Chapter 8.12
A Novel Architecture for E-Learning Knowledge Assessment Systems

Krzysztof Gierłowski
Gdansk University of Technology, Poland

Krzysztof Nowicki
Gdansk University of Technology, Poland

ABSTRACT

In this article we propose a novel e-learning system, dedicated strictly to knowledge assessment tasks. In its functioning it utilizes web-based technologies, but its design differs radically from currently popular e-learning solutions which rely mostly on thin-client architecture. Our research proved that such architecture, while well suited for didactic content distribution systems is ill-suited for knowledge assessment products. In our design we employed loosely-tied distributed system architecture, strict modularity, test and simulation-based knowledge and skill assessment and an our original communications package called Communication Abstraction Layer (ComAL), specifically designed to support communication functions of e-learning systems in diverse network conditions (including offline environment).The system was tested in production environment on Faculty of Electronics, Telecommunications and Informatics, Technical University of Gdansk with great success, reducing staff workload and increasing efficiency of didactic process. Tests also showed system's versatility as the system was deployed in environments of classroom, remote and blended learning.

INTRODUCTION

The task of knowledge assessment is one of the fundamental elements of didactic process. It was also one of the first didactic tasks to be conducted by various electronic learning devices employed to support didactic process.

Currently there are many e-learning solutions supporting knowledge assessment both as their

main functionality or as an additional module. Almost any advanced e-learning tool offers this functionality, with Open Source products like Sakai ("Sakai", 2007) and Moodle ("Moodle Course Management System", 2007) as prime examples. In light of those facts we could conclude that this area of e-learning is a well explored one and suitably supported in practical e-learning products.

Our experience with e-learning systems both as their users and designers, leads us to conclusion that the above statement is far from correct. Vast majority of currently available electronic knowledge assessment tools are extremely similar and offer strictly limited functionality. Such products offer almost exclusively knowledge assessment based on various choice tests and their automatic grading mechanisms most often are not very comprehensive and fit to support different grading scenarios.

In complex e-learning systems knowledge assessment functionality is treated as mandatory element, but also receives no special consideration, which often results in a simple implementation of choice test. Specialized knowledge testing solutions (employed for example by Microsoft during their computer proficiency exams) include more advanced mechanisms, like adaptive question selection, but they are few and still do not go beyond the basic scenario of choice test ("Learning Management Systems", 2004), (Jesukiewicz et al., 2006).

Apart from these weaknesses, our experience (Gierłowski & Gierszewski, 2004), (Gierłowski et al., 2007), (Nowicki et al., 2005), (Gierłowski et al., 2005), (Gierłowski & Nowicki, "Internet...", 2004), (Nowicki & Gierłowski, "New technologies…", 2004), (Gierłowski & Nowicki, "Implementation...", 2004), (Nowicki & Gierłowski, 2002), (Nowicki & Gierłowski, "Implementation…", 2004), (Gierłowski & Nowicki, 2002), (Gierłowski et al., 2003) indicates that one of the most serious problems with currently available products and especially the most popular ones based on

web-based thin-client architecture, is their strict dependence on network connectivity. Majority of such products require constantly active network connection during e-learning session and few are fit to function under other circumstances, such as periodic or no network connectivity, and still remain a part of managed e-learning system. The quality of network service is also a factor in case of many of such products (Gierłowski & Gierszewski, 2004).

Having analyzed above limitations of currently available knowledge assessment products, we designed and created our own dedicated knowledge assessment system. Its basic design differs greatly from currently available solutions, as it creates what can be called "knowledge assessment platform", servicing many forms of assessment and supporting tasks. It is also extremely scalable, easy to deploy, customizable and able to integrate with third-party products.

It was designed to provide highly modifiable platform for various knowledge testing tools, able to provide its functions in any network connectivity conditions (including no connectivity scenario). The system can scale from very simple setup (adequate for servicing a single exercise) to a large, distributed solution fit to support an enterprise. Strictly modular architecture allows users to employ only a selected set of its mechanisms and extremely easily integrate it with third-party solutions. The selection of employed modules depends completely on user needs – there is no mandatory control module or management platform which must be present.

We created a number of client modules with full sup-port for low/no-connectivity scenarios, for example:

1. the classic, but highly configurable and versatile, multiple choice knowledge testing solution,
2. an unique simulation-based knowledge and skill assessment module, dedicated to exer-

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