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An Application of the LS-Plan System to an Educational Hypermedia

Carla Limongelli, Roma Tre University, Italy

Filippo Sciarrone, Roma Tre University, Italy

Giulia Vaste, Roma Tre University, Italy

ABSTRACT

LS-Plan is a system capable to provide educational hypermedia with adaptivity. During the student's navigation in hyperspace, the system, by means of a suitable interface, receives in input, for each visited learning node, a behavioral pattern, containing the student's knowledge acquired or not acquired in that node and measured by a post-test questionnaire. Then, by means of the adaptation algorithms, the system returns a Learning Object Sequence to the hypermedia, just to be recommended to the student. In this work we investigate in detail the adaptation algorithms together with the didactic strategies behind them, through an application to a real learning domain, subdivided in five case studies. Moreover, we show in detail how the automated planner, embedded into the system, allows consistency checks during the arrangement of the pool of Learning Nodes, allowing the teacher to define possible didactic strategies during automatic course personalization. Finally, the performance of the system is evaluated by means of an experimental design with positive results.

Keywords: *Hypermedia Technologies; Web Delivered Education; Web-Based Learning; Web-Based Teaching*

MOTIVATIONS AND GOALS

Personalization and adaptation in Web-based courses are considered two very important requirements for providing an effective distance learning. Student models are more and more investigated and, beyond knowledge, new systems take into account student's personal traits as well, such as interests, cognitive and learning styles (see Brusilovsky and Millan (2007) for a review of student modelling techniques in Adaptive Hypermedia).

In this article, we present an extensive application of the LS-PLAN system (Limongelli, Sciarrone, & Vaste, 2008) to the Java programming domain in order to allow students to learn some basilar programming concepts. The aim of our work is a deep investigation

of the adaptation algorithms together with the didactic strategies behind them in a real didactic context where students need learning. From the student's point of view, our adaptation algorithms give particular attention to student modelling and adaptation of the system to his progresses and troubles during his fruition of the course. From the teacher's point of view, we propose a "didactic guide" based on typical teacher's behaviours.

LS-Plan system is based on the synergy between Learning Styles refinement procedures, based on student's self-assessments and navigation behavior, and on an adaptation algorithm, capable to guide the student step by step, especially in recovery activity, like a teacher should do. The Learning Styles updating procedure is based on the idea that Learning Styles are tendencies and may change through educational experiences (Felder & Spurlin, 2005). So the system takes into account the information gathered from the student's behavior (that is however free to navigate in the learning hyperspace), in order to evaluate the effectiveness of the current teaching strategy, modifying it, if necessary.

Our adaptation algorithm mimics the teacher's behavior in presence of learner's difficulties in the study of a given topic: like a teacher usually does, the system tries to explain the same learning material again, supposing that the student has not paid sufficient attention on it; in case of a new student's failure, the system, if possible, tries to explain the same concept in a different way; in presence of a new failure a prerequisites check is suggested. The proposed materials and their sequencing are based on the student's knowledge, updated during the fruition of the course, and on his Learning Styles. The use of Pdk planner (Cialdea Mayer, Limongelli, Orlandini, & Poggioni, 2007) for the sequence generation allows the teacher to express in an easy way his didactic strategies, such as the difficulty level of the course, or the presence of mandatory contents for all the learners, or a particular preferred approach to teach a topic.

Here we address the following research question: "Does the LS-Plan system produce suitably personalized didactic plans on the basis of the student's behaviour?"

The rest of the article is organized as follows. Next section illustrates the related works; then the architecture of the LS-Plan system is sketched. Subsequently, the proposed adaptive methodology is shown together with the illustration of the relevant case studies. Afterwards the evaluation of the system with the experimental results is reported, and finally conclusions and future work are drawn.

RELATED WORK

Modern research in distance learning focuses most attention on personalization and adaptation of courses to student's needs, as opposite to the traditional "one-size-fits-all" approach (Brusilowsky, 2001). In this context, Learning Styles (*LS*) are more and more considered in educational systems: teaching strategies, based also on the student *LS*, might increase the effectiveness of learning and motivate learners. A lot of studies have been carried out in this direction, but opposite opinions are reported about the effectiveness of adaptation based on *LS* (Brusilovsky & Millan, 2007). However Felder and Silverman's Learning Styles Model (Felder and Silverman, 1988) has been often taken into consideration in the literature and Zywno (Zywno & Waalen, 2001) showed its effectiveness in engineering educational context. Different systems have been proposed on the basis of the Felder and Silverman's model, such as the add-on for the Moodle Learning Management System proposed in Graf and Kinshuk (2007), where a course personalization, based on *LS*, is presented. Tangow (Alfonseca, Carro, Martin, Ortigosa, & Paredes, 2006) system uses information on student *LS* to encourage collaborative learning through group formation; moreover it takes into account two dimensions of the Felder and Silverman's Model and initializes the Student Model (*SM*) in an explicit way, through the Felder and Soloman's