LEARNING STYLES THEORY FOR INTELLIGENT LEARNING ENVIRONMENTS
Adapting the Instruction

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Abstract: It is well known that personalized tutoring helps to improve the learning process and to obtain better results. With this aim we are developing a model including the learning styles of the students. We based our model on the Felder-Silverman Learning Styles Model. According to the student learning style, the instruction is established by a proposed set of rules. To prove our model we propose to use an LMS in compliance with SCORM. In this paper we present our general proposal.

1 INTRODUCTION

Up to the present time most of the intelligent learning environments personalize learning basically by following what the student knows and selecting the next learning object or tutorial action according to the student's current knowledge. This is usually implemented with a student model where student's knowledge state is a subset of the knowledge of an expert in the subject matter (overlay model). However, to adapt the instruction to students is not only concerned with students' current knowledge; therefore many other proposals have appeared to try to adapt the instruction to other aspects of students. In (Ferguson et al, 2006) the authors propose to model students in terms of skills mastery to select the next problem or hint to be presented to students. There are proposals which emphasize the importance of the motivational and affective state. For example, self-efficacy has been proposed as a highly accurate predictor of students' motivational state and their learning effectiveness (McQuiggan and Lester, 2006). Other proposals of personalization are based on the use of affective models, for instance, a model of a affective tutor is presented in (Hernandez, Sucar and Conati, 2008); however few proposals are reported in the literature; and the same happens with personalization using learning styles (Graf and Kinshuk, 2007). A general framework to include learning styles in educational systems is presented in (Parvez and Blank, 2008). In this paper we present a proposal to adapt the instruction base on the Felder-Silverman Learning Styles Model; the instruction is presented according a rules set taking into account student learning style which is identified by an assessment instrument gave to students. The rest of the paper is organized as follows: in the next section, the learning styles model is presented; in section 3, an introduction to the LMS Moodle is provided; in section 4 we present our proposal, we justify why to use Moodle to implement intelligent tutors at Instituto de Investigaciones Eléctricas (Electrical Research Institute) in México. Finally, conclusions, future work and references are provided.

2 LEARNING STYLES MODEL

Learning theories describe proposals about how the people learn new concepts and abilities; several learning theories have been proposed, all of them states different, and some times, contrasting points of view; for example the dispute between proposals focused in the student and proposals focused in the teachers. The learning styles theory relies on the hypothesis where each individual has a particular way to learn including strategies and preferences, emphasizing that individuals perceive and process information in different ways. Consequently, learning styles theory states individuals' learning has more to do with a process focusing the learning style

than with the individuals' intelligence (Funderstanding, 2008). Several learning styles models have been proposed, our proposal is based on the Felder-Silverman learning Styles Model (Graf and Kinshuk, 2007; Blouin, 2010; Felder and Silverman, 1988), which is a well-known and broadly used learning styles model. In this section, firstly, the model is presented and then the rule-based proposal to incorporate learning styles in intelligent tutors is presented.

The Felder-Silverman categorizations of learning styles are: sensing-intuitive, visual-verbal, active-reflective, and sequential-global.

- Active and reflective learners. The active style learner understands information best by doing something with it and likes group work. The Reflective style learner understand information best by thinking about it quietly first and prefers to work alone.
- Sensing and intuitive learners. The sensing learner likes learning facts and solves problems by well-established methods and dislike complications. The intuitive learner prefers discovering possibilities and relationships and likes innovation and dislikes repetition.
- Visual and verbal learners. The visual remembers best what they see: pictures, diagrams, flow charts, time lines, films, and demonstrations. The verbal gets more out of words, written and spoken explanations
- Sequential and global learners. The sequential gains understanding in linear steps and follows logical stepwise paths in finding solutions. The global learns in large jumps and solves complex problems quickly once they have grasped the big picture.

To identify the learning style of a person, the Felder-Silverman assessment instrument is used; this instrument is a Soloman and Felder questionnaire, consisting of 44 questions (Felder and Soloman, 1993).

To implement the Felder-Silverman Learning Styles Model we use a collection of rules where each rule proposes a set of teaching instructions for one learning style (Savic and Konjovic, 2009). Table 1 shows the rules.

Rules are conceptually easy to implement in tutoring systems. However, to apply these rules, every lesson of a course has to be converted into 8 different lessons according to the teaching instructions. This effort is justified if there are many potential students classified in each of the learning styles so that they can benefit of the personalized learning objects. Given the learning styles remains over the complete session, the learning style of a person is assessed once at the beginning of the course.

Table 1: Rules of teaching instructions for each learning style in the Felder-Silverman model.

Learning style	Teaching instructions
Active	Show exercises at the beginning of the chapter because they like challenges and problem solving
	Show less examples. They are not interested in the way others have done something, because they want to solve a problem by themselves
Reflective	Show exercises at the end of a chapter
	Show examples after explanation content, but before exercises
	Show less exercises, because they learn better by thinking about a topic instead of solving problems actively.
Sensing	Show examples at the beginning of a chapter (before explanation content) because they like concrete content.
	Show exercises after explanation content, because they solve problems by already learned approaches
Intuitive	Show less examples, because they like to discover topic application by themselves
	Show examples after explanation content, because they like abstract content more than concrete
	Show exercises before explanation content, because they like challenges
	Show less exercises with a similar teaching goal because they don't like repetition
Visual	If possible, show resources as a picture or a video
Verbal	Show resources as a text or an audio
Sequential	Show learning content in a standard sequence – explanation content, examples, exercises and summary, because they like linear approach
Global	They are less interested in details, because they need to create a global picture of the topic. Therefore, add an overview of each chapter at the beginning of the lesson
	Show summary before examples and exercises, because summary helps you to create a global picture

3 LEARNING MANAGEMENT SYSTEM

The use of programs to manage the activities around training and education is rapidly growing; universities and other institutions are widely using them to support the education/training programs. The simplest definition of learning management system (LMS) is a software application for the administration, documentation, tracking, and reporting of training/education programs for e-learning and b-learning; however, an LMS is also concerned with centralize and automate administration, provide self-service and self-guided services, assemble and deliver learning content rapidly, consolidate training initiatives on a scalable web-based platform, support portability and standards and personalize content and enable knowledge reuse (Ellis, 2009). The functions of an LMS vary from systems for managing training and educational records, to software for distributing courses over the WWW with features for online collaboration.

An LMS should provide the following elements: The syllabus for the course, administrative information, a notice board for up-to-date course information, student registration and tracking facilities, basic teaching materials (These may be the complete content of the course, or copies of visual aids used in lectures), additional resources (including reading materials, and links to outside resources in libraries and on the Internet), self-assessment quizzes which can be scored automatically, formal assessment procedures, electronic communication support including e-mail, threaded discussions and a chat room, with or without a moderator, differential access rights for instructors and students, production of documentation and statistics on the course, easy authoring tools for creating the necessary documents including the insertion of hyperlinks. In addition, the LMS should be capable of supporting numerous courses, so that students and instructors in a given institution experience a consistent interface when moving from one course to another (Wikipedia, 2010). An important feature of LMS is the adherence to standards, such as SCORM (Ellis, 2009); it means that the LMS can share content complying with standards regardless of the authoring system that produced it.

There are many commercial and open source LMS. Some of popular commercial LMS are: Blackboard (Blackboard, 2010), WebCT (WebCT, 2010) and the leading open source LMS is Moodle

(Moodle, 2010). For our proposal we decided to use Moodle.

Moodle is a software package for producing Internet-based courses and web sites. It is a global development project designed to support a social constructionist framework of education. The word Moodle was originally an acronym for Modular Object-Oriented Dynamic Learning Environment. Moodle allows providing documents, graded assignments, quizzes, discussion forums, etc. to students with an easy to learn and use interface. Figure 1 shows a screenshot of the Moodle site we are assembling to develop our proposal for the Instituto de Investigaciones Eléctricas (Electrical Research Institute) at México.

Figure 1: Moodle site for the Instituto de Investigaciones Eléctricas (Electrical Research Institute) at México.

Figure 1 shows the elements from a Moodle site we are developing for the proposal; it is composed by a log-in section, a calendar, a news section and a list of the available courses. The availability of a course depends on the student profile.

As we mentioned, an important feature of LMS is the adherence to standards, such as SCORM, therefore, we develop the instructional material as lessons, tests, and exams in compliance with SCORM (ADL, 2009). SCORM is a specification for e-learning system.

To develop courses to be presented by Moodle and SCORM compliant we base our proposal on an algorithm rooted in artificial intelligent planning techniques proposed by (Brusilovsky and Vassileva, 2003). This method obtains a SCORM activity tree from a AND/OR graph or a tree that represents a tutor plan. In this way, an individual course is generated for each student base on her individuals needs and on a learning goal. This will allow running SCORM compliant intelligent tutors in Moodle.

4 INTEGRATION APPROACH

As previous work, we developed a student model that considers the affect and knowledge to decide the next tutorial action. The tutor monitors the affective state of students and reacts in consequence. The affective state is established with base on students' personality traits and their performance in the tutorial session (Hernández, Sucar and Conati, 2009; Hernández, Sucar and Conati, 2008). Now, we want to have more adaptive instruction identifying the learning style of students and to provide students with an instruction according with their learning style. In this way, our integration approach allows building intelligent tutors that are adaptive in response to the knowledge state, the affective state and the learning style of the students. To incorporate learning styles in the adaptation of tutoring systems allows identifying the best tutorial action given the students' preferences, strategies, experience, and so on.

The learning style assessment instrument (Felder-Silverman) is applied to the student to indentify the student learning style just once, when the student visit for the first time the educational environment or maybe at the beginning of a course. Once, the learning style is identified we base in the AND/OR graph and in the rules from Table 1, we generate a course individualized for each student. In this way, the learning style determines the type of explanations to be presented to the student when taking the course. Additionally, during the course, the tutor monitors and reacts to the knowledge and affective states of the student; therefore, the course is re-planned considering the new students conditions and with base on the learning style rules.

5 CONCLUSIONS AND FUTURE WORK

In this paper we presented an approach that will allow us to integrate affective behavior and learning styles of the students into intelligent environments to complement the current approach in intelligent tutors that follow what the student knows using a model that tracks the knowledge state of the student. The affective behavior and learning styles models increase the degree of personalization of the intelligent environments.

In the future we plan to implement and test our approach using a training course for the IIE postgraduate center and we plan to include the new SCORM features that support intelligent tutors.

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