Adaptive E-Learning Environments: Research Dimensions and Technological Approaches

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ABSTRACT

One of the most closely investigated topics in e-learning research has always been the effectiveness of adaptive learning environments. The technological evolutions that have dramatically changed the educational world in the last six decades have allowed ever more advanced and smarter solutions to be proposed. The focus of this paper is to depict the three main dimensions that have driven research in the e-learning field and the evolution of the technological approaches adopted for the purposes of building advanced educational environments for distance learning. Then, the three different approaches adopted by the authors are discussed; these consist of a multi-agent system, an adaptive SCORM compliant package and an e-learning recommender system.

Keywords: Adaptive E-Learning Environment, Distance Learning, Multi-Agent System, Recommender System, SCORM Standard

INTRODUCTION

Research in the field of educational technology has always focused strongly on the learning effectiveness of adaptive environments, in most cases demonstrating that they are successful in building the learning processes best suited to the individual learner (Brusilovsky, 1998; Brusilovsky, 2011; Kaplan, 1993; Perez, 1995). These environments, in fact, are a technological evolution and revolution of the first educational systems, that could only supply the same content to all students: CAI (Computer Aided Instruction). Then, it became clear that the “one-fits-all” approach was not an appropriate use of the new emerging technologies and, thanks to the introduction and the development of Artificial Intelligence, innovative techniques...
were experimented with the aim of tailoring the learning process to the learner’s specific needs and/or domain models. The AI rules allowed a new generation of learning systems, named ITSs (Intelligent Tutoring Systems) or ICAI (Intelligent Computer Aided Instruction), to be defined and developed.

During the last six decades educational technology research has sought to find answers to these typical questions: *What should be adapted in the learning process? How should the learning process be adapted? Why should the learning process be adapted (on the basis of what)?*

The first result, as always, was that there is no one-fits-all answer. The choices about what, how and why to adapt such processes are different according to each set of conditions in which the solution is applied.

Following this trend, our research has been focused on giving different kinds of answers to those questions. The aim of this paper is to present the evolution of the different approaches adopted in our research in order to retrieve Learning Objects (LOs) and to tailor learning resources and paths in SCORM compliant distance learning environments.

The first question (what) was addressed using two different approaches aimed at distinguishing two dimensions of tailoring: intra-adaptivity and inter-adaptivity (Di Bitonto, 2010a). The intra-adaptivity approach is aimed at tailoring the content of each single learning resource by modifying the navigational path within the LO, whereas the inter-adaptivity approach is aimed at compiling different learning resources in order to define the flow of events best suited to the learner’s needs and preferences.

In particular, as regards content tailoring for each LO, this has been investigated using two different technological approaches (how). Firstly, using an agent-based approach defining a MAS (multi-agent system) composed of an adapting agent and a rule-based system, that are able to modify the navigation within a SCORM compliant didactic resource, to choose the best teaching strategy to be applied according to the learning style of the individual learner (Di Bitonto, 2010b). However, a more convenient approach has been used in Di Bitonto et al. (2011), where the SCORM sequencing and navigation rules are adapted according to the learner’s cognitive style using some API functions that affect only the client side of the SCORM content package without requiring any intervention on the LMSs. In addition, the recommender system approach has been investigated. In this case, a hybrid knowledge-based recommendation strategy was defined in order to suggest learning/teaching activities (inter-adaptive approach) taking into account the reference learning context in terms of the LO learning goals, the teaching strategy, as well as the learner’s learning style (Di Bitonto et al., 2010).

As regards the characteristics which go to make up the tailoring approach (why), differences in learning and cognitive styles have been investigated.

The paper aims at presenting the evolution of the different solutions adopted in our research about adaptive e-learning, as well as the pros and cons of each of them. The paper is organized as follows: the related works section presents a literature survey of the various research directions and technological approaches; the section on the adaptation process describes the three approaches investigated in our research; the discussion section aims at describing analogies and differences among the three approaches; finally, some conclusions and future works are discussed.

**RELATED WORKS**

The issue of personalization in e-learning is one of the main focuses of research in the field of educational technology, as witnessed by the number of papers available in literature on this topic. As stated in the previous section, there are three main questions that have been investigated in these years, aiming at discovering *What, How and Why* it is best to tailor learning resources.

From the *What* point of view, the intra and inter-adaptivity approaches can be identified on the basis of the tailoring goal. The
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