LS-PLAN: An Effective Combination of Dynamic Courseware Generation and Learning Styles in Web-Based Education

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Abstract. This paper presents LS-PLAN, a system capable of providing Educational Hypermedia with adaptation and personalization. The architecture of LS-PLAN is based on three main components: the Adaptation Engine, the Planner and the Teacher Assistant. Dynamic course generation is driven by an adaptation algorithm, based on Learning Styles, as defined by Felder-Silverman’s model. The Planner, based on Linear Temporal Logic, produces a first Learning Objects Sequence, starting from the student’s Cognitive State and Learning Styles, as assessed through pre-navigation tests. During the student’s navigation, and on the basis of learning assessments, the adaptation algorithm can propose a new Learning Objects Sequence. In particular, the algorithm can suggest different learning materials either trying to fill possible cognitive gaps or by re-planning a newly adapted Learning Objects Sequence. A first experimental evaluation, performed on a prototype version of the system, has shown encouraging results.

1 Introduction

Personalization and adaptation in learning environments are two very important requirements for providing an effective educational service on the Internet. In this context, Dynamic Courseware Generation [6] and Instructional Planning [15] are two of the most important research areas.

In this work we address the problem of helping the student during his learning activity by means of a synergy based on his cognitive state, his learning styles and the teacher’s didactic strategy. The main contribution of our work is given by an adaptation algorithm, capable to modify the student’s model and to guide the student step by step, especially in recovery activity. At the same time the system lets the student free to navigate in the learning hyperspace in accordance with the constructivist pedagogical theory [16]. Here we propose LS-PLAN, a Web-based system, capable of providing Educational Hypermedia with adaptation and personalization. The system is based on the synergy between classical planning techniques and Learning Styles refinement procedures.
The architecture of LS-PLAN includes three main modules: the Adaptation Engine, the Planner and the Teacher Assistant. The Adaptation Engine manages the adaptivity mechanism and the user model, from its initialization to its update. The Planner produces a Learning Objects Sequence (LOS), on the basis of the current Student Model and of the learning strategies previously set by the teacher. The Teacher Assistant allows the teacher to modify the teaching strategies related to the learning material. The pedagogical background of the Student Model is based on the student’s Cognitive State (CS) and Learning Styles (LS). The student’s CS is defined as a set of Knowledge Items, i.e., atomic elements of knowledge concerning the learning domain, according to the Knowledge Space Theory [9]. Learning Styles are the student’s learning preferences as defined by Felder-Silverman’s (FS) Learning Styles Model [10]. Moreover, the system models the student’s knowledge by an Overlay Model [5], based on three of the five levels of Bloom’s Taxonomy [2]. Our system is based on the idea that LS are tendencies and may change through educational experiences [11]. In fact, the system takes into account the information gathered from the student’s self-assessments and navigation, in order to evaluate the effectiveness of the current teaching strategy, modifying it, if necessary.

In the literature, different systems have been proposed on the basis of the FS Model and for generating LOS. In the system proposed in [1], an adaptive interface has been presented, while the CS383 system [8] and the Intelligent Web Teacher system [7] propose an adaptive presentation based on learning material typologies. Our system generates LOS by means of planning techniques, similarly to the Dynamic Course Generation (DCG) system [6], following the style of the systems AHA! [3] and ELM-ART [17]: while AHA! does not exploit assessment for adaptivity, ELM-ART and DCG do not make use of LS. Our adaptation mechanism provides both features and it is very fine grained: a specific learning material has associated its own LS, thus providing the teacher with the possibility to implement suitable didactic strategies for different learners.

The rest of the paper is organized as follows. Section 2 illustrates the architecture of LS-PLAN together with its main components. Section 3 shows a first experimentation of the system to a real instructional environment. In Section 4, our conclusions are drawn.

2 The Adaptive System

The overall system, that is LS-PLAN together with the Adaptive Educational Hypermedia (AEH), is shown in Figure 1 where the main components are highlighted with grey blocks. The teacher, through a suitable framework, the Teacher Assistant, arranges a pool of learning objects, i.e., learning nodes, building the Domain Knowledge, stored in a special repository inside the AEH system. The teacher also prepares the initial Cognitive State Questionnaire for evaluating the starting knowledge of the student, that is the knowledge already possessed by the student with respect to the topic to be learned. Moreover, the teacher provides each student with his own instructional goal, and specifies the