ABSTRACT

This article provides an overview of personalized e-learning services and related technology and presents a multi-agent system for delivering adaptive e-learning. We discussed the main issues related to personalization in e-learning: technology advancement and the shift in perception of the learning process, one-size-fits-all vs. personalized services, and the adaptation process. The article provides also an overview of most known implemented systems for adaptive e-learning, as well as detailed description of the architecture and components of the proposed multi-agent framework. Finally, the article concludes with some comments about the dimensions to consider for implementing personalization.

Keywords: adaptive delivery; multi-agent architecture; personalized e-learning

NEW TRENDS IN E-LEARNING SERVICES AND NEEDS FOR PERSONNALIZATION

New Trends
Computers have great potential as support tools for learning: they promise the possibility of affordable, individualized learning environments. In the early teaching systems, the goal was to build a clever teacher able to communicate knowledge to the individual learner. Recent and emerging work focuses on the learner exploring, designing, constructing, making sense of, and using adaptive systems as tools. Hence, the new tendency is to give the learner greater responsibility and control over all aspects of the learning process. This need for flexibility, personalization, and control results from a shift in the perception of the learning process. In fact, new trends emerging in the education domain are significantly influencing e-learning (Kay, 2001):

• The shift from studying to graduate to studying to learn: most e-learners are working and have well-defined personal goals for enhancing their career.
• The shift from student to learner: this shift has resulted in a change in strategy
and control, so that the learning process is becoming more cooperative than competitive.

- The shift from expertise in a domain to teaching beliefs: the classical teaching systems refer to “domain and teaching expertise” when dealing with the knowledge transfer process, but the new trend is based on the concept of “belief.” One teacher may have different beliefs from another, and the different actors in the system (students, peers, teachers), may have different beliefs about the domain and teaching methods.

- The shift from a 4-year program to graduate, to life-long learning: most e-learners have a long-term learning plan related to their career needs.

- The shift to conceiving university departments as communities of scholars, but not necessarily in a single location.

- The shift to mobile learning: most e-learners are working and have little spare time. Therefore, any computer-based learning must fit into their busy schedules (at work, at home, when traveling), so that they require a personal and portable system.

### The One-Size-Fits All Approach

The one-size-fits all approach is not suitable for e-learning. This approach is neither suitable for the teaching material (course content and instruction methods), nor for the teaching tools (devices and interfaces). The personalization of the teaching material has been studied and evaluated in terms of the psychology of learning and teaching methods since the middle of the 20th century (Brusilovsky, 1999; Crowder, 1959; Litchfield, Driscoll, & Dempsey, 1990; Tennyson & Rothen, 1977). The empirical evaluation of these methods showed that personalized teaching material increased the learning speed and helped learners achieve better understanding than they could have achieved with nonpersonalized teaching material (Brusilovsky, 2003). The personalization of the teaching tools has been addressed in the context of new emerging computing environments (ubiquitous, wearable, and pervasive computing). Gallis, Kasbo, and Herstad (2001) studied how medical students use various information and communication devices in the learning context and argued that “there is no ‘one size fit all’ device that will suite all use situations and all users. The use situation for the medical students, points towards the multi-device paradigm” (Gallis et al., 2001). The multidevice paradigm fits well with the e-learning context, in which students use different devices depending on the situation, environment and context.

### WHAT CAN BE PERSONALIZED?

An intelligent teaching system is commonly described in terms of a four-model architecture: the interaction model, the learner’s model, the domain expert, and the pedagogical expert (Wenger, 1987). The interaction model deals with the interface preferences, the presentation mode (text, image, sound, etc.) and the language. The learner model represent static beliefs about the learner, learning style and in some cases, has been able to simulate the learner’s reasoning (Paiva & Self, 1995). The domain expert contains the knowledge about the subject matter. It deals with the domain concepts and course components (text, examples, playgrounds, etc.). The pedagogical expert contains the information on how to teach the course units to the individual learner. It consists of two main parts: teaching strategies that define the teaching rules (Vassileva, 1994) and diagnostic knowledge that defines the actions to take depending on the learner’s background, experience, interests, and cognitive abilities (Specht, 1998).

Based on these four components individualized courses are generated and presented to the learner. Moreover, the system can adapt the instructional process on several levels:

- Course-content adaptation: adaptive presentation by inserting, removing, sorting, or dimming fragments
- Course-navigation adaptation: links-adaptation support by hiding, sorting, disabling or removing links, and by generating new links.
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