OUTLINING COMPETENCY-BASED AUTOMATIC CONTENT ADAPTATION

L. de-Marcos, C. Pages, J.J. Martínez, J.A. Gutiérrez
Computer Science Department. University of Alcalá
Alcalá de Henares. Madrid. Spain
luis.demarcos@uah.es, carmina.pages@uah.es, josej.martinez@uah.es, jantonio.gutierrez@uah.es

Abstract

Competency definition and standardization is actually a highly active research and development trend in the e-learning area. Meanwhile adaptive systems and techniques have a consolidated background and they have been widely used to construct personalized e-learning systems. This paper aims to join these two different areas developments in order to propose a new framework where competencies can be used to create standardized adapted contents for each learning activity participating learner.

Keywords
e-Learning, competency, learning object, personalized e-learning, Learning management system

1. INTRODUCTION

Within e-learning arena, the learning object (LO) paradigm drives almost all initiatives. This paradigm encourages the creation of small reusable learning units called learning objects. These learning objects are then assembled and/or aggregated in order to create greater units of instruction (lessons, courses, etc) [1]. Learning objects are stored and published in repositories so that instructional designers could localize and use them to construct learning experiences.

Although competency-based learning is not a new issue, some new trends are being explored in order to incorporate competencies to the current learning object paradigm in a standardized way. Such inclusion could open new challenges to research and development projects that are being carried out in that area. Concretely, this paper explores how competencies can be used to create content adapted to the knowledge and skills of individual learners.

The paper is structured as follows: Section 2 expounds how competencies are defined and addressed within current e-learning approaches, section 3 presents the components of a process that performs the automatic content adaptation, in section 4 a broader adaptation framework, enclosing the previous process, is proposed, and finally section 5 outlines conclusions and future research lines.

2. COMPETENCIES

“There is an enhanced focus the last few years on defending competency-based curricula rather than knowledge based curricula” [2]. Competency-based education encourages a model where learner records and achievements are defined in terms of the skills they acquire during the learning process. No grades or scales are used, so a learning program consists solely on set of qualifications that learners will be able to carry out [3]. “Competencies are multidimensional, comprised of knowledge, skills and psychological factors that are brought together in complex behavioral responses to environmental cues” [4].

A current trend in e-learning is trying to define and, delimit competencies inside the learning object paradigm. According to these works competencies could be addressed within this e-learning approach in a twofold way: (1) They can be used to define learner’s knowledge and current skills, and (2), they can also define learning objects prerequisites and expected learner outcome skills. These developments are also trying to define these issues in a standardized way, so that different systems could interoperate using common specifications.

It is worth quoting the following specifications:

- IMS "Reusable Definition of Competency or Educational Objective" specification [5],
- IEEE Learning Technology Standards Comitee (LTSC) "Draft Standard for Learning Learning Technology - Standard for Reusable Competency Definitions "[6] specification
- and HR-XML Consortium "Competencies (Measurable Characteristics) Recommendation" [7]

3. AUTOMATIC COMPETENCY BASED CONTENT ADAPTATION

Brusilovsky [8, 9] presents a taxonomy and a detailed report of adaptive hypermedia educational systems and frameworks. According to that taxonomy, adaptive systems could use different kinds of adaptive techniques. Concretely, adaptive presentation technology, adaptive navigation support technology and user modeling have been widely used for developing experimental educational systems. For web-based education systems, additional techniques, such as curriculum sequencing and problem solving support, are proposed in [10].

Figure 1 depicts a process that automatically sequence contents (learning objects) adapted to learner skills (modeled as competencies). This objective could be achieved simply using curriculum sequencing techniques and adaptive navigations support techniques (direct guidance) as proposed in literacy. Producing these contents in a standardized way, according to current e-learning specifications, is the innovation of the proposed model.

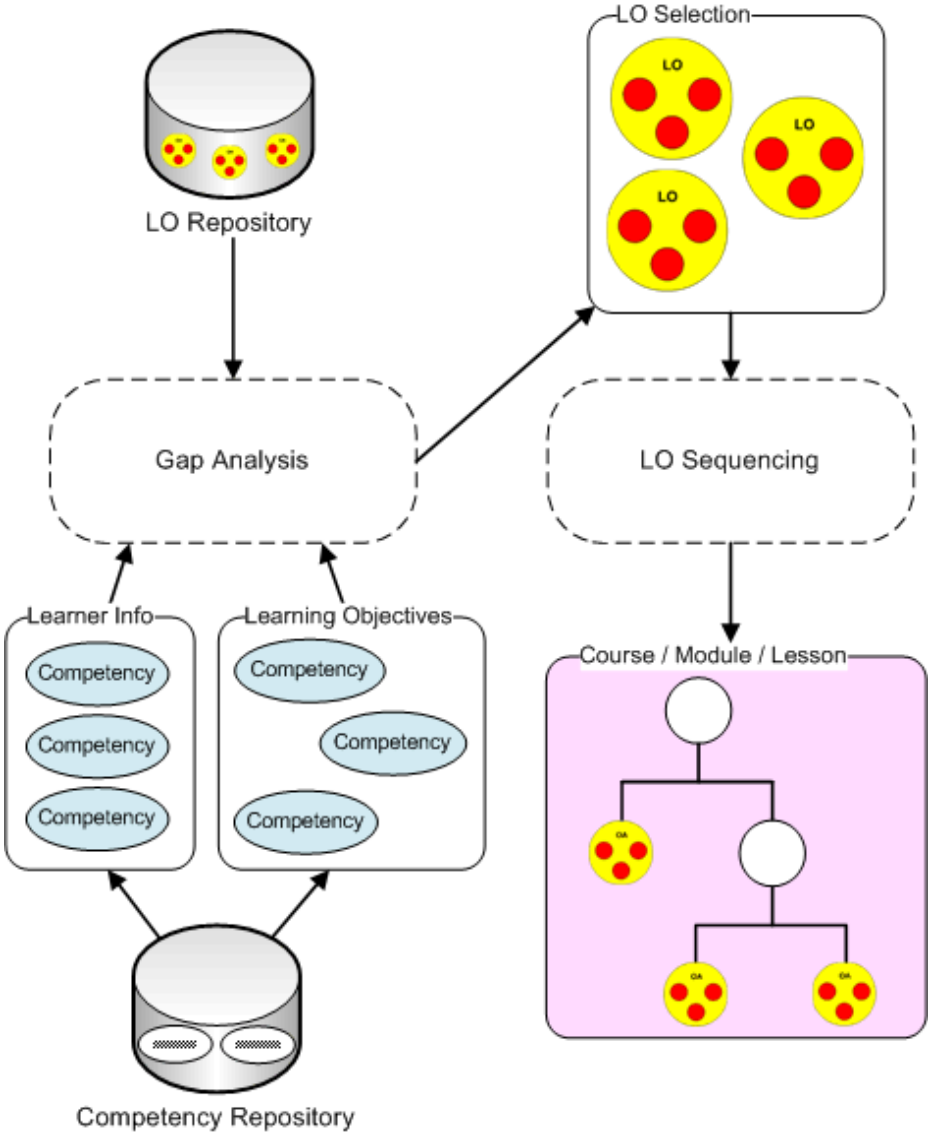

Figure 1. Automatic competency-based content adaptation process

Properly meta-tagged learning objects are stored in public standardized repositories. Some actor (i.e. a learning institution or an authority regulator) must select a set of competencies that will constitute the learning action objectives. Each individual learner skills are also modeled in terms of competencies. Learner competencies and learning action objectives are stored in a repository. Both sets of competencies constitute the input for a gap analysis sub-process. This process performs a search in local and/or distributed remote repositories in order to identify the set of learning objects that fill the gap between learner current knowledge and the learning objectives. Gap analysis techniques have been widely discussed [11].

An additional step is required to produce the adapted content. Gap analysis process returns a set of ordered learning objects, but these learning objects must be assembled and structured in a comprehensive way, so that basic units are presented to the learner previously to advanced lessons. These actions will be performed by the LO sequencing sub-process depicted in Figure 1. Above mentioned adaptive hypermedia techniques and intelligent tutoring systems background could be used to produce final contents, but authors' acknowledge that LO automatic sequencing sub-process require a deep research and traditional artificial intelligent and knowledge engineering methods should be considered.

E-learning standards and specifications usage will ensure interoperability among contents, systems and platforms, so compliance with these specifications is necessary to perform the automatic composition process. Mandatory specifications, in authors' opinion, include: IMS Digital Repositories Interoperability (DRI) [12], IEEE Learning Object Metadata (LOM) [13], ADL Shareable Content Object Reference Model (SCORM) [14] and the above mentioned competency specifications.

4. FRAMEWORK PROPOSAL

In this section, a wider framework that encloses the content adaptation process is proposed. The aimed objective is to present a complete teaching-learning model in which the automatic composition is the core process, identifying the actors and systems that take part in the interaction. Figure 2 depicts the framework.It is worth quoting that (1) a initial process for performing a competency assessment to incoming learners is necessary (i.e. adaptive testing offer appropriate methods); and (2) that learner's course taking may update his/her competency records, thus allowing new automatic compositions adapted to new competencies.

Once again, specification compliance will ensure interoperability among platforms and systems. Vendors widely adaption of previously mentioned specifications will allow for example: (1) competency sharing and interoperation across multiple repositories, think about employees moving from one company to another; (2) final courses and contents exchange among LMSs; and (3) to build integrated systems using solutions and systems provided by different vendors (content creators may offer learning objects, learning institutions should offer learning services using its own LMS, and secured recognized authorities will offer competencies data base services)

5. CONCLUSIONS AND FUTURE WORK

A process for performing competency-based content adaptation in a standardized way has been presented. This process has been enclosed in a wider framework that comprises the complete teaching-learning process in a highly automatic way.

Future research lines include intelligent learning object sequencing techniques and competencies aggregation (metadata inclusion and semantic processing will be required); competency-based user modelling analysis; negotiate and payment integration; and presentation & interface difference issues

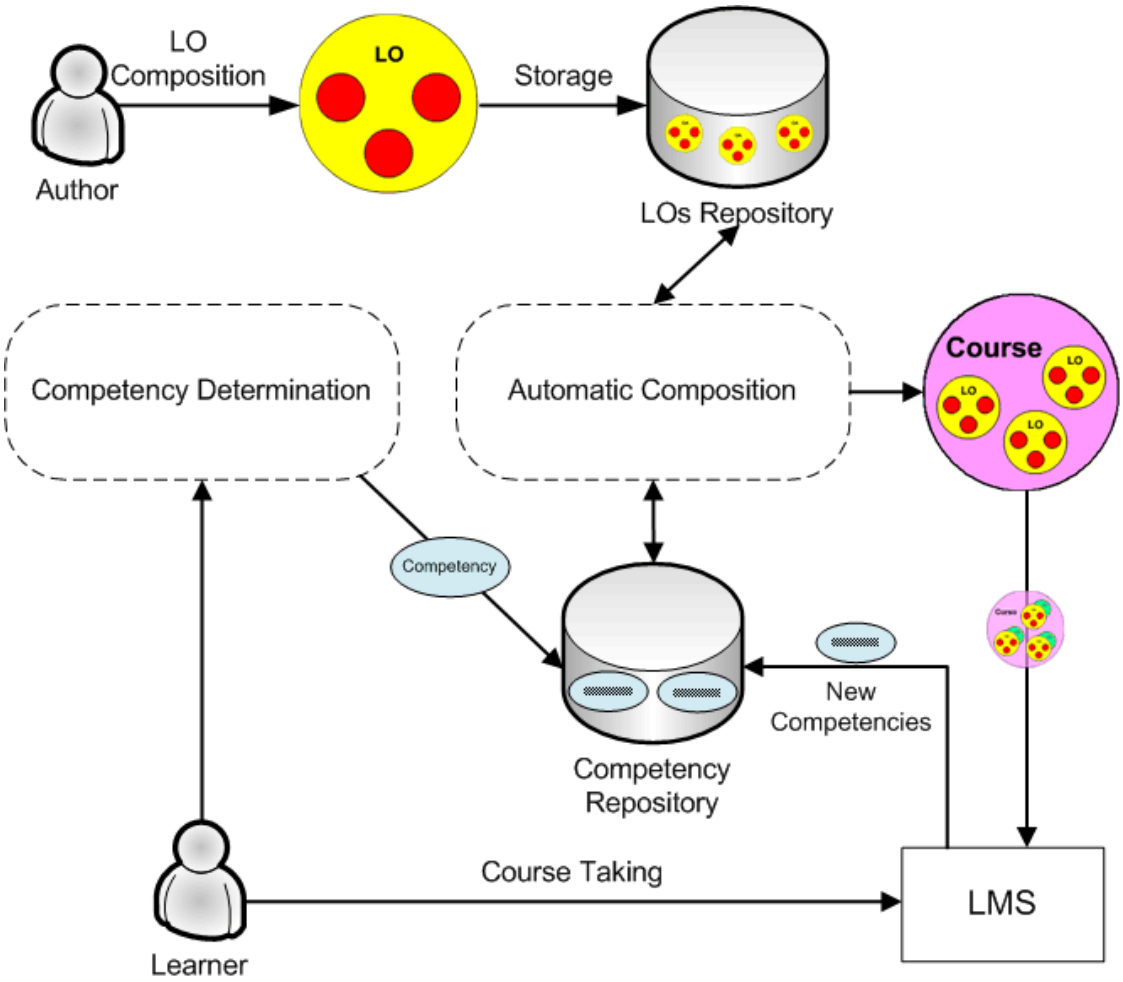

Figure 2. Framework Proposal

6. ACKNOWLEDGMENTS

This research is co-funded by: (1) the University of Alcalá FPI research staff education program, (2) the Spanish Ministry of Industry, Tourism and Commerce PROFIT program (grants FIT-350200-2007-6 and FIT-350101-2007-9), Spanish Ministry of Education and Science PROFIT program (grant CIT-410000-2007-5) and by (4) Castilla-La Mancha autonomous community under the educational innovation cooperation program. Authors also want to acknowledge support from the TIFyC research group.

References

[1] D. A. Wiley, "Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy," in The Instructional Use of Learning Objects, D. A. Wiley, Ed., 2000.

[2] T. J. Mouthaan, W. Olthuis, and H. Vos, "Competence-based EE-learning: (how) can we implement it?," in IEEE International Conference on Microelectronic Systems Education, 2003. Proceedings. 2003, 2003, pp. 33-34.

[3] D. Ainswoth, "Examinig de Basis of Competency-based Education," The Journal of Higher Education, vol. 48, pp. 321-332, May-Jun 1977.

[4] J. Wilkinson, "A matter of life or death: re-engineering competency-based education through the use of a multimedia CD-ROM," in IEEE International Conference on Advanced Learning Technologies, 2001. Proceedings, 2001, pp. 205-208.

[5] IMS, "Reusable Definition of Competency or Educational Objective - Information Model," IMS Global Learning Consortium, 2002.

[6] IEEE, "Learning Technology Standards Comitee (LTSC). Draft Standard for Learning Learning Technology - Standard for Reusable Competency Definitions," IEEE, 2006.
[7] HR-XML, "Competencies (Measurable Characteristics) Recommendation," HR-XML Consortium, 2006.
[8] P. Brusilovsky, "Adaptive Hypermedia," User Modeling and User-Adapted Interaction, vol. 11, pp. 87-110, 2001.
[9] P. Brusilovsky, "Methods and techniques of adaptive hypermedia," User Modeling and User-Adapted Interaction, vol. 6, pp. 87-129, 1996.
[10] P. Brusilovsky, "Adaptive and Intelligent Technologies for Web-based Education," Künstliche Intelligenz, Special Issue on Intelligent Systems and Teleteaching, vol. 4, pp. 19-25, 1999.
[11] M. A. Sicilia, "Ontology-based competency management: Infrastructures for the knowledge-intensive learning organization," in Intelligent learning infrastructures in knowledge intensive organizations: A semantic web perspective, M. D. Lytras and A.Naeve, Eds. Hershey: Idea Group, 2005, pp. 302-324.
[12] IMS, "Digital Repositories Interoperability - Core Functions Information Model," IMS Global Learning Consortium, 2003.
[13] IEEE, "Learning Technology Standards Comitee (LTSC). Learning Object Metadata (LOM). 1484.12.1," IEEE, 2002.
[14] ADL, "Shareable Content Object Reference Model (SCORM). The SCORM 2004 Content Aggregation Model." vol. 2005: Advanced Distributed Learning (ADL) Initiative, 2004.