TOWARDS AN ADAPTATIVE AND COOPERATIVE TELE-LEARNING

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Abstract *¾ The aim of this paper is to show that Adaptativity and Cooperation should be the main characteristics of tele-learning systems. Adaptativity is the best way to take more benefit of asynchronous tele-learning because each learner has a profile different from the others and needs to get his course at his own rate and according to his abilities and objectives. Cooperation is necessary to include pedagogical rules and assistance in the training. The SMART Learning System shows that these characteristics could be included smartly in a distance training system and often can be integrated in the course itself. It also shows that these characteristics can remain even on the web learning unlike most existing systems. Its implementation has been made possible by the usage of XML and associated tools.*

Index Terms ¾ Tele-learning, Adaptative learning, cooperative learning, SMART Learning.

INTRODUCTION

In order to benefit more from the advantages of asynchronous tele-learning, we propose an approach directed towards the adaptability of the course to the learner. Indeed, each learner has a profile different from the others and aspires to reach a course which meets his needs and fits his abilities, in such way that the learner takes the course at his own rate [1][2]. We also propose, within our system, a means which allows to control the pedagogical progression of the learner within the course contrary to the majority of the courses met on the Internet, cooperation between learners and teachers is considered very important. All these tools will be available on the Internet because of its huge usage.

Generally, courses that are available on the Internet are hypertext documents. The structure of the hypertext and the reading modes it leads to are opposed to some *educational principles*. A learner can access any pedagogical sequence of a course without order constraints of these sequences and without having the preliminary knowledge. Consequently, the teaching objectives (specialty, type of training...) aimed by the access to the course will not be reached. In our view and to ensure a *pedagogical learning*, the course must take account of the learner profile (capacities of training, previous knowledge, native language...) and the learner evolution (prerequisite, speed of knowledge acquisition...).

We try to resolve these problems in the SMART-Learning [3] system (System for Multimedia Adaptative and coopeRative Telelearning) project which is in progress at the RIM (Computer Networks and Multimedia) training and research unit at the Ecole Mohammadia d'Ingénieurs. The objective of this project is to develop a virtual university for a telelearning which proposes adequate methods of training to meet the needs of the learners without neglecting the educational principles. The system is intended for university students as well as companies staff as part of their continuing training.

This project provides courses to distant learners without any space or time constraint, including the possibility of having synchronous sessions (real time) for the conversation between the various actors intervening in the process of learning (learners, trainers...). Learners and tutors can also cooperate on the course document basis within a virtual class. This allows the learner to be followed during all his pedagogical progress insuring respect of pedagogical rules.

The power of SMART Learning lies in the adaptative capacity of the courses according to the profile of learners, in the capacity of cooperating even through the document, and the use of widely available tools based on Internet, as XML. Adaptativity an cooperation are the main topics of this paper.

ADAPTATIVITY

In most tele-learning systems, the learner actually accesses to the course without any space nor time constraints. However, the pedagogical content which is presented to him is the same that the one presented to the other learners. Then, the learner must cram into his head informations which can seem obvious to him or not understandable, conversely. Moreover, he is obliged to get medias (text, video or sound) from the network that are not of good quality because of an inappropriate rate of the network access. SMART-Learning offers solutions to adapt the pedagogical content to the learner with an acceptable quality of network. It offers two levels of adaptativity :

- Course adaptativity is the ability to adapt the course to the learner abilities and to the learning objectives ;
- Environment Adaptativity is the ability of downloading the courses medias according to the quality of service provided by the network connection of the learner.

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Courses Adaptativity

The success of a training fundamentally relies on the knowledge brought by the teacher to the learner through the course. Thus, a course which is well adapted to the training needs and objectives to each learner will be a decisive contribution in the training quality [4] [5].

Generally, the ITS (Intelligent Tutorial System) which are interested in the adaptability of the learning material are based on static techniques of generation [6], suggested by the author and chosen by the learner once for all without taking account of the feedback of the learner with the system during the process of training. It would be thus desirable to develop an open or generic system which allows a *dynamic adaptability*.

Our approach makes a significant advance compared to the typical approach, which provides courses as hypertext documents [7]. In the typical approach a learner can access any element of a course without order constraints on these elements and without having the necessary knowledge. Consequently, the teaching objectives (specialty, type of training...) aimed by the access to the course will not be reached. In our view and to ensure a pedagogical learning, the course must take account of the learner profile (capacities of training, previous knowledge, language ...) and the learners evolution (prerequisite, speed...).

This approach makes it possible to generate an individual course for each learner based on his profile and a generic course (cf. Pedagogical process). If, for example, the profile of a learner is modified following the result of an evaluation, the course will be automatically regenerated so as to consider the new knowledge obtained by the learner.

Computer Environment Adaptativity

Once the personalized course generated, its content is presented to the learner on the web. This content includes a set of media (text, audio, video, ...) which should be synchronized and presented to the learner.

These media could be bulky and need an important speed. The present Internet characteristics do not allow a sufficient Quality of Service for all connected learner. Indeed, and mostly in southern countries, Internet Quality if Service depends a lot upon the time of access and the place from where the connection is made.

Providing a poor quality to the learners inevitably leads to a breakdown of the used tele-learning. In order to fulfill this problem, SMART-Learning also offers, in addition to a adapted course to the learner according to his capabilities and pedagogical objectives, a course which is adapted to his computer environment and mainly the available network speed.

The speed or throughput is the parameter which influences the most the quality of the presented media and the needed time of downloading. Thus, it is important to define the way which should use the learner to access to his course to avoid a systematic and long wait for media downloading. In this context, in order to allow a better presentation in a short time, SMART Learning provides to the learner different ways of downloading medias according to his Internet characteristics and quality of service.

These accesses modes act on how to download bulk medias which generate a lot of traffic on the Internet and slow down the transfers. The learner gets the voluminous media in advance during low hours or through a CD-ROM. These media are then stored on the learner computer as independent objects.

The learner access to the Internet will only need the transfer of light courses element which correspond to the course structure, the learner profile or data related to the progress in the course.

This adaptativity is made realizable thanks to the internal structure of the course which meets the GCM (Generic Course Model) [3] defined in the SMART Learning system.

COOPERATION

Usually, in Web Training, the learner is left alone with the hypermedia document. Cooperation, in the sens of tutoring, interactions and communication, is fundamental in order to make the training more consistent and efficient. In Smart Learning, all the design is done in order to satisfy pedagogical and educational objectives and constraints, 2 levels of cooperation are provided :

- Cooperation, communication between learners and teachers ;
- Cooperation through the course document.

Learner and teacher Cooperation

In most tele-learning systems the learner has the ability to communicate with a teacher. This communication is necessary to insure the tutoring of the learner. The learner can ask questions and have answers to his lack of understanding or complementary information. This communication is mainly asynchronous and based on the electronic mail. It could also be synchronous with the help of the chat or the visio-conference. This communication between the learner and his tutor is necessary but insufficient in order to get a better training quality.

On a pedagogical point of view, this communication should be compared with the communication exchanged within an habitual classroom. In this latter, every learner is aware of all the questions asked by the other learners and their answers. This could also suggest other questions and make a strong interactivity which allows a better understanding and training.

SMART-Learning simulates this cooperation with the help of the virtual classroom notion. Learners who follow the same course are registrated in several classes of limited number of students. The learner can then communicate with the teacher but also with other learners of the classroom. The

communication can be peer to peer or with all the classroom according to the object.

This communication can also constitute a feedback for the author who can reconsider his course according to questions and remarks made during this exchange.

Cooperative Courses

The courses which are generally spread on the Internet are simple hypertext documents. The permissive structure of the hypertext and the reading methods this structure leads to are contrary with some pedagogical principles. A learner can access the various parts of a course without taking into account his aptitudes and the order that is necessary to follow between the parts. Consequently, the pedagogical objectives (specialty, training type…) pursued by the access to this course will not be achieved.

Moreover, existing systems do not take into account the different interactions between the learner and the course. These interactions could lead to a more appropriate and different route within the course than the one which was decided at the beginning.

In order to fit this need, SMART Learning defines a cooperation based at the course document. Then learner will be able to access a given part of the course only if he has understood the required other parts. For example a test can be inserted after a part to decide if the learner can go on in the course or has to make the part again. This control is made all along the course, the course is the said cooperative. The teacher can also put some other pedagogical rules as synchronization points or homework to be done.

These sequencing rules which make the course cooperative are defined in the GCM (Generic Course Model) within the SMART-Learning System [3]. Some aspects will be developed in the "pedagogical graph" section.

PEDAGOGICAL PROCESS

The ITS (Intelligent Tutorial System) which are interested in the adaptability of the learning material are based on static techniques of generation [6]. The course is suggested by the author and chosen by the learner once and for all without taking account of the feedback of the learner during the learner process and the wide range of learner profiles. So, it would be thus desirable to develop an open or generic system which allows a *dynamic adaptability*.

Our approach is based on the production of a **generic course**. It is characterized by its use of intelligent hypertexts [9], that is to say, popularized and simple use methods.

The generic course is intended for all profiles. It is a document which contains, in addition to the learning material, the pedagogical expertise of the teacher. A generic course must take into account of the various objectives pursued by the course and the various types of the learners profiles who will have access to the course. It is necessary to take into consideration all the details, including the optional parts of the course. In the traditional teaching, the teacher is present at the time of the training and can add missing information or make a not initially considered reminder, whereas in a tele-learning application, if the contents of the reminder are not initially considered, teaching will be then defective.

This approach makes it possible to generate for each learner based on his profile a specific course by using a system of generation (figure 1). If, for example, the learner's profile is modified following the result of an evaluation, the course will be automatically regenerated so as to consider the new knowledge obtained by the learner.

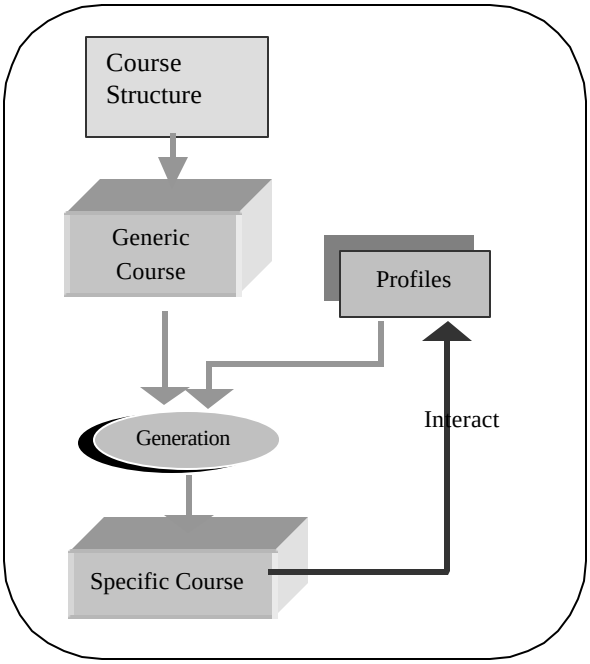

FIGURE 1 : FUNCTIONA L MODEL

Learner Profile

The learner's profile is a key element in the SMART-Learning education process as it intervenes on all the learning process levels. It is represented by a some information which characterize one learner in this process [10]. In SMART-Learning, the profile consists of two types of information:

- General information: This information is generally static or changes little during the process of training. It is particularly made up of the identification, of the learner teaching language[s], the computer environment (network speed,…), the objectives to be reached (diploma, degree of knowledge), the training level to be reached (engineer, technician, manager,…) the field of knowledge which it wishes to reach in the field of (computer sciences, networks, telecom, management…).
- Contextual information: This information is dynamic. It changes with the evolution of the learner in the process of learning as well as with a better knowledge

of the learner by the system. It corresponds, for example, to the learner's training level so as to control his progression. The results of examinations and other tests feed the profile continuously. They allow, with the reaction speed of the learner, to better know his psychological level and factors taking into account the teaching contents to be preserved to him and in the duration with which it is adequate to present it.

For the same training objectives, the learner will have his own course corresponding to his language, his learning speed or his capacity. This method makes it possible to obtain a targeted teaching and better adapted. It will then be more interesting than a traditional course and more pedagogical than a gross document hypertext.

Further, we can say, that at every moment, the profile reflects a reliable and complete intellectual image of the learner and keeps tracks of his progress, so that the next access will take account of the real profile and provide adequate knowledge of the learning.

Generic Course Structure

A generic course is a document which contains, in addition, to the learning resources, the pedagogical expertise of the teacher. A generic course must take into account of the access conditions to each element of the course according to the various objectives pursued by the course and the various types of learners profiles who will have access to the course [11].

The generic course covers a complex reality involving the learning resource and the pedagogical methods of teaching. If the courses are to fill these functionalities, we think that it is necessary to model the generic courses. A double reasons results from this:

- To help the author to easily conceive his course based on this model;
- To take account of the various educational constraints which are defined in the model.

Then the generic course must be sufficiently flexible to fit to a large variety of learners in order to adequately meet the needs for training according to educational objectives. Any production of a course is based on an educational design which is used to structure the contents in order to facilitate the learning [12].

The principal criteria to be respected are the following :

- To stratify information in order to take account of the complexity levels and to adjust it with the preliminary knowledge of the learner
- To structure the presentation in learning units in order to facilitate the selection, the organization and the integration of information
- To produce the course in several languages in order to improve its deployment for the larger number of possible learners
- To consider the use of various media (text, audio, video...) which encourages the learner to carry out a tele-learning course
- To consider the presence of optional activities (illustrations, reminders,...)
- To provide indications and means of self-evaluation allowing the learner to know the progress state of his understanding.

To satisfy these criteria, we propose a standardized course structure as a group of structured pedagogical sequences in the form of tree structure with a single root. A Pedagogical Sequence (PS) can represent a course, a chapter or even a slide according to the way of structuring of the author and according to the used educational system. This structure makes our system independent from any specific educational terminology and way of structuri educational material. A simplified example of our structure is schematized in the figure-2- This structure also fit standardization LOM of LTSC.

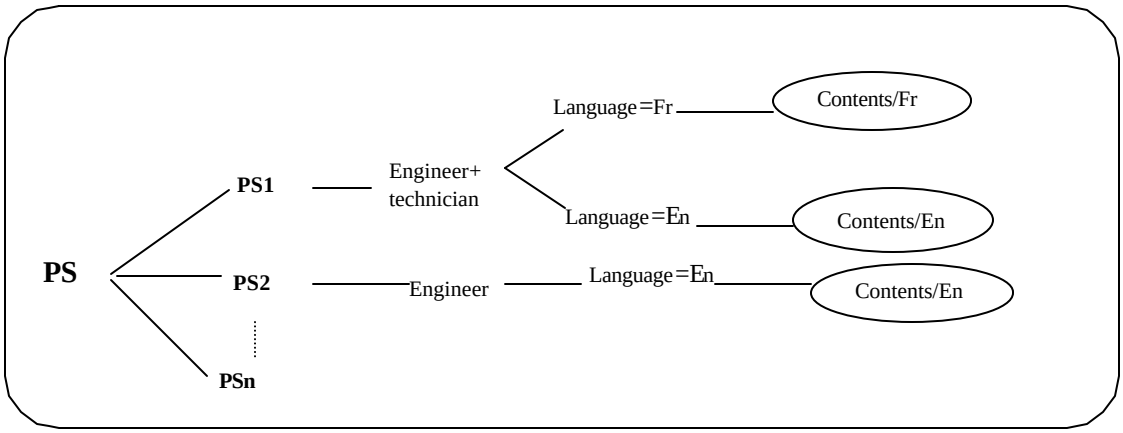

FIGURE 2 : EXAMPLE OF GENERIC COURSE STRUCTURE

For example, within figure 2, the SP1 content will be presented to the learners following technical or engineer training according to their spoken language choose between English or French. But SP2 is reserved to engineers learners who understand English.

Pedagogical Graph

Once the course was generated for a specific learner, this one starts with the first pedagogical sequence of the course. At the end of a sequence, an interaction of the learner, an evaluation for example, can happen in order to test acquired knowledge. According to the results of the test, the learner will be authorized to pass to the following pedagogical sequence or will have to remake the same sequence, if necessary with a modified profile taking account of its re-examined abilities. Passing from a sequence to another can also be conditioned with an event coming from the teacher. These interactions and events or conditions correspond to a direct or indirect cooperation through the course between the teacher and the learners.

Thus, the passage from a pedagogical sequence to another is not carried out in a random or automatic way but according to precise pedagogical rules. These pedagogical rules are translated by relations between the pedagogical sequences and it is the course author task to clearly define these transitions in the form of a pedagogical progression graph or network (cf figure 3) . In fact, the progression in the course is based on a set of transitions between the different pedagogical sequences of the course, in a progressive way until the last sequence of the course is reached.

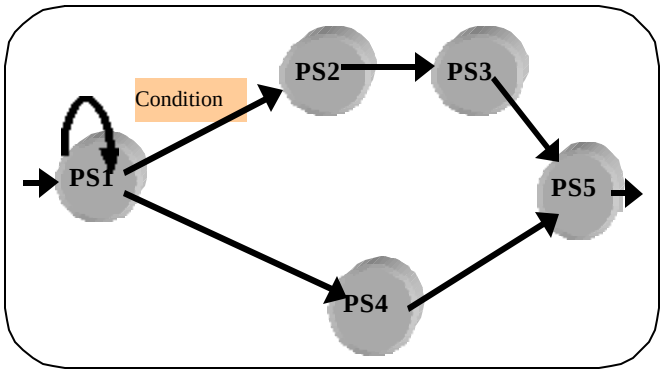

FIGURE-3: EXAMPLE OF A PEDAGOGICAL PROGRESSION GRAPH

The pedagogical progression graph represents all the pedagogical rules [3][13]. It controls the succession of the various pedagogical sequences of the course in order to achieve a pedagogical goal (succession, choice…).

In the example of figure 3, at the end of the Pedagogical Sequence n°1, the learner must meet the condition (a test for example). In this case, he will be able to pass to the pedagogical sequence which could be PS2 or PS4, these last being independent. The learner won't be able however to reach PS5 unless he has done sequences PS2 and PS3 in the order and also PS4.

In case of the condition PS1 is not met, the learner will have to remake PS1 with a consequently modified profile leading, for example, to different visit duration of PS1.

DEPLOYMENT

It is now a question of finding a means allowing to describe a generic course with its content part and its presentation conditions part.

Moreover, make our system accessible to a large users require the choice of means and tools, which are available and know by great number of users. In our view, to provide courses to learners anywhere in the world, the use of Internet, is impossible to circumvent. Indeed, the number of users of Internet increases continuously.

The XML language [eXtended Markup Language] [14], famous for its easiness to exchange complex documents on Internet, was selected to structure the courses. We could use XML in a simple way in order to solve the adaptability problem in its realization phase. We thus defined an approach based on tools of the XML family (DTD, XSL, DOM…).

As the course is produced once and the system generates several specific versions, the functional model consists of two main components:

- one for the course production (generic course and pedagogical progression graph)
- and the other for the learning process (specific course with profile modification).

The respect of the courses structure is easily carried out with a DTD document (Document type definition). In order to structure the course, the DTD imposes different construction elements as well as the links between these elements. The use of the DTD ensures the coherence of the course structure.

An XML document allows the description of the course contents without worrying about the presentation problems. The presentation form is described independently by the stylesheets. We thus separate the pedagogical material and the form in two distinct documents. This makes it possible to easily modify the presentation form of a course. The description language which deals with the adaptability problem and which allows to express the pedagogical selection conditions of the course sequences is XSL (eXtensible Stylesheet Language) thanks to its abilities of transformation and conditional presentation [15] [16].

Thus, any profile modification of a learner will lead to a modification of the corresponding XSL document and the presentation conditions to present to the learner the course contents corresponding to his new profile.

The course adaptability is thus solved in a simple way while respecting the pedagogical constraints and remaining in conformity with the presentation rules on the Web.

CONCLUSION

The realization of a prototype enabled us to confirm the relevance of our conceptual choices, the simplicity and the performances of the selected method to implement multimedia adaptative courses for various learner profiles by using generic courses based on hypertext documents.

This prototype of our system was carried out and tested at our research unit with a great success and satisfaction. Furthermore, we underline the use of XML/XSL to provide adaptable courses on the Internet has several advantages. We will mention his simplicity, the transfer of the structure of the individual course from the course server to the learners, allows to upload only the elements of the learner is in need, also one can anticipate the transfer of the course elements which will be used later. Another advantage lies in the fact that our application requires only one light processing to adapt the course to one learner.

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