Chapter 2.21
Modeling Learner's Cognitive Abilities in the Context of a Web–Based Learning Environment

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ABSTRACT

Our study is concerned with making the instruction suitable to the individual learner's characteristics. This chapter describes the methodology used to investigate how to model the learner's Cognitive Ability Level (CAL) based on the observation and analysis of his/her behaviour in a Web-learning environment. In our study, the CAL represents the learner's cognitive stage development according to Bloom's taxonomy. The methodology encompasses two phases: (i) the generation of the CAL classes for the target population and (ii) the study of learning trajectories of CAL classes in an experimental learning module. As a result, we have identified the CAL classes' parameters values that best discriminate these classes from the observation and analysis of their learning trajectory on the Web. The entire knowledge obtained from this investigation will make possible to automate the learners' CAL diagnostic. It will also give us the background to develop Web-learning environment contents.

INTRODUCTION

In the context of adaptive Web-based learning environments, there is a big challenge related to the development of a high quality pedagogical material and to intelligent and efficient online assistance to the remote learner. The adaptation of

the course contents' presentation to the learner's individual characteristics is the major requirement of the Web-based learning environment. From psycho and pedagogical points of view, important questions must be carefully thought, such as:

- How to identify the aspects that positively influence a long distance learning process in a hypermedia environment;
- How to provide a psycho and pedagogical assistance to a broad variety of learners' cognitive profiles and how to manage their difficulties along the learning process; and
- How to deal with the absence of feedback to the teachers, who are not online or don't have information about the difficulties of the learners who, in turn, tend to feel isolated and potentially lost and discouraged.

Besides the psycho and pedagogical questions, several others arise under the computational point of view, such as:

- How to trace the learners' interactions with the pedagogical material over the Internet;
- How to computationally analyse and interpret the learner's behaviour along his/her learning process; and
- How to model the psycho and pedagogical characteristics of the learners.

A wide variety of studies are found in the literature stressing interest on these questions. They clearly demonstrated a trend towards taking into account individual learner's characteristics (e.g., learning style, cognitive style, emotions, personality, etc.) to adapt the instruction in a suitable manner.

Our study focuses on the computational modeling of the learner's CAL, aiming to customize the pedagogical strategies to this individual characteristic. Our main assumption relies on the idea that if the system could diagnose the learner's CAL characteristic by observing his/her interactions with it, it would guide the learner's learning process by stimulating the development of his/her cognitive abilities.

The development of the cognitive abilities certainly would increase learner's probability of success on a learning task. Consequently, the psycho and pedagogical advantages to the learner would be related to: (i) the smoothness on the progress of the learning task he/she performs; (ii) the increasing of the effectiveness of his/her contents apprenticeship; and (iii) the increasing of the learner's efficiency in the learning process.

RELATED WORK

An important issue addressed in an adaptive system is related to the user model. According to Brusilovsky (1995), there are many features related to the current context of the users' work and to the user as an individual, which can be taken into account by an adaptive system. These features were identified as: user's goals, knowledge, background, hyperspace experience, and preferences.

Nowadays, there is a great trend of modeling the learner's individual characteristics in a complementary way compared to the learner's features mentioned by Brusilovsky. This tendency can be expressed by the cognitive science researchers concern in making the adaptation take into consideration the learner's individual characteristics such as: personality (Riding & Wigley apud Riding & Rayner, 2000), emotional factors (Soldato, 1995), gender (Reed & Oughton, 1997), learning orientations (Martinez & Bunderson, 2000), and cognitive and learning styles (Felder & Silverman, 1988; Ford & Chen, 2000; Riding & Cheema, 1998), among others.

The empirical researchers have been theorizing in different ways about and pursuing the relationship between some individual differences and learning environments trying to find out cor-

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