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New Approach to Optimize using Intelligent Tutoring System in Repositories of E-Learning Resources

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***Abstract*— This paper examines the principles for creating intelligent tutoring systems, which are active in dynamically growing repositories of e-learning contents. Paper present an approach to Intelligent Tutoring Systems which adaptively personalizes sequences of learning activities to maximize skills acquired by each student, taking into account limited time and motivational resources. At a given point in time, the system tries to propose to the student the activity which makes him progress best. To make such a system work it is necessary to give the contents appropriate structure to enable it to be used in numerous educational contexts. The architecture of intelligent tutoring system is based on ontology with expert knowledge, which has been used for repository resource indexing, and which is a basic component of domain model.**

Keywords—Intelligent tutoring system; E-learning; Repositories; E-learning Resources.

I. INTRODUCTION

The number of people using the web is increasing every year. Also, the bandwidth and speed increase. The web use has become complete in all our surroundings. This web communication and the control capacity have become important for the needs of the 21th century and makes success available to everyone.

The technology has changed the world outside the educational Institutions and now education and teaching within schools and universities. Each teacher and each student has a laptop to use at school and at home. The laptop is used every day as a personal learning and teaching aid for many educational tasks. In the electronic learning, the student gets a big chance of education through the laptop, the internet connection and the use of the educational environment. An important thing in the electronic education is the laptop to be used at any time and everywhere. This facilitates education. It differs from the PCs that connect to a certain place. The computer is integral with the curricula. It is the education tool, not the target. The education is co-operative and communicative as students can work with their classmates, teachers and experts in the society. Educationalists can follow their opinions with students' parents.

Many approaches have evaluated the electronic education and concluded the effective electronic education has promising results. The researches declared that the rich technological educational environment can be more positive. When reviewing researches, the results of the electronic education can be divided into five categories: the students learning, teaching and the tool, the family and home, the meeting and society and the economic development.

The approaches concluded that the electronic education help the relation between the student and his\her study and his\her school presence- which are the main requirements of education. It can also improve the performance of the studied curricula. It can develop the 21th skills in both developed and developing countries.

A growing number of educational resources created in response to the demands of e-learning opens new possibilities for creation of educational solutions adapted to suit learners' needs. A dynamic growth of materials results from the fact that they can be created independently by didacticians working with authoring tools. Materials created for one particular training program can be used in different educational contexts in total or in part [6]. When the materials have a structure that supports reusability it is possible to select from among available components those that fully meet the requirements of learners) at the same time realizing pre-set didactic objectives. Contents adjustment can be done 'manually' by the didactician who, after identifying needs, provides the learner with relevant content retrieved from the repository. For massive repositories, however, it is necessary to dispose of solutions that will automatically adjust contents to identified needs, without teacher's intervention.

The American Mayn state applied the electronic education 1:1 in schools. The study includedd more than 42000 students and 5000 schools. The survey study concluded that more than 80% of educationalists agreed that students became more interested, interactive and creative. Both school managers and teachers registered their opinions that the electronic education increased the intentions of students to learn, classroom participations and good behaviors. In an electronic learning program 1:1 in 10 secondary schools in Malysia, 85% of teachers declared that the program enabled them to create an educational environment that was modern and co-operative. In the USA Mitchell Institute, the electronic learning environment raised the presence of students from 91% to 98%. To get more detailed data, see www.K12bluePrint.com.

Through technology, teachers can use tools to evaluate students and to get an immediate feedback of students' progress as individuals or as a classroom. Teachers can develop subject materials or use present websites teaching resources to teach high quality curricula.

In the teacher-based education system, the student relies on the teacher as as source of information, direction and guidance, but in the student-based education system , the students become independent and self-reliable gradually. They guide themselves and practise high creative thinking of solving problems and co-operative skills. They teach themselves rapidly. They can review school subjects to reinforce learning or seek for extra ones to enrich their information. The Information and Communication Technology facilitates this kind of education.

Currently existing e-learning solutions are created with technical specifications that guarantee interoperability of didactic content between e-learning platforms (Learning Management System; LMS). The fundamental assumption in this approach is that contents developed by authors are organized in packages (courses, presentations) that exhaustively discuss a subject and are delivered to the learner as a whole. The most common specification is Sharable Content Object Reference Model (SCORM) [10], which permits to create e-learning contents mainly in a web-based environment. A newer specification, Tin Can, permits to manage content created also for mobile devices. A part of SCORM specification, which is Content Aggregation Model (CAM) describes the components used in a learning experience, content organization, content packaging, and metadata facilitating storage and exchange. Another part, namely Run-Time Environement (RTE) specifies content launch process in LMS, standardized communication between content and LMS and data model elements for tracking a learner's experience with the content objects. SCORM 2004 is the most technologically advanced version of SCORM, which introduces additionally Sequencing and Navigation (SN) mechanisms designed to create educational materials that adapt to learner's needs. SN introduces sequencing concepts (e.g Activity Trees that represent hierarchical learning activities derived from a content package) and sequencing definition model (control modes, limit conditions and sequencing rules description) that may be used by content developers to define intended sequencing algorithm and behavior within the context of an Activity Tree. A dynamic run-time data model (Tracking model) that capture information gathered from learner's interaction with the content objects associated with activities, is also defined. As SCORM SN is deemed complex and difficult by those authors who refuse to get involved with the technological intricacies or to create self-adapting contents, and because of emergence of technological changes, a new specification – Tin Can – aims by contrast to simplify the architecture of the entire solution. Therefore, in light of popularity of SCORMand very good documentation, SCORM SN still remains a tool that in the hands of specialists may be used to build complex educational strategies outside IT systems. Thus, solutions in which such strategies are embedded right in ITS as compiled code can be left behind.

An interesting feature of SCORM 2004 is that in itself it can be treated as ITS [9,3]. In this particular approach SCORM CAM as well as SCORM SN both play the role of pedagogical model. Student model may be expressed via Tracking Model and SCORM RTE Data model. In this approach, it is assumed that Expert model may be embedded with leaf activities of CAM. Operation of ITS so conceived is always based on the contents collected in content package. Studies on ITS in e-learning environment focused on determination of system architecture of this type [4,1]. In [1] a solution was adapted, in which the entire architecture was based on Learning Objects generated by the system from available resources. In this system emphasis was laid on domain knowledge management as expressed by ontologies independent of the system. In [4] a solution was presented where ITS is implemented directly onto Learning Object and may be SCORM transferable between LMS systems. However, there are no solutions in which ITS would work on e-learning content repositories that increase dynamically and on which contents are recorded in a specification supporting interoperability.

II. THE COPMONENTS AND WORK OF ITS

The ITS starts by evaluating what the students can really do (the student Model) Then, what the student needs to learn (the domain expert) Next, the study element (the study unit) that must be transferred to and the best ways to present it (the trainer or the educational Strategy of the System) After that, creating and solving a problem (by the domain expert) or recalling a programmed solution and comparing it to the student's and evaluate his\her level on account of the agreement (or disagreement) between the two solutions. The system comments depend on the relation between the student and the teacher (e.g when was the last interaction between them? Did the student get any advice?) Thus, the student's level increases or decreases. The updating activities modify the shape and form of the student's model. The whole recycle is repeated to start or create a new solution.

Not all intelligent systems contain these components. It doesn't adequately represent (a problem- a test – a comment) all the systems. However, this qualitative description doesn't apply a lot of present systems. The designer has executive alternatives that reflect the difference in concepts and the practical reality.

The presented architecture determines the principles of expanding LMS architecture in such a way that it plays the role of ITS on the contents of the entire repository. The solution is based on e-learning content organized with a specification such as SCORM. The entire solution realizes a traditional architecture of ITS system [2], where components such as Domain model, Pedagogical model and Student model are used to make decisions about subsequent instructional steps. The interface of components of the e-learning contents collected in the repository is acknowledged as tutoring system interface. The system architecture makes it possible to conduct tutoring independently by the system (automatic mode) and to support the didactician by suggesting the content (hand-made recommendation) that is the most relevant at any given stage of instruction (semiautomatic mode). The architecture of the system is presented in Fig. 1. The system works on content collected in a repository that may be supplemented with e-learning content, e.g. in SCORM. The technical structure of content in repository is compatible with SCORM CAM content organization, i.e. information about content hierarchy, metadata and sequencing behavior is stored. Any number of learning components of SCO or Assets type may be linked to the organization. In the process of content creation content designer (author) defines the location of content on taxonomic path (by ascribing UCTS interpretations), i.e. determines which content may be reused many times. In indexing process subject matter of content is determined by ascribing lexical units from wordnet based ontologies that make up domain model. Lexical units used for indexing make up index of tags.

The system is responsible for sequencing learning components based on the results of a learner's interactions with the launched content components. This is carried out by using tracking model which captures learner's interactions with the content components associated with activities from the Activity Tree. Activity Tree is derived from the Content Organization of e-learning course carried by the student. Sequencing is carried out in accordance with the premises of currently realized pedagogical strategy. Pedagogical strategies are mapped onto Activity Tree either from sequencing behavior recorded by content designer in content organization or directly onto the system. In the latter case when creating pedagogical strategies a reference maybe made to a set of pedagogical patterns built in accordance with SCORM sequencing definition model.

The measuring entry of the student architecture includes acting the new knowledge and skills. The computer interacts with the updating observations in a modifying curriclua in all its details, so we find education depends much on the history of the person's responses.

There is an alternative entry that includes the evaluation of acquired knowledge and skills whether instead of or in addition to the new ones. This alternative enables the system to modify the curriclua due to the performance of the student (whether the temporary performance or the whole performance or both of them) According to the nature of the computer reaction on this performance in other systems , the trainer or the teacher may not be there. For example the strength of small frames (the exploration environments) lie in the presence of imitating models and applying interfaces that give liberity to the student to manage his\her experiences and to realize safe and rapid results. This privildge has a special importance in dangerous or rarely occurred domains. Moreover, these systems can greatly reinforce the student by creating difficulties that make students attentive to continue the exploration and by giving them chance to achieve success to avoid any frustrations.

As ITS works on the resources of the entire repository and not just on contents of one content package, both pedagogical strategy implemented using sequencing rules in SCORM CAM content structure, and rules implemented on ITS agent are treated as pedagogical model. ITS agent is a software agent, which subject to the realized strategy, can exert diverse influence on learning components delivery. Pedagogical strategy may refer to Student Model that is stored in LMS as independent data structures (Learner data). This approach makes it possible to manage learner's competence without any limitations, e.g. it is possible to use solutions dedicated to student model management, e.g. such as IMS ePortfolio [5]. The fact that ITS by deciding about consecutive instructional steps goes beyond learning components placed by author in an e-learning course content structure means that the system is responsible for decisions about which sections of materials are the most relevant for a given user at a given stage in the learning process. In making this decision (retrieving module) the following content characteristics must be taken into account: its level of difficulty, target group, duration of course, etc. Such characteristic may be expressed by means of metadata system as for example IEEE Learning Object Metadata (LOM) [10]. Usually to describe various types of learning components vocabulary tokens defined for a given metadata element are sufficient (e.g. to describe Resource Type tokens such as exercise, simulation, questionnaire, etc. can be used). However, in order to define the location of content on the taxonomic path in a specific classification system or to define subject matter it is necessary to refer to a more complex description system.

The style of presenting the teaching content varies in the environment and the way of transferring and browsing. The student can transfer between the pages and the subjects of the content sequentially by branched transferring through the branched text. The student transfer from one subject to another that is related to the subject or the page that student is reading.

The student can transfer between these contents where the environment senses him; when he has entered a subject till he finishes, meaning how long did student take to browse?

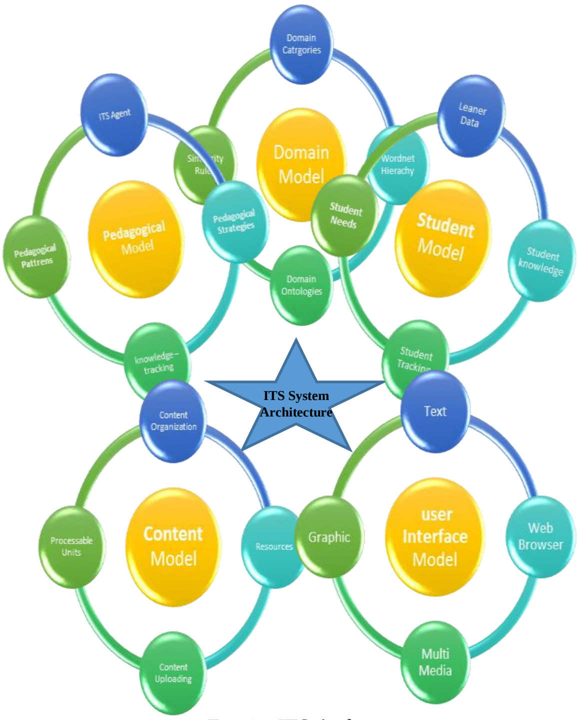

Fig. 1. ITS Architecture.

A. Domain Model

A domain model comprises a set of domain ontologies, wordnet based ontology and index of tags. Domain ontologies are to conceptualize a pre-determined domain or sub-domain. This type of ontologies is mapped on wordnet based ontology used in ITS. The mapping is carried out in accordance with the algorithm described in [7]. It consists in mapping concepts from ontologies onto synsets, linking them to Domain Categories that were created in accordance with taxonomic structure of ontology and creating the relations between concepts by means of domain relations from wordnet based ontology. Mapping domain models on wordnet-like structure makes it possible to incorporate expert knowledge into ontological system.

Wordnet based ontology is used in pedagogical strategy in the process of constructing queries for the repository. Such queries (Search Conditions) consist of similar concept calculated on the basis of Concept Similarity Rules. The rules are of heuristic character and let determine similarity criteria between concepts e.g. referring to wordnet hierarchy or domain relations between concepts [8].

B. Pedagogical model

A pedagogical model consists of Pedagogical strategies, Pedagogical Patterns and ITS Agent. Pedagogical strategy defines how consecutive learning steps are realized by learner. Pedagogical Strategy is implemented by the use of SN sequencing rules. Thanks to this solution it is possible to determine its structure and principles of delivering individual learning components to learners in relation to their progress. The use of SN enables expression of very advanced educational strategies that are being realized. In order to provide learner with learning components retrieved from repository and not only inserted by content designer into content organization SCORM SN was extended. This extension consists in adding a new sequencing control mode (Extension point) devised to point out those learning components in which reference is to be made to repository to find new learning components. Pedagogical strategy may be imported along with content (as package in SCORM 2004) or it may be created in the system based on Pedagogical Patterns.

Pedagogical Patterns is a set of predefined rules which, after mapping onto a given content structure, constitute Pedagogical Strategy. Technically, they are schemes that show how to use SN rules so that a defined system behaviour is achieved in the process of deciding about further instructional steps. Pedagogical Patterns create a catalogue of system behaviours so that Pedagogical Strategies can be created by content designer. Beside reference to the tracking model, which describes possible behaviours of contents included in the content structure by the author at the moment of its creation, Pedagogical Patterns may also refer to Agent ITS so that they suggest repository content to the learner. Typical pedagogical patterns include for instance Case Study Inclusion Strategy Pattern, which enables retrieval from repository of case studies which complement given theoretical material, or Similar Content Strategy Pattern, which is responsible for searching repository for the most adequate content in response to an identified competence gap. The last rule (pseudocode) may look like this:*If a competence gap has been detected for the topic described by the concept X, then insert after the current item the item retrieved from the repository that meets the Search Conditions.*

C. Content model

Defining the location of content on taxonomic path determines the structure of contents stored in a repository. This has an impact on how content will be delivered to learner. The task for ITS is to deliver contents in response to identified needs. A question then arises about how large portions of material should be delivered to the learner. It is obvious that the same topic can be exhaustively discussed in a monograph or more perfunctorily in a brief, demonstrative chapter. The difference between such materials does not only result from the method of presenting the material but also from the location of a given component in the context of other components. In the presented architecture the content is described with Universal Curricular Taxonomy System. This ensures uniformity of materials in a repository as it has been supplied by various authors over a long period of time.

D. Student Model

The student model is emphasizes cognitive and affective states of the student in relation to their evolution as the learning process advances. As the student works step-by-step through their problem solving process, the system engages itself in model tracing process. Anytime there is any deviation from the predefined model, the system flags it as an error.

The student module forms a framework for identifying a student's current state of understanding of the subject domain. The knowledge that describes the student's current state of mind is stored in a student model. Greer (1997) suggests that in order to make any learning environment adaptable to individual learners it is essential to implement a student model within the system. The student module should permit the system to store relevant knowledge about the student and to use this stored knowledge to adapt the instructional content of the system to the student's needs. In order to identify a student's needs a number of student modelling architectures have been devised. Student diagnosis is the process to evolving the student model. In order to evolve the student model interactions between the student and the Intelligent Tutoring System need to be analyzed [11].

E. User Interface Model

This is the interacting front-end of the ITS. It integrates all types of information needed to interact with learner, through graphics, text, multi-media, key-board, mouse-driven menus, etc. Prime factors for user-acceptance are user-friendliness and presentation.

Finally, the new ITS makes use of domain knowledge and teaching model to design a teaching process based its cognition or knowledge about the use of intelligent e-learning. A student state used to record information about the student vital for the system's student-adapted operation. It includes personal data that concerns information that for the identification of the student. Knowledge level such as novice, beginner, intermediate, advanced, etc. of the sub-domains and the whole domain. Interaction records which record the interaction of a student with a system. User characteristics and knowledge levels directly affect the teaching process whereas most of the interaction information indirectly.

III. CONCLUSION

In the article intelligent tutoring systems and e-learning contents respositories must be evaluating "the existing systems" to be able to improve the level of the developed systems and raise it to use it in the educational process integrally. E-learning and the internet that left their impact on the educational information technology that will be an important reference to evaluate and spread the intelligent tutoring systems and the effective use of the educational tools and e-learning content.

The e-leaning contents respositories and the intelligent tutoring systems have witnessed an important and exciting revolution. We find the new communication technology and the huge connection between the computers and the digital lines and satellites on one hand and, on the other hand, we find the new educational entries. All this has a remarkable impact on the development and the architectures of the intelligent tutoring systems in the framework of e-learning contents

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