ECOOL: Generation of Collaborative Multiplatform Scenarios with Interactive Learning Objects

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Abstract In this paper we present a method for automatically generating a series of Collaborative Multiplatform Scenarios based on Interactive Learning Objects. The overall learning process of a learner interacting with an eLearning system is interpreted as a workflow that provides tools to guide individual and group learning processes. There is a plethora of learning environments but the collaboration management and definition is only included intrinsically, while in this approach is explicitly included as a first class citizen and spread over the whole process. On top of classical standards used for specifying learning objects, a meta-description of scenarios is defined based on an extension brought to UsiXML, a XML-compliant User Interface Description Language. Describing a user interface in this way facilitates the automated generation of user interfaces over multiple computing platforms while maintaining portability and consistency between the multiple versions. Finally, the extension brought to UsiXML is intended to support the interaction description via Learning Objects. This approach is illustrated based on Claroline, an open Source eLearning and eWorking software platform allowing teachers to build effective online courses and to manage learning and collaborative activities on the web for the learners.

1. Introduction

A *learning object* is defined as a self-standing, reusable, discrete piece of content broken down into smaller chunks that can be reused in any environment in order to meet an instructional objective [22]. They can be presented in many forms [7] such as web pages, PDF documents, video, audio, animation and 3D representations [17]. Learning objects have been developed in order to technological and pedagogical support the virtual education. Nevertheless, these products can be

used under any condition or circumstance where the training or the distribution of the knowledge is required; classroom lessons, staff training in the industry, self-learning process, among others. The concept of reusable learning object has evolved from the need to standardize and reuse online learning material [22]. In order to become reusable, a learning object must include information about its own contents in the form of metadata. These metadata allow the object to be indexed, making it easy to store and to retrieve from a repository. The Learning Object Metadata (LOM) IEEE standard establishes which kind of information could be stored to assure interoperability between *Learning Objects Repositories* (LORs) [13]. This implies some economic advantages (e.g., create once, use several times) as well as pedagogical advantages (e.g., high quality interactive multimedia easily available for courses, individualized learning) [1]. There is a big need for more and better education, to find ways out of poverty and to give all children the possibility to have access to education. To become efficient and stimulating you need a strategy to follow [1]. A strategy has been the use of audio visual content, taking advantage of human's cognitive system which responds more effectively to visual perception stimuli compared to the textual processing. Audio visual content includes the Virtual Reality (VR) channel. VR has been used to represent learning objects in Interactive3D [17], an effort that combines a pedagogical concept and VR to cover the lack of literacy in Africa for effective learning, it provides users online access to a set of interactive learning VR objects. While VR is *the option* in the Interactive3D project, in our context we consider VR as *an option* for the final representation of the learning object User Interface (UI). There is considerable variation between individuals in the way they learn, and an individual may well learn in different ways at different times. In order to learn effectively, it is important to tailor your study habits to your own needs and style, this often means choosing techniques that help you to learn. In this paper, a method to support the design of collaborative Learning Objects is presented. Section 2 presents all the related concepts used to specify learning processes, task models, roles, context, and learning objects, as well as the method used to derive the UI of a learning process. Section 3 describes and evaluates the related work. The paper ends with some conclusion and discussion about the future work.

2. ECOOL: supporting the dEsign of COllaborative Objects for Learning

ECOOL is a virtual learning environment (VLE) architecture conceived to support the design of learning content on a collaborative context. ECOOL relies on the existing characteristics of a VLE system, Claroline [8], which are:

- *Users' manager:* supporting mechanism to add, delete and modify (ADM) users, provide access to the system, determine access privileges, provide assistance to recover a password.

- *Courses' manager:* supporting mechanism to ADM courses. Accordingly to user's privileges users:
  - *Search for courses*, providing different mechanism to search the courses' database.
  - *Visualize the content of a course*: description, agenda, and announcement.
  - *Visualize your courses*, when users login the system they visualize just the courses they are registered.
  - *Register/Unregister* to a course. Registering a new course includes *metadata* about the author of the course, related information, keywords, etc.
  - *What's new* section, mark new content on the web site
  - *Agenda,* each course has its agenda of the course which is normally edited by the professor or administrator or the course.
  - *Announcements* section to post messages relevant to the course. The characteristic of an announcement is that it can be sent by email to the student registered to the course.
  - *Documents and links* section is a collection of files and hyperlinks to content relevant to course.
  - *Exercises* section provides a list of exercises related to the course, with an evaluation, if it is the case.
  - *Learning path* section describes a sequence of tasks to be performed (this feature is discussed in the next section in detail).
  - *Assignments* section groups the assignments given by the professor for the course with the following characteristics: title, type, start and end dates.
  - *Forums* section shows discussion between the groups, number of posts, the date of the last message, and the topics in each group.
  - *Groups* section allows user to group between each other, naming groups, defining the maximum number of members that can be part of it.
  - *Chat* section allows users to interact while they are logged in the system using text messages.
  - *Users* section shows the students registered to the course, their personal data, profile, role in the course and, the group name.

For learning environments the requirements are numerous [7]; among them: **Interactions**, metadata associated to the learning object for rich interaction, for instance, questioning the system for examples. Users, different categories of users are capable of manipulating the system. **Information**, the information corresponding to learning objects (source, maintaining information, sharing information). **Workflow support**, for instance, workflow techniques, i.e. the document produced by X must be sent for approval to Y and Z before to be displayed; controlling who is in virtual space, who is (and has been) doing what; following the evolution of the learning process. A reference framework to support collaboration in the context of education is characterized by: flexibility, adaptability to the users, to specific needs and situations.

2.1 Learning paths revised

In our proposal, this feature is based on the platform iCampus of the Université catholique de Louvain (www.icampus.ucl.ac.be) and has been created on top of Claroline [8], an open Source eLearning and eWorking software platform allowing teachers to build effective online courses and to manage learning and collaborative activities on the web for the learners. This allows us to define a set of exercises to be done, to achieve the next task users must do the exercises, the progression on each exercise is stored and displayed on the screen, students and professors are aware of the progress on each task. This feature is coordinated with system user agendas (teachers/students) in order to see the overall development of the learning process. Figures 1 and 2 are taken from iCampus only for demonstration purposes. Figure 1 shows a small learning path for understanding how to select a usable widget in UI design that fits the user's needs. For this purpose, the learner has to read and understand some preliminary documents (some of them could be documents in iCampus or external URLs), then go to exercises.

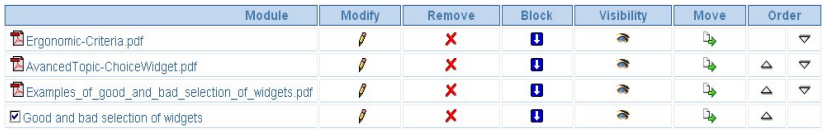

Figure 1. Learning path for selecting a usable widget.

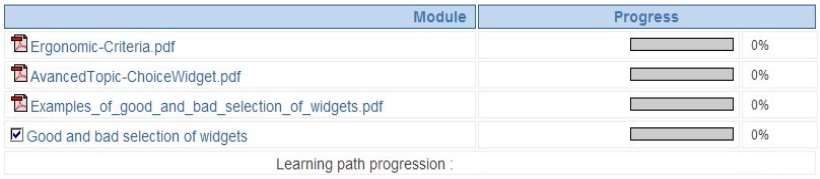

Figure 2. The progress of the student could be seen as percentage lines.

2.2 ECOOL Architecture

We designed the ECOOL system following a three layer scheme (Figure 3). The First layer includes seven modules: The LO management module (in charge of LO modification), the assessment engine (in charge of recovering evaluations in order to present them to the user), the translation engine for transforming our definition from/to known standards as well as including rules to produce a LO from the definition of a task to some specific UI, Collaborative tools module (Email, forum and chat), the security module (in charge of authentication issues) and finally a designer tool (Figure 3, section 1). All these modules are in communication and under the authority of a major component: the workflow management tool. Indeed, this component will deliver the other part of the collaborative process, the modeling and control of the flow of all the activities in the Virtual Learning environment.

The second layer deals with persistence issues (the data base control and management) besides the application server (Figure 3, section 3). This section corresponds to any typical middleware architecture. The only novelty is the strict separation between the LOs and the assessment repositories (Figure 3, section 2). Next, we have the client layer (Figure 3, section 4) where after the first admission to the system, it would be mandatory to download a client engine/plug-ins to deal with the virtual renders and extra capabilities provided by the 3D world [11] and Rich Internet Applications [16].

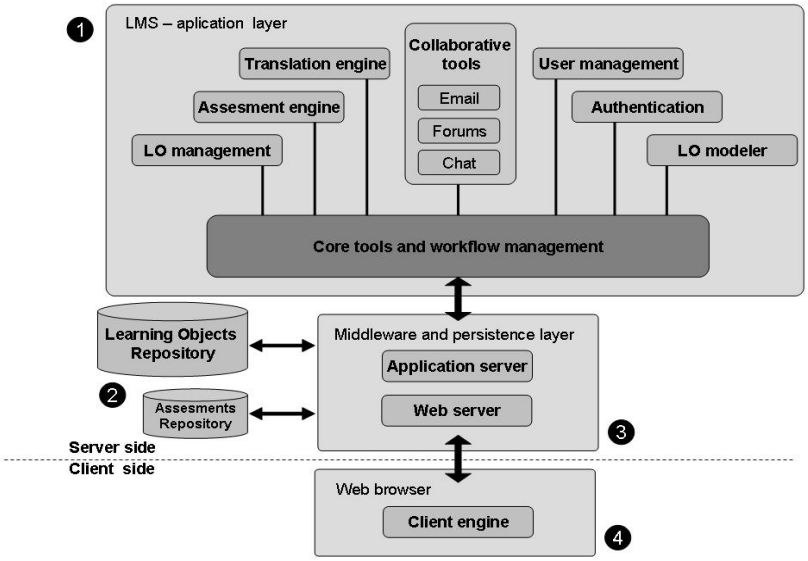

Figure 3. Architecture of ECOOL.

2.3 Meta-Model

The structure of a LO could be specified by four elements components: Knowledge unit with any learning goal, exercise, evaluation and related subjects [16]. The first element is the knowledge content of any area where a learner can study in order to cover a learning goal. The exercise allows put in practice the theoretical aspects coming from knowledge unit with any learning goal using interactive simulation mechanisms in order to learn by doing, design by him/her self problem and solutions. Evaluation component offers to user a series of tests to auto-evaluate his/her acquired theoretical and practical knowledge. The final part gives further information on line about other related learning object. We proposed a workflow model [12] that is composed of workflow, process, task and organizational models (Figure 4). The workflow model is recursively decomposed into processes which are in turn decomposed into tasks (Figure 4, section 1). Now, as

there are many different learning types and approaches to learning, this is believed to occur as a progressive series of tasks, i.e. a workflow. So, a workflow model can be used to plan and to design the process of all aspects of learning. There is a teaching process for the instructors, a learning process for the students/learners, and an organizational workflow for all participants, and a management workflow. All these components interact to each other to form an overall learning workflow. In order to have a graphical representation, we can use Petri Nets [20] for the specification of processes, and CTT [18] for the representation of tasks (Figure 5).

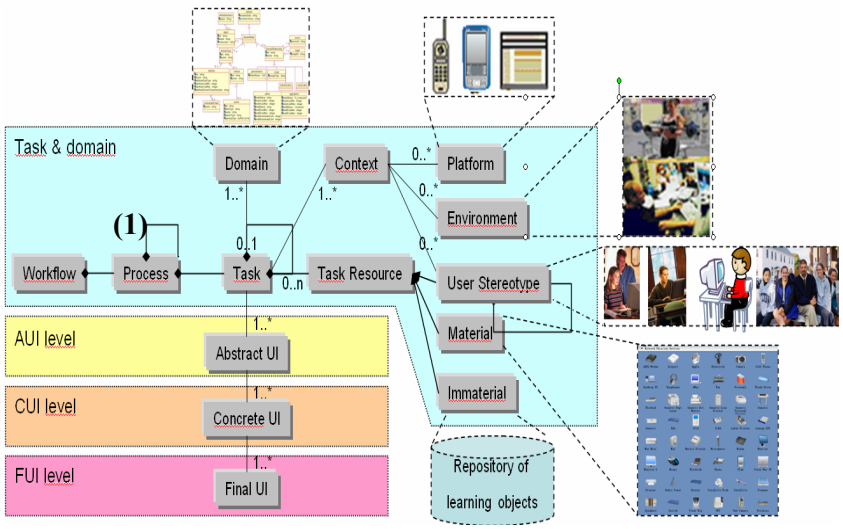

Figure 4. Meta-model of ECOOL.

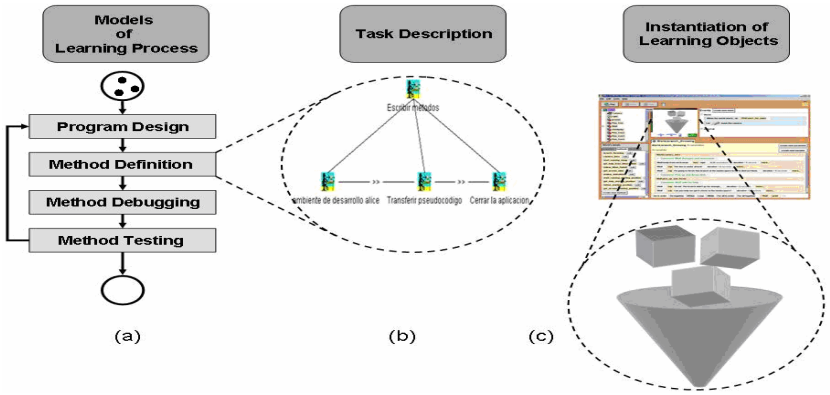

Figure 5. Example of User Interface design in terms of Petri nets and CTT trees.

A learning environment is a social space where multiple actors (also called users) produce information. It is possible to see the social space as an organizational unit where each user has a job (the total collection of tasks, duties, and responsibilities assigned to one or more users) and has a hierarchical position inside the social space. Between the principal users are: teachers, students, domain experts, manager, among others. The idea of building learning spaces is that users interact intensively through them and share information in order to learn, then the users could work as groups in cooperative (working together in a same project at different time), collaborative (working together in a same project at same time), competitive (striving for the same object, position, etc.), or coopetitive (the combination of cooperation and competition) way. For instance: Dominique Stuart (user), a teacher (job) in computer science faculty (organizational unit), has 10 students (users/job) which need to work in the resolution of simple equations (task). In order to facilitate the task and integrate all students, she decides that students will work in pairs (groups) and the couple that resolves the equations in less time (competition) wins an extra point.

2.3 User Interface model for learning objects

The method proposed expands the current User Interface Description Language (UIDL) UsiXML [15], based on the CAMELEON Reference Framework [4] and introduces a higher level of description with the workflow model. The current models are: *Task Model* that represents user's tasks along with their logical and temporal ordering; *Domain Model* with concepts as classes, attributes, methods, objects and domain relationships; *Abstract User Interface Model (AUI)* that represents a canonical expression of the rendering and manipulation of the domain concepts and functions in a way that is as independent as possible from modalities and computing platform specificities; *Concrete User Interface Model (CUI)*, a UI model allowing a specification of an appearance and behavior of a UI with elements that can be perceived by users; *Context Model*, a model describing the three aspects of a context of use in which an end user is carrying out an interactive task with a specific computing platform in a given surrounding environment; *Inter-Model Relationships* (i.e., the mapping model), model integration is a well-known issue in transformation driven development of UI; *Final User Interface (FUI)* that Corresponds to the code generation for common languages such as: Java, Flash, HTML or even for Three-dimensional UIs [11].

3. Related Work and Discussion

There is a plethora of computer-assisted learning environments/tools [21]. For the sake of simplicity, Table 1 presents only a few of the possible environments that could help us to understand the current state of the area. The needed requirements for an interaction system in the learning domain should include [1]: First,

the facilities to interact during and after the lecture; Second, an open architecture which should include the possibility of allow extensions. And third, the system must be scalable (i.e. the system should be able to manage a single course or a whole university). We are going to use loosely these requirements as base of comparison between *Learning Management Systems* (LMSs). The platform of choice for most of the learning environments is the web browser [1,5] (this platform helps in the scalability and open architecture issues). Also, common elements are: tools for creating course material, assessment as well as collaborative tools (forums, emails and chats). These tools achieve the goal imposed by the first requirement because with them we could deliver interaction during and after the lecture (synchronous and asynchronous learning modes [14]). The adhesion to standards such as SCORM is part of all environments but alternative or modified versions are often available (for instance, Hard SCORM [14]). There is a lack of integral treatment of collaborative facilities and the control is leaved to the users. Also, the management of users and roles is contemplated in most of the systems but the collaboration is not controlled nor modeled in the system [21]. Specifically, some researchers are exploring the power of workflow modeling in LMS e.g. [5] where the system is aware of the different pace and interests of students. These approaches are near to our work. However, our proposal expands the concept with the integration of the automated UI definition and the modeling of LOs with an orientation to 3D Objects. In the other hand, the process of creation of the UI is straightforward: there is a general theme and platform, and the results are always the same. The process of customization is reduced to changes in style, size and colors, in fact professors could not really define the course structure, just create content [5]. Major changes could be delivered by plug-ins (also to cover the scalability requirement) but this implies a separated design process and recoding. For instance, in [23] the author proposes a migration of Moodle [10] to the mobile domain. The process involves manual changes in order to fit the new platform. Also systems such as [1] are constrained to a single platform unless there is available a port but the system itself is not capable of deliver such changes in the UIs that cover LOs [23, 1, 21]. Other possibility to overpass the problem of the extensions is using a *Service Oriented Architecture* (SOA) as in [6] where some functionality is leaved outside the LSM and make it available though web services. As last commentary in this review, we observe that most of adaptation is limited. Specially, two capital features in the analyzed environments: Customizable interfaces and Personalization. All of the systems are unable to offer the UI capabilities of the *ECOOL* proposal. Since we have a meta-definition of the UI in order to provide portability and ease in the updating and migration processes. Besides that ECOOL includes workflow features that are missing (or not integral part of other environments). Note: Table 1 includes the following information: License type (Commercial, Free software and Open Source), the scalability of the system, the collaborative facilities definition or standard of the LOs used. Finally, in a very rough way, we could classify them in two kinds of systems: Learning management systems (LMS) and Course management system (CMS) depending on their focus to course management or the control of the whole learning process.

Table 1. Comparing different learning tools.

Name	License	Language	Type	UI Design	3D	Collaborative facilities	Scalability
Claroline [8]	O	PHP	LMS	+	-	+	++
Dokeos [8]	F , O	PHP	CMS	+	-	+	++
Moodle[10]	F , O	PHP	CMS	+	-	+	++
Sakai [21]	F , O	Java	CMS	+	-	+	++
Blackboard [3]	C	Java	CMS	+	-	+	++
Sloodle [19]	F , O	PHP	CMS	+	+	+	+
ECOOL	F , O	Neutral	LMS	++	++	++	++

4. Conclusion

In this paper we have presented an alternative method for the automatic generation of Collaborative Multiplatform Scenarios with Interactive Learning Objects. The overall learning process is seen as a workflow. This approach introduces a flow control that allows tackling at the same time, the problem of divergence in individual learning and the definition of the learning process in terms of collaboration agents and processes i.e. giving the system the capacity of managing collaboration between students/professor, as well as, defining in an explicit way the network and control points of collaboration. Other innovation is the modeling of the interaction of the LOs which includes the introduction of a meta-description (in UsiXML) that is going to aid in the process of generation of multiple UIs to be spread over multiple platforms. Instead of creating a new environment, we preferred to work on top of a well-established eLeaning environment: Claroline. The process of deliver a modify version is on its way. The future work includes an exploratory research of integration of external tools, a process of expansion in order to deliver a version of the system that follows a Service-Oriented Architecture. We are also working on a solution for integrating assessment to collaboration in order to create a metrics to improve the delivering of LOs in local (individuals) and global (whole courses).

Acknowledgments We gratefully acknowledge the support of the SIMILAR network of excellence (http://www.similar.cc), the European research task force creating human-machine interfaces similar to human-human communication of the European Sixth Framework Programme (FP6-2002-IST1-507609), the AlBan program supported by European Commission and the CONACYT program supported by the Mexican government.

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