of teaching documents must be designed in a way that makes possible these adaptation operations: seek, filter and assembly. With this intention, we took as a starting point the model of teaching documents detailed in (Behaz and Djoudi, 2005). This model is founded on the principle of the content's fragmentation of the document in units of fine granularity, called elementary teaching units (ETU), and the detailed description of each one. This description is ensured thanks to the installation of a unit of properties classified in two levels:

3.1 Logical level (or cognitive level) :

At this level a logical type will be affected to each ETU. The logical types are classified in three categories:

- Lesson: this activity can be an introduction, a theorem, a formula, an illustration, a definition, an explanation, etc.
- Steered Works (SW): this activity can be a Multiple Question Choice, exercises of simulations, etc.
- Practical Works (PW): this activity can be a case study, a project, etc.

3.2 Semantic level

This level concerns the description of the existing semantic relations between the various ETUs. There are three types of semantic relations: composition, obligatory pre required and optional pre required. Moreover, we note the integration of other semantic information being used for better detailing the description of an ETU such as the physical type, the duration, the level of difficulty, etc.

The model of teaching documents which we propose inherits certain characteristics of the model described before. Furthermore, we indicate the addition and the modification of certain aspects to improve its adaptive side. Indeed, we keep the principles of fragmentation however we apply to every level the following changes:

At the logical level, the logical properties will be classified in four categories:

- Lesson: Identical to that described before.
- Steered Works (SW): It is a set of exercises and there are four types of exercises: (1) Text with holes, (2) Answer with text field, (3) Answer of the type "single choice ", (4) and Answer of the type "multiple choices ".
- Practical Works (PW): this category has the same structure of its previous one with the addition of the type of exercises "case study" and small "project work". The answers of both types will be manually corrected by the teacher.
- Evaluation Test: this category has the same structure of the PW category. The only difference with it is that the obtained results by learner will be taken into account in his passage from one learning level to another.

At the semantic level, we exploit the other semantic information, thanks to the following properties implementation:

- Physical Type: in order to describe the physical type of the ETU (text, image, sound, video, etc.).
- Learning duration: It is multiplied by a specific learner coefficient to determine the necessary duration to finish his learning.
- Difficulty level: there are three difficulty levels namely: (1) Novice, (2) Average and (3) Advanced.

On the other hand, we get rid of the use of the other semantic relations, such as composition and required meadow, from the moment that we use the standard IMS-LD (IMS-LD, 2003) in the conception of the various lessons. It enables us:

- To build the ETU forming the lesson: Indeed, IMS-LD and its Level A of representation, enables us at this level to define the various ETU or fragments which constitute our lesson. And this, thanks to two important contributions, the first is the use of XML as a language of representation facilitating the specification and the implementation. And the second is taking account of the existing semantic links between the various ETU.
- To define proprieties describing ETU: These proprieties are defined thanks to level B of the representation. This level B permits on the one hand proprieties definition of each ETU and on the other hand taking account of values that proprieties could have during the learning process and the manner they affect the document content presented to the learner.

4 LEARNER MODEL

In order to insure a good quality of content's adaptability of the generated teaching documents, a good representation of the learner profile turns out very important. To do it, we opted for the model described in (Balacheff, on 1992) and used in the project METADYNE.

We opted for this model sight its capacity to describe the learner through two sub-models, the epistemic sub-model and the behavioral sub-model.

4.1 Epistemic sub-model

In (Balacheff, 1992), the author defines the word epistemology as follows: " By epistemology we indicate here the study of the reports which maintains an individual, or a community, with a knowledge object. It can be notably the study of these reports at some point of the history of a science or during its evolution, it is the object of the historic epistemology, or the study during the individual development, it is for example the genetic epistemology of Piaget. "

So, the epistemic sub-model is interested in the cognitive aspect linking the learner to its domain of study. We can describe this sub-model as a sub-set of the expert domain. It describes knowledge rate that learner has on every concept of his study domain through relations of level-headedness. There are three types of relations of level-headedness:

- The binary level-headedness, having for value '1' in the case that learner knows the concept in question and '0' otherwise.
- The discreet level-headedness based on the categories' statement such as novice, average and advanced.
- The continuous level-headedness, which value belongs to a very precise interval.

In our case we opt for the first type of level-headedness considered adequate, seen that we are going to decompose the lesson to a set of elementary activities of fine granularity and consequently, we shall not need the two other types.

In our proposed model of adaptive educational hypermedia, the epistemic sub-model operates as following: At the beginning of his learning, the learner has to answer a questionnaire which will clarify towards which generic epistemic profile he will be steered. There are three types of epistemic generic profiles; the profiles "Novice", "Average" and "Advanced". Every generic profile possesses a set of coefficients of level-headedness that we called objectives' coefficients. They indicate the elementary educational activities to be gone through during the learning process. Besides the objectives' coefficients, we set up the experiences' coefficients. These coefficients will indicate the elementary educational activities validated by the learner and will be updated as one goes along throughout his progress in the lesson. At the end of the learning process, the objectives' coefficients must be identical to those of the experiences.

4.2 Behavioral sub-model

Whereas the epistemic sub-model is characterized by a directed description domain, the behavioral sub-model is rather centered on a description of the learner profile. This description is completely independent from the domain model. Indeed, the purpose of this sub-model is to widen the adaptability dimension so that it extends over the other criteria which were not taken into account in the classic learners' models, such as the preferences in presentation and lesson structure, the learner cognitive capacities, etc.

The author in (Delestre, 2000) explained the choice of a lesson by a learner according to the following three main criteria:

- The lesson presentation: this criterion relates mainly to the visual and organizational preferences.
- The study subject: the study of certain subjects requires certain cognitive level on behalf of the student as well as more or less long duration of learning.
- The learning context: the way of learning varies from a context to another one, for example during a revision; the learner tends to concentrate on the study of the examiner documents.

To integrate these criteria within the learner model, the authors organized them in three categories namely: preferences, objectives and cognitive capacities of the learner.

4.2.1 Preferences

For this category concerning the visual and organizational preferences, the authors proposed the solution of pattern. A pattern describes the order in which lessons parts are scheduled in a specific order. Let us note that in order to not damage the educational aspect, the learner will not have the task to build its own pattern but he will choose one among a list, predefined by the teacher. To strengthen the visual adaptability in our model, we chose to give the learner the possibility to choose its own working environment (themes, colors, etc.).

4.2.2 Objectives

The purpose of this category is to adapt lesson to the learning context in order to bring more flexibility and efficiency in the learning. Indeed, for the same learner, lesson usage for the first time differs from that during a period of revision. For that, we define two learning modes: evolutionary and revision. In the first mode the learner goes through the totality of the lesson at all the stages corresponding to its profile, whereas in the second mode the lesson learning will be directed in its majority to revision exercises and some key theoretical notions defined by the teacher.

4.2.3 Cognitive capacities

This category is interested in the lesson adaptation to the learner cognitive capacities and this, by the definition of two types of coefficients:

- Forgetting coefficient: serves for determining the renunciation duration, at the end of which the learner should redo certain activities.
- Duration coefficient: serves for determining the duration needed by the learner to be able to finish an activity.

5 LEARNING SCENARIO

A lesson is a set of orderly chapters, from the beginning level at the advanced level. Every chapter consists of a set of ETU (described in the teaching document model) whose cognitive type can be "Lesson", "SW" or "PW". To begin his learning, the learner has to answer a questionnaire which will judge to which generic profile it belongs: “Novice”, “Average” or “Advanced”. Afterward and for every chapter, the learner has to go through all the activities (ETU) which are proposed to him. When he finished them, an activity having for cognitive type “Evaluation Test” will be proposed to him and according to the obtained note three possibilities will be presented:

- In the case of a good result, the learner will reach the following level.
- In the case of a less good result, the learner will be led to revise only the activities considered badly learnt and will rehearse again the evaluation.
- In the case of an inferior result, the learner will be led to revise the totality of the current chapter.

If the duration; separating the validation of the current level and the beginning of learning of the following level will exceed a certain interval T, the learnt notions are considered forgotten and the student has to rehearse the evaluation test.

6 MODEL APPLICATION

The framework of application is a project financed by the ‘Agence Universitaire de la Francophonie’. The various participating parts in this project are: the University of Technology of Compiegne in France, the University of Craiova in Romania, the National Institute of Computing of Algiers and the Institute of the High Commercial Studies of Carthage. The objective of this project is the development of an interactive support of lessons for the autonomous learning of algorithmic and C programming. To do it, one of the tools the actors used in this project is ‘NetUniversité’, an eLearning platform based on the standard IMS-LD and serving for lesson hosting.

6.1 Platform

NetUniversité (Giacomini, E. 2005) is an eLearning platform developed in 2005 in the University of Compiegne. The objective to develop such a platform is to supply to non-computer specialists’ designers of on line lesson, a way which facilitates their task. Indeed, NetUniversité allows to conceive and to administrate educational Web sites by taking into account different aspects; pedagogical, organizational and visual aspects. One of the key points of the platform NetUniversité is that it is based on the specifications IMS Learning Design. This factor has for consequence the following advantages:

- The usage of the level A of the IMS-LD in the representation of the static organization of the contents, guarantees a well structured description of the lesson on the one hand, and serves for promoting the exploitation of this lesson by facilitating the tasks of search and selection on the other hand.
- Thanks to the integration of the level B of the IMS-LD, NetUniversité allows to adapt the lesson with regard to the preferences and the profile of every learner.
- The lesson organization in the form of educational scenario allows interaction between the various actors (learners, teachers, tutors, etc.).

6.2 Static version

The current version of the lesson hosted in NetUniversité is static; our objective is to realize a dynamic adaptive version of this lesson. This version is organized as a set of scenarios where every scenario consists of a certain number of identical activities of learning for all the learners having access to this lesson. The learning scenarios are:

- "Theory": this scenario is formed by twelve activities' structures forming the various chapters. Every chapter contains various theoretical activities in texts, images and Multiple Choice Questions (MCQ).
- "List of the exercises ": this scenario contains learning activities presented under forms of exercises of various types (Problems with correct versions, MCQ, questions with unique choice, etc.). All these exercises are classified in activities' relative to the chapters of the scenario "Theory".
- "Pedagogical games": this scenario contains a set of pedagogical games which have for subject the algorithm learning and for objective to improve the playful aspect of the learning.
- "Simulation": this scenario contains a set of simulations under the shape of Java programs classified by chapter. The objective of these simulations is to facilitate the assimilation of certain concepts (iterations, conditions, arrays, etc.) thanks to a higher degree of interactivity.

According to the description of the lesson static version detailed before, we detected two inconvenient who can damage the good progress of the learner learning process. The first inconvenience is identified at the level of the lesson scenario, indeed we notice the separation of the scenarios "Theory" and " List of the exercises ", this separation has for consequence to decrease the linearity of the lesson route of the learner and to oblige him to move from a scenario to an other one to look for the exercises corresponding to the theoretical lesson. Besides the separation of the scenarios, we notice that the learner is absolutely free to navigate between the various educational activities; it seems to us better to oblige him to follow a specific sequence of tasks in its learning. So we decrease the risk of neglecting important notions in the lesson further to a lack of motivation noticed in the learner. The second identified inconvenience concerns the absence of any type adaptability, indeed all the learners having the access to this lesson, have access to the same learning activities without taking into account cognitive differences which exist between them.

6.3 New lesson scenarisation

We chose to replace the various separated scenarios by only one. So the lesson will have the following structure:

- A set of activities' structures representing the various chapters.
- Every chapter consists of a structure of activity entitled "lesson" grouping together all the theoretical learning activities.
- Another structure of activity entitled "SW" grouping together exercises relative to the proposed theoretical notions.
- A learning activity entitled "Evaluation test" which objective is to decide if the learner is capable to pass to the following chapter or not.

Let us note, also, that the learner will have access to specified chapter activities only if he crossed successfully the evaluation test of the previous chapter.

6.4 Adaptive aspects

The adaptive aspects amount in three principal points, namely: (1) the creation of three generic profiles (Novice, average and advanced), (2) The use of the level B properties of the IMS-LD and (3) the use of the conditions to associate every profile to all the learning activities which correspond to him. Below, we describe each of these three aspects.

- Generic profiles: Before beginning his learning, the learner has to choose a generic profile among three, relative to three different levels of difficulty.
- Properties use: The level B properties of the IMS-LD are used to protect the data concerning the level of difficulty of the learner, and marks obtained in the various tests made by him.
- Conditions use: The level B conditions of the IMS-LD are used to start the following actions:
  - Show or mask the learning activities on the base of the level of difficulty associated with every learner as well as its validation of the previous chapter.
  - End evaluation tests by determining if the obtained mark is sufficient or not.

7 CONCLUSION

Our initial objective was to conceive a dynamic adaptive educational hypermedia model insuring a better adaptability of the contents with regard to the profile of a learner. The obtained results show well the following contributions:

- A better adaptability thanks to a well structured organization of the teaching document and the detailed description of the learner, by taking into account both aspects: cognitive and behavioral.
- Thanks to the proposition of a standard learning course, clarifying the rules of passage from a level to the other one and the way with which the learner has to go through the various activities of its lesson, the proposed model is capable of allying adaptive and educational aspects.
- The appeal to normalization through the standard IMS-LD allowed a better representation of the lesson besides the possibilities that it offers to improve the search and the accessibility to the information.
- The application of the model within the framework of a platform of eLearning, namely NetUniversité, allowed us to identify the limits of this platform in terms of adaptability to be able to envisage solutions and in terms of features to be added to avoid certain failures.

This work opens obviously perspectives which main objective is to improve the adaptive aspect within the educational hypermedia. Indeed, the behavior of the learner taken into account in our model through the behavioral sub-model can be studied more in detail to have a system hypermedia capable of learning customs and behavior of the learner. Thanks to such an automatic learning it would be possible to improve the adaptability of the visual, navigational and cognitive aspects.
Besides, it seems to us beneficial to work the improvement of the adaptive aspect within the platform NetUniversité by improving the description of the learner profile thanks to a standard structure of the model of the learner on the one hand, and of a better interaction between the model of educational documents and the model of the learner on the other hand.
A last perspective, which we propose, concerns the improvement of the accessibility to the various learning units by endowing the adaptive educational hypermedia model proposed by a search engine and to refine the search for these units by having appeal to techniques based on metadata and the ontology.

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