Chapter 16: User Adaptation in Supporting Exploration Tasks in Virtual Learning Environments

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1. INTRODUCTION

In the increasing heterogeneous student population in both the academic and corporate training environments, the need of a customized instructional design is becoming more and more obvious. There are a variety of factors, including the past experience, cognitive abilities, and personal preference, that could influence the knowledge transfer, acquisition, and construction during the learning process.

The ideal learning environment described by Gilbert and Han (1999) consists of many (or more exactly “infinite”) instructors, each having their unique teaching styles, available for every learners where the learners could choose the instructor that perfectly matches their own learning styles. Forbus and Feltovich (2001) even added that the instructors or assistants should be at every learner’s elbow whenever they are ready to learn, and for however long it takes. Aptitude-Treatment Interaction theory (Cronbach & Snow, 1989) also suggests that the best learning results when the instruction matches the learner’s aptitude.

Virtual learning environments (VLEs), which are defined in the context of our research as sets of computer/internet-based tools created to enhance learners’ learning experiences, attempt to provide individualized instruction by means of customizing the domain content and appearance of the learning environment, hence matching the instruction to the learner’s attributes. In the VLEs, customization could be within users’ control (adaptable), or achieved without users’ intervention (adaptive). Nonetheless, the generalized term “adaptivity” supersedes both of them and is used to cover the idea in the following discussion. Systems equipped with adaptivity have been proven more effective and efficient than traditional non-adaptive systems (De Bra et al., 1999). Sampson et al. (2002) provide an extensive discussion and examples of VLEs that are built with the idea of adaptivity.

Most of the recent VLEs have been implemented as adaptive hypermedia systems due to the widespread use of internet as a medium of learning. The adaptive techniques used in such systems can be categorized into either adaptive navigational support or adaptive content presentation (Brusilovsky et al.,
Adaptive navigational support works at the link level and is usually implemented as visual cues attached to links to express suggestions. On the other hand, the adaptive content presentation works at the (learning) content level and tailor the presentation of information according to learners’ competence level, preferences, goals, and so on.

One of the most important components in an adaptive VLE is the student model. Attributes of students are collected, analyzed, and stored in student models. Most student models focus on students’ competence levels (hence called competence models), and they are implemented either as state models (Staff, 2001) or as process model (El-Sheikh & Sticklen, 1998). However, there is a growing consensus of student (user) modeling community that modeling competence alone could not provide sufficient adaptative ability that a VLE should have in an increasingly heterogeneous demography of the learners (Lovett et al., 2000).

We, therefore, introduce a new and complementary approach to student modeling, called the cognitive trait model (CTM). CTM is concentrated on those student attributes (cognitive traits) that are persistent for a long duration, and consistent for a variety of tasks. The role of CTM is not to replace existing competence models but to supplement in order to provide fine-grained adaptivity. We shall examine the existing adaptation techniques that rely on the student modeling, and then describe how CTM provides a more efficient and reliable way to achieve them.

2. ADAPTATION IN VIRTUAL LEARNING ENVIRONMENTS

The adaptive characteristics improve the usability of the VLEs. Without adaptivity, these environments would present the same material, with the same set of links, to all learners. It could work well if the intended user group has the same/similar learning characteristics, but it is rarely the case in real learning environment. Without adaptivity, such systems will mimic the traditional classroom, with one-to-many interaction.

Adaptive VLEs, with the ability to change the content or structure of the links according to the student’s need, provide similar situation as there are many instructors available for each individual student, “the learner’s chances of doing well in this classroom would appear to be significantly better than in a classroom with one instructor because each learner would adapt to the instructor(s) that would facilitate his/her learning style” (Gilbert & Han, 1999). Inclusion of adaptivity makes these systems more usable and suitable for a wider range of users. Brusilovsky et al. (1998) further distinguished two categories of features that could be adapted in VLEs: navigational adaptation and content adaptation.

Navigational adaptation focuses on building a sensible navigational path for every individual student. It supports the learning process by providing