

KnowledgeTree: A Distributed Architecture for Adaptive E-Learning

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ABSTRACT

This paper presents KnowledgeTree, an architecture for adaptive E-Learning based on distributed reusable intelligent learning activities. The goal of KnowledgeTree is to bridge the gap between the currently popular approach to Web-based education, which is centered on learning management systems vs. the powerful but underused technologies in intelligent tutoring and adaptive hypermedia. This integrative architecture attempts to address both the component-based assembly of adaptive systems and teacher-level reusability.

Categories and Subject Descriptors

H.4 [Information System]: Information System Applications.
K.3.1 [Computers and Education]: Computer Uses in Education - *Distance Learning*.

General Terms

Management, Design, Human Factors, Standardization.

Keywords

Adaptive Web, E-Learning, Learning Portal, Adaptive Content Service, Student Model Server, Learning Object Metadata, Content Re-use.

1. INTRODUCTION

The technological landscape of modern E-Learning is dominated by so-called learning management systems [10] such as Blackboard [4] or WebCT [42]. Learning management systems (LMS) are powerful integrated systems that support a number of activities performed by teachers and students during the E-Learning process. Teachers use an LMS to develop Web-based course notes and quizzes, to communicate with students and to monitor and grade student progress. Students use it for learning, communication and collaboration. As is the case for a number of other classes of modern Web-based systems, LMS offer their users "one size fits all" service. All learners taking an LMS-based course, regardless of their knowledge, goals, and interests, receive access to the same educational material and the same set of tools, buffered with no personalized support.

Adaptive Web-based Educational systems (AWBES), a recognized class of adaptive Web systems [9] attempt to fight the "one size fits all" approach to E-Learning. After almost 8 years of research on adaptive E-Learning, this field can demonstrate some impressive results [6]. For every function

that a typical LMS performs we can find a number of AWBES that can do it much better than the state-of-the-art LMS. Adaptive textbooks created with such systems as InterBook [8], NetCoach [44] or ActiveMath [29] can help students learn faster and better. Adaptive quizzes developed with SIETTE [34] evaluate student knowledge more precisely with fewer questions. Intelligent solution analyzers [43] can diagnose solutions of educational exercises and help the student to resolve problems. Adaptive class monitoring systems [32] give the teachers a much better chance to notice when students are lagging behind. Adaptive collaboration support systems [37] can enhance the power of collaborative learning.

The traditional problems involved in authoring adaptive learning content have been nearly resolved by the new generation of powerful authoring tools. Authoring support in modern AWBES such as NetCoach [44] or SIETTE [34] is comparable with modern LMS. Moreover, a number of existing AWBES are provided with a wealth of existing or newly created learning materials, while the typical LMS expects teachers to develop all learning materials themselves. For example, ELM-ART [43] comprehensively supports the most important portions of a typical Lisp course - from concept presentation to program debugging. Yet, seven years after the appearance of the first adaptive Web-based educational systems, just a handful of these systems are actually being used for teaching real courses, typically in a class lead by one of the authors of the adaptive system.

The problem of the current generation of AWBES is not their performance, but their architecture. Structurally, modern AWBES do not address the needs of both university teachers and administration. *The first issue is the lack of integration.* While AWBES as a class can support every aspect of Web-enhanced education better than LMS, each particular system can typically support only one of these functions. For example, SIETTE [34] is a great system for serving quizzes, but it can't do anything else. To cover all needs of Web-enhanced education with AWBES, a teacher would need to use a range of different AWBES together. This is clearly a problem for the university administration that is responsible to maintain and provide training for all these systems. It is also a burden for the teacher who needs to master them all and for the student who needs to manipulate several systems and interfaces - all with separate logins - and all at the same time. E-Learning stakeholders have a clear need for a single-entrance, integrated system that can support all critical functions in one package. LMS producers have recognized this need several years ago. Just in a few years after their emergence, LMS have progressed from one-or-two function systems into Web-based monsters that can cover all needs.

The second issue is the lack of re-use support. Modern AWBES are self-contained systems and can't be used as components. A teacher who is interested in re-using some

