Available online at www.sciencedirect.com
ScienceDirect
Procedia - Social and Behavioral Sciences 116 (2014) 3905 – 3910
Procedia
Social and Behavioral Sciences

5th World Conference on Educational Sciences -WCES 2013

Formalization of learning objects for image-based language learning in mobile environments

Oleg Starostenko [a] *, Claudia Perez-Lezama [a], V. Alarcon-Aquino [a], J.Alfredo Sanchez [a]

[a] *Department of Computing, Electronics and Mechatronics, Universidad de las Americas Puebla, Cholula, Pue. 72810, Mexico*

Abstract

Current mobile learning approaches demand for combining learning media and resources, open communities and customizable tool for individuals. We have focused on the formalization of learning digital resources using the Formal Learning Object Model (FLOM), which describes required components for constructing learning objects, their life cycle from inception to implementation, establishing tasks and roles of all actors involved in the development, learning, interaction, evaluation and feedback processes. The FLOM model has been evaluated on an image-based language learning application, which has been designed for interpretation of Japanese kanji and Mayan glyphs, using emerging data exchange technologies and some approaches for retrieval and visualization of multimedia documents in mobile environments.

Selection and/or peer-review under responsibility of Academic World Education and Research Center.
Keywords: Mobile language learning, learning objects, multimedia document processing, educational technology;

1. Introduction

The development of technological tools that promote personalized learning as well as environments where individual users can create and maintain digital learning material is related to the creation and usage of learning objects (LOs). LOs are atomic or self-contained information units that could be available in different formats, related to other resources, combined for forming more complex units or resources and shared through repositories (Pérez & Sánchez, 2011; Polsani, 2003). Current reports about LOs have been focused mainly on their conceptual definition (attributes, characteristics, taxonomies, life cycle), creation (size, granularity, design tools), use (metadata for searching engines) and storage (management of LO repositories) (Ciaffaroni, 2006; Oldfield, 2008; Pérez-Lezama, 2012). However, *a)* most tools are not based on formal pedagogical or instructional design models; *b)* they do not take into account student's interests, skills and knowledge; *c)* they do not promote the creation of learning communities with collaborative generation of LOs; *d)* there are no formal specifications on how to achieve interoperability between created networked repositories. Thus, we have proposed a formal model for the generation of LOs, where a learner becomes the developer of LOs by adapting technology-based multimedia resources according to their own needs and learning styles. This model, referred to as FLOM, was first introduced in (Pérez-Lezama & Sánchez, 2010). In this paper we discuss the use of FLOM for the case of image-based languages that use

* Corresponding name:Oleg Starostenko. Tel.: +52 222-229-2654
E-mail address: oleg.starostenko@udlap.mx

Selection and/or peer-review under responsibility of Academic World Education and Research Center.
doi:10.1016/j.sbspro.2014.01.864

Japanese kanji and Mayan glyphs, which have been selected to develop a learning environment on mobile devices. Taking into account the convergence occurring between new conceptions of learning and new mobile technologies, it is a challenging task to develop appropriate learning distributed environments, which may support users on the move operating in informal situations considering the ubiquitous nature of learning. As a result, we have designed computational approach for multimedia documents processing suitable for mobile devices, optimizing their user interfaces to mobile language learning activities, particularly for learning Mayan glyphs and Japanese kanji anywhere anytime. Obviously, language learning goes beyond symbol recognition, but the ability to generate and manage LOs and services, to carry out actions according to specific behavioral model empower users to become active learners responsible for their own knowledge acquisition and decision making.

2. The formal learning object model (FLOM)

The main function of LO is to facilitate re-use, distribution and customization of educational contexts on Internet. Numerous attributes of LOs have been discussed in literature that include granularity, durability, mobility, interoperability, accessibility, scalability, reusability, extensibility, productivity, and manageability (Polsani, 2003; Ciaffaroni, 2006; Hernández et al., 2008). LOs can be created from combination of simple resources or from the meaning acquired by resource depending on its context. Actual composition/content models lack the formalization of aggregation levels or functional granularity of Los, which is necessary for establishing how multimedia resources should be assembled in order to build a LO. Salient projects that propose formal models for composition of LOs are summarized in Table 1.

Table 1. Main features of formal models

Model	Main focus	LO composition	Formalization approach
3-level model (Bouzeghoub et al. 2006)	Three-level Model (domain, learner, LO) based on a semantic description of each LO	a) Web page, file or program b) Operator-node, LO-node, query-node; c) ILO	RDF implementation of the description model
Multi-facet model (Hernández et al., 2008)	Multi-faced representation of documents using LOM/SCORM, educational theory thematic and learning design diagram	a) Assets; b) SCO; c) CA	UML. It uses IMS-LD to model sequencing activities allotted to each role to attain goal of course
3-part conceptual model (Knight et al., 2006)	3-part conceptual model introduces learning object context level between learning design and learning objects layers	a) LO b) LOC	3 ontologies: learning object content, learning design, connecting ontologies using OWL and Protegé
ELO (Santacruz, 2005)	Assemblies and reuse of LO through ontologies	a) Information unit; b) Content unit; c) Didactic unit	OWL, XML Schemas for IU, CU and DU

The main deficiencies of presented models are: *a)* zero participation of learner in creating LOs; *b)* lack of formal specifications to describe how performers interact in development of LOs; *c)* rather informal validation of proposed models; *d)* model is not accompanied by a development methodology. Thus, the proposed formal model must detail required components for digital resources to be considered as learning object and must state the type of interactions that should exist between actors involved in the LO development process. Although there are different points of view with respect to LO components, we consider that LO must be composed of the following elements: *Learning objectives* (educational goals that must be reached after using LO); *Competencies/Skills* (abilities, attitudes and values acquired after interacting with LO); *Requisites* (knowledge or competencies the learner should have acquired previously in order to be able to take advantage of LO); *Content (*digital resources that make up LO); *Practice (*tasks the learner must perform while interacting with LO); *Evaluation* (mechanisms designed to measure knowledge acquired after interacting with LO); *Metadata (*predefined identifiers that facilitate LO storage, organization and searching). Thus, we have developed a hierarchical structure defined by four layers (see Table 2), which describes the elements that comprise LO and how such elements can be assembled to obtain meaningful resources.

The description of LOs just introduced is integrated into FLOM, which consists of composition and group models. The composition model specifies the elements making up LO and the way in which these elements must be assembled. Three diagrams in UML notation can be used to describe the composition process of LO (structure), the minimum content required to conform LO (elements) and the metadata used to describe LO. The group model

identifies the main activities of LO generating via organizational structure, collaboration and use cases diagrams. We have implemented a software environment that demonstrates how FLOM works with three major players: the learner, who takes courses; the facilitator, who teaches courses; and the administrator, who manages courses (Fig. 1). The course comprises topics, which in turn are composed of LOs. Players access system components in four categories: administrator (2 modules), facilitator (3 modules), learners (3 modules), and shared repositories. The minimum components for creating a LO are: metadata, pre-requisites, competences, and at least four IOs which are assembled from DOs. These can be images, audios, videos or text, and each DO is in turn a group of bytes. Therefore, this model clearly defines the elements required for creating LOs and permits establishing the roles involved in LO development and activities assigned to each role during the generation of LOs.

Table 2. Layered formal model for description of LOs

Layer 4: Learning Collections (LCs)	LC is comprised of LOs. It includes associated knowledge, requirements necessary for its understanding, specific objectives, exercises or practices on the subject, and partial evaluations of such subjects. Examples of LCs are tutorials, sections, chapters, courses, units and topics.
Layer 3: Learning Objects (LOs)	LO represents knowledge acquired after understanding, applying, synthesizing and evaluating a specific subject. LO is formed by combination of at least four IOs: content or associated knowledge IO that has certain requirements for its comprehension, learning objective IO, exercises or practice IO that ensure understanding of subject and evaluation or feedback IO to measure acquired knowledge after interact with the object. Examples of LOs are demonstrations, principles, procedures and processes.
Layer 2: Information Objects (IOs)	IO is composed of various DOs assembled in template to ensure a sequence and a logical order. Since the IOs are compound entities, they may require a certain prior knowledge in order to be comprehended. Examples of IOs are definitions, examples, exercises, concepts and summaries.
Layer 1: Digital Object (DOs)	DO is a simple object that contains unique resource, possibly consisting of multimedia contents. DO by itself does not complete learning objective nor does it provide user with knowledge about specific subject. Examples of DOs include texts, videos, audios, images, graphs, tables, figures, and animation.

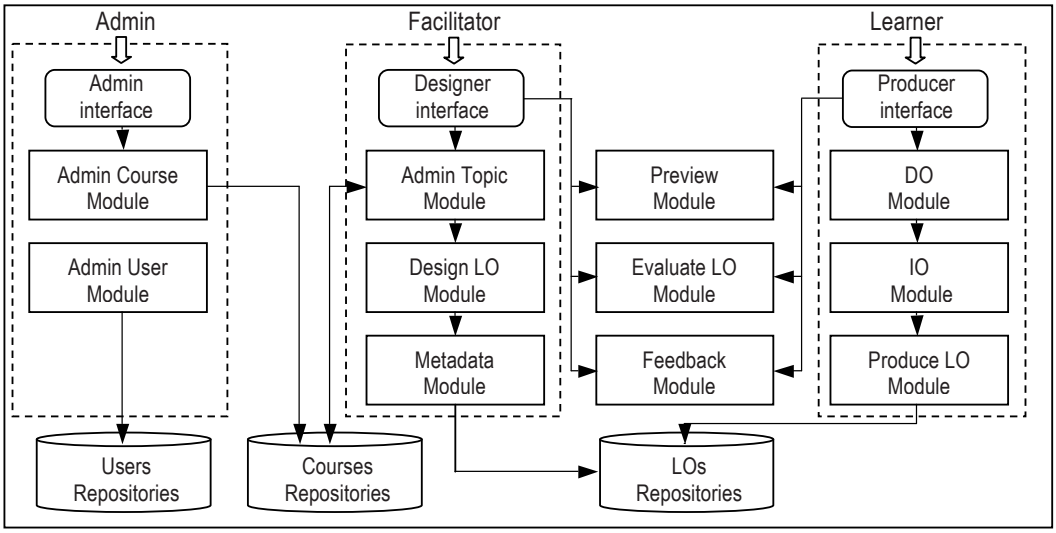

Figure 1. FLOM software architecture.

3. Designed system for image-based language learning

We have used FLOM for the development of a functional prototype for image-based language learning (Japanese kanji and Mayan glyphs) on mobile devices, a block diagram of which is shown in Fig. 2. The implementation technique selected for exploiting mobility and access to information and services was the Model View Controller using a server-thin-client approach and providing simple definitions of data structures and development of high

performance dynamic interactive interfaces. The server is implemented on an Intel processor architecture under OpenSUSE 11.2 Linux OS, using a GCC compiler supported by the BlueCove library. The client is implemented on Sony Ericsson phones Java platform 8.3 supported Java ME, with screen resolution of 240x320 pixels using specifications JSR-75 JSR-82, JSR-135 and JSR -234 that support JPEG images.

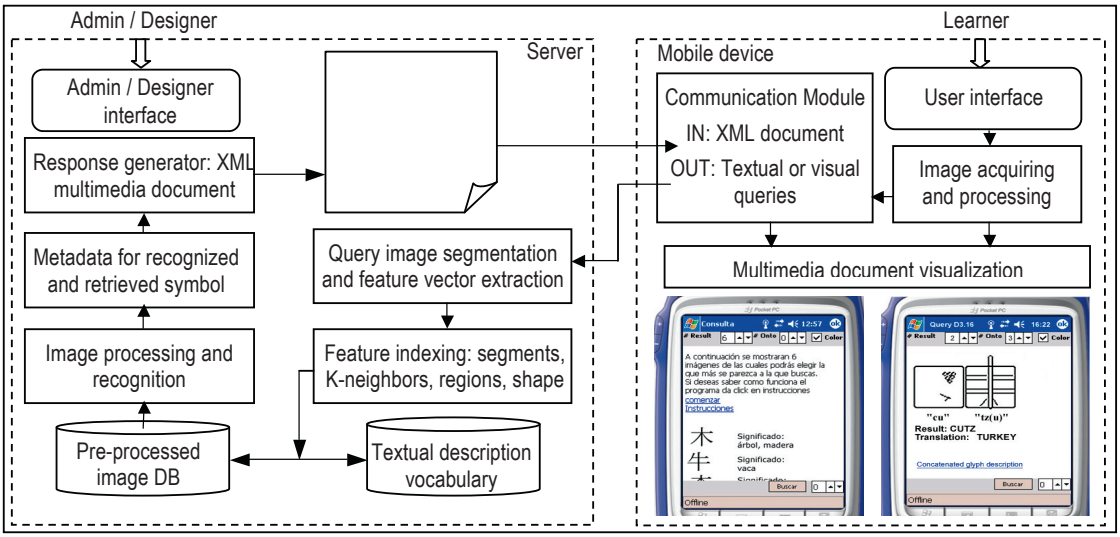

Figure 2. Block diagram of system for Japanese kanji and Mayan glyphs recognition and interpretation.

For image processing and classification the *K*-nearest neighbor shape algorithm has been used to take advantage of their simple implementation and high speed that provide symbol recognition in real time. A learner generating LO sends a query and receives XML document, which contains relevant multimedia information about a learned character, corresponding metadata and reference to other dictionaries retrieved from Pre-processed symbol image database and Textual description vocabulary. Considering that portable devices have limited resources, small screens and restricted processing and networking capabilities the optimized interfaces for LO generation and management have been developed, which provide language learning activities on mobile devices.

4. Experiments and discussion

The most critical steps of the designed system are segmentation and recognition. Six training sets with more than 200 symbols have been used for tests. Each set contains symbols with similar structure, where vertical, horizontal, diagonal or circular segments are dominated. Table 3 shows the segmentation ability and recognition precision.

Table 3. Evaluation of segmentation and recognition algorithms for Kanji and Mayan glyphs

Total characters in the testing set	Correct kanji segmentation (%)	Correct Mayan glyph segmentation (%)	Precision of kanji recognition (%)	Precision of Mayan glyph recognition (%)
34	90	92%	84	85
35	89	94%	86	90
35	90	92%	85	88
32	89	89%	84	85
32	84	88%	82	86
35	86	91%	83	88
Total: 203	**Average: 88%**	**Average: 91%**	**Average: 84%**	**Average: 87%**

The average percentage of correct Mayan glyph segmentation and recognition is about 91% and 87%, respectively. The precision of Japanese kanji is less than Mayan symbols due to small distance between segments

that compose kanji. The experiments show that proposed image processing approach is rigorous enough and correctly retrieves recognized images (Starostenko & Alarcon-Aquino, 2010). The response time for different steps of recognition process is: image acquisition - 0.2s, preprocessing - 0.6s, segmentation - 0.2s, symbol retrieval - 0.5s. 1.5 seconds per symbol is acceptable time. The average recognition time does not include communication delays.

The evaluation of FLOM environment was well appreciated by participants, since they found it easy to use. Facilitator and learners were able to perform their assigned tasks without any serious difficulty. We obtained favorable user feedback because students actively participate in development of LOs and share obtained knowledge with different people in mobile environment promoting the generation of collaborative learning communities.

5. Conclusion

This research is important for CSCL area because it defines general mechanisms for using technologies promote a change of learner role in virtual environments where student become developer of LOs adapting technology-based multimedia resources according to his own needs and learning styles. The proposed formal model transforms LOs into fundamental elements of learning and defines interaction that must exist between actors involved in LO development. Another advantage is the possibility of sharing LOs with other students creating virtual learning communities. The designed infrastructure for integration of mobile devices to distributed environment provides learners with simple access to the most recent content data and educational resources using emerging technical standards and specifications of wireless network technologies. The designed software embedded in portable devices may be considered as pedagogical agents for mobile learning acting as a tool to perform a task, to assist learning, to help a learner to generate and organize ideas, to provide guidance on developing skills, etc. The computational approaches implemented and tested in proposed system can suggest ways of studying and organizing resources remembering ideas and events. Finally, the proposed approach could be considered as alternative way for the development of image-based language learning systems assisted by mobile devices.

Acknowledgements

This research has been partly supported by European Grant #247083: Security, Services, Networking and Performance of Next Generation IP-based Multimedia Wireless Networks

References

Bouzeghoub A., Defude B., & Lecocq C. (2006). A knowledge-based approach to describe and adapt learning objects, *Journal on e-Learning; ProQuest Education Journals*, 95.

Ciaffaroni M. T. (2006). What learning theory behind the learning objects? *Current Developments in Technology-Assisted Education*. 726-731. Retrieved from http://123seminarsonly.com/Seminar-Reports/037/47803733-726-731-e-learninglearning-theory.pdf

Hernández N., Mothe J., Ralalason B., Ramamonjisoa B. & Stolf P. (2008). A model to represent the facets of learning objects. *Journal of e-Learning and Learning Objects*, 4.

Knight C., Gasevic D., Richards G. (2006). An ontology-based framework for bridging learning design and learning content. *Educational Technology & Society*, 9(1), 23-37.

Oldfield, J. D. (2008). An implementation of the generative learning object model in accounting. *In Proceedings ascilite Melbourne 2008,* 687-695. Retrieved from http://www.ascilite.org.au/conferences/melbourne08/procs/oldfield.pdf

Pérez C. & Sánchez, J.A. (2011). Learning through the collaborative development of learning objects. *EDMedia*, Lisboa, Portugal.

Pérez-Lezama, C. & Sánchez, J.A. (2010). A formal model for learning objects. *In Proceedings of the International Conference on Education and New learning technologies*. EduLearn 2010, Barcelona, July, 5-7.

Pérez-Lezama, C. (2012). *A Formal Specification for the Collaborative Development of Learning Objects.* (Ph.D. dissertation, Universidad de las Américas Puebla, Mexico, 2012).

Polsani P. (2003). Use and abuse of reusable learning objects. *Journal of Digital Information*, 3(4). Retrieved from http://journals.tdl.org/jodi/index.php/jodi/article/view/89/88

Santacruz L. (2005). *Automatización de los procesos para la generación, ensamblaje y reutilización de los objetos de aprendizaje.* (PhD dissertation, Universidad Carlos III de Madrid). Retrieved from http://hdl.handle.net/10016/685

Starostenko O. & Alarcon-Aquino V., (2010). Computational approaches to support image-based language learning within mobile environment, *Journal of Mobile Learning and Organisation*, 4(2), 150-171.