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PERSONAL(ONTO): Personalizing the Learning Process in Virtual Environments by means of Adaptive Formative Itineraries based on Reusable Learning Objects and Ontologies TIN2006-15107-C02

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Abstract

Personalization in e-learning allows the adaptation of contents, learning strategies and educational resources to the competencies, previous knowledge or preferences of the student. This project takes a multidisciplinary perspective for devising standards-based personalization capabilities into virtual e-learning environments, focusing on the concept of *adaptive learning itinerary*, using reusable learning objects as the basis of the system and using ontologies and semantic web technologies.
Keywords: virtual learning environments, e-learning, personalization, standards, metadata, learning object repositories, ontologies.

1 Project goals

1.1 Introduction

The use of Information and Communication Technologies (ICT) in education has made feasible distance learning in the form of e-learning, giving rise to virtual leaning environments (VLE). To succeed in e-learning, we need to encompass both pedagogical and technological issues. Technological aspects include hardware and software based on standards and specifications that make possible the interoperability between learning management systems. On the other hand, pedagogical aspects include rethinking the learning process, i.e. redesigning programs and courses shifting from content-based courses to the application of social-constructivist pedagogical approaches that are learner and community-centered, such as the Bologna process (the new European Higher Education Area) promotes, using a competence development model. Formalizing the learning process requires to take into account current standards and specifications oriented to combine all elements involved in such process, as the IMS Learning Design

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(LD) specification proposes. Amongst these elements, we have learning resources also known as Learning Objects (LO) that have to be described by means of metadata elements, as those proposed by the IEEE Learning Object Metadata (LOM) standard. Metadata empowers search, reuse and availability of LO that are stored in digital repositories. By adding semantics using ontologies in the formalization of the learning process and in the description of LOs, it is possible to improve the location, composition and sequencing of previous elements in a personalized learning experience. In addition, it makes also possible to introduce different levels of personalization in the learning process, according to students' needs and interests by means of the definition of adaptive learning itineraries.

1.2 Project goals

The PERSONAL(ONTO) project regards all phases of design, creation, management and distribution of the teaching contents that compose a learning object repository, and establishes the requisites needed for its integration in content management tools, as a digital library, for instance, and the interoperability among learning and multimedia content description standards. Based upon these elementary learning units, we establish the necessary customization criteria to assure itineraries are correctly used by students, allowing content adaptation, taking into account both the declared and proved competencies of every student profile, and the learning goals. Thus, it is important to include usability studies and an analysis of the user experience, providing to the teaching team a response mechanism to the students' use of the learning itineraries and the basic learning units, in order to continually adapt and improve them, increasing the learning contents reusability degree. Finally, this project will also allow us to deepen our knowledge of the learning process in itself, because it will give us quantitative data about the students' user experience and their interaction with the system, so we will be able to analyse the learning itineraries and contents, allowing their continuous improvement, in a closed cycle of design, use and analysis. Therefore, the project goals are:

1. Modeling and establishing the pedagogical base of the concept of adaptive learning itinerary based on elementary learning units, with different interpretations for learning.

2. Definition of the learning object repository requirements, with the goal of achieving reuse and interoperability of content description standards.

3. Creation of an ontology allowing the definition of adaptive learning itineraries, as a result of pedagogical criteria based also on competencies and activities, not only on content, according to the needs and particular features of every student.

4. Establishing criteria and tools for usage and usability evaluation of learning environments and learning contents.

5. Putting the research results into practice through a virtual university or an e-learning platform, making the conclusions publicly available as a study case.

In order to achieve these goals, the following Work Packages were planned in the project proposal:

1. WP1: Project coordination. Month 1 - Month 36. The organization, coordination and results dissemination tasks are relevant to the project and they have been considered an objective itself. Results dissemination includes both journal publications and conferences, at both national and international levels, and also the participation of several members of the two project teams in the SPDECE symposium, the REDAOPA thematic network and the organization of a specific workshop on this subject (see 3.6).

2. WP2: Formalization of adaptive learning itineraries. Month 1 - Month 10. The objective is to establish the requirements of the adaptive formative itinerary concept, which have an effect on the rest of elements that are part of the project: the reusable learning object repository and the ontologies that formalize the learning process. This includes a revision of the state of the art in adaptive systems, intelligent tutors and standards for the formal description of the learning process which are relevant to the goals of the project.

3. WP3: Design of a learning object repository. Month 5 - Month 18. This objective consists of the definition of both the architecture and the requirements for the learning object repository that will serve as the basis for the e-learning platform with personalization capabilities. It will be necessary to review the standards for educational content and multimedia description, such as LOM, Dublin core and other multimedia content description standards such as MPEG-7. The integration with content managers, such as digital libraries, will also be studied.

4. WP4: Formalization of the learning process by means of ontologies. Month 11 - Month 16. The engineering of the learning process ontology will be developed with this objective. The basic elements of the constructivist and social cultural theories will be covered, taking into account the existing activity oriented standards such as IMS Learning Design.

5. WP5: Integration in a virtual learning environment. Month 19 - Month 27. The different elements of the learning process with personalization capabilities will be integrated in an e-learning platform, that is, the learning object repository, the learning process management system, and the personalization system, governed by the ontology.

6. WP6: Development of a proof of concept. Month 17 - Month 28. This objective consists of the development of the pilot experience that will act as demonstration of the capacities of the e-learning platform with adaptive formative itineraries. This pilot experience will also provide a good practices guide for the creation of educational content with personalization capabilities, including the metadata related aspects, the structuring of the educational contents in formative itineraries, and the students learning process logs and evaluation data.

7. WP7: Design of the monitoring system. Month 29 - Month 36. This objective is to establish the criteria for the evaluation and monitoring of the data collected from student's use of the formative itineraries pilot experience. With these data it will be possible to determine the adequacy of the proposal, to detect possible errors, omissions or inconsistencies in any of the elements that are part of the project: the metadata, the ontology and the formative itineraries of the pilot experience.

2 Project achievements

This report has been written during the month 27 (December 2008) with respect to the project scheduling (October 2006 - September 2009), although the project actually started in January 2007, which caused a slight shift specially for the first working packages. According to the project scheduling, and taking into account the initial project delay, WP2, WP3 and WP4 are already finished, WP5 is in its final stage and WP6 is under development, while WP7 has not started yet. In consequence, we think that is clearer to review project achievements with respect to the main project goals, as described in Section 1.2.

2.1 Goal 1: adaptive itineraries (WP2, WP4)

One of the first research questions we have addressed in this project is the following: "what does personalization mean in a virtual learning environment?". We proposed the concept of "adaptive formative itinerary", a sequence of activities that guides the learner in order to achieve one or more learning goals:

- adaptive: the sequence of activities is adapted according to learner's profile.
- formative: activities are part of a process (the learning process) and evaluation focuses mainly on such process, rather than on the outcomes.
- itinerary: the learning process is a path starting on the learner's initial situation pointing towards the desired learning goals, including as many options as possible.

In this WP we have identified the key elements in the learning process which are capable of being personalized and the necessary elements that must be formalized in order to build a formal representation for personalization purposes. Basically, any e-learning environment can be characterized by the following elements: users, contents and services. Regarding users, the personalization system needs to "know" learners in order to provide them with adaptive formative itineraries. This means that the concept of user profile containing all information related to user background, preferences, and so needs to be part of the personalization system. Regarding contents, one of the main conclusions that have modified the original project approach is that content cannot be designed in advance with all the personalization possibilities. On the contrary, content should be independent from itineraries, and these should be build on top of content, using the appropriate structure. Finally, regarding services, personalization can be seen as a dynamic service that operates on top of other services in order to, first, gather information about the interactions between the learner and the system when using any other service and, second, to use information previously stored in the user profile altogether with the context for personalization purposes. The basic idea is to convert any current teaching plan (which is usually a completely linear document, static and isolated), into the skeleton of a dynamic and variable process which involves aspects of instructional design for user centered personalization and it is related to all the learning objectives which appear throughout an academic period (materials, resources, activities, teaching calendar, etc.), giving rise to what is called an adaptive formative itinerary.

Personalization is a set of technologies and functionalities used in the design of user experiences. The functionality that is part of the personalization can vary, from simply show the

user name on a flat web page, to a complex cataloging of the user navigation and the adequacy of products and services based in complex user models. In online learning, personalization is revealed of great utility and importance. The adequacy and adaptation of the learning process it is very interesting as much at educational level as a level from establishing a one to one relationship with the student, and in this sense, it allows to present and offer high quality services and advantages to an every time more satisfied student. It is interesting to remark the difference between the personalization and the individualization of the learning process. In this project it is not intended to individualize the learning process but to bring a methodology that allows the system to adapt the formative itineraries to the student needs and behavior. This project is concerned with the design of a standards-based e-learning platform that permits the creation of personalized user training itineraries, using reusable learning objects as the basic building blocks of the system as well as arriving at a formal methodological and normative specification for automated and semi-automated processes normal for any virtual environment system in the area of e-learning. One of the conclusions of WP2 is that a personalization system cannot be a set of walls limiting the options of learners or be very intrusive. On the contrary, personalization should be as transparent as possible, providing learners with the most appropriate options, following a recommendation approach.

Nevertheless, current learning environments are not prepared yet for describing the learning process based on competencies including personalization issues. The new EHEA paradigm (also known as Bologna process), which bases the design of any educational offer in terms of competence acquisition and development, promotes personalization as a way to ensure a proper development for each learner, taking into account his or her particularities, preferences, the already acquired competencies and the desired learning goals. Furthermore, most of the current e-learning standards and recommendations focus on content description and packaging, and there is only one specification available for describing the learning process (IMS Learning Design). It is necessary to evolve from content oriented standards to activity based ones and then towards higher level specifications that allow the description of hierarchical structures such as those required for personalization issues using competencies. In fact, although it is possible to extend the current content description standards for including competence definitions, it is much better to put competencies in a higher level with respect to content, as itineraries are also at a higher level with respect to content.

In this project several standards and specifications have been assessed. In the case of WP2, related to the formalization of the adaptive learning path, IMS LD has been chosen given that is the only specification that allows to share learning contents as well as to structure them according to the activities required in a learning scenario. The inclusion of personalization issues requires adopting IMS LD level B, although level A with a few extensions should be enough for basic personalization purposes. Other auxiliary specifications have been considered in this WP; this is the case of those specifications that allow representing learner data as IEEE PAPI (Personal and Private Information) and IMS LIP (Learner Information Packaging). According to the requirements of the personalization system, the selected option has been IMS LIP. The IMS LD specification tries to describe all the aspects and the elements more related to the learning process in itself, such as sequencing or role playing. It seems clear that all this information cannot be stored in the learning objects (LO), but in a higher semantic level. Although the IMS LD specification may seem too complex for practical applications, its flexibility and multilevel description capabilities allow the specification of any learning

process ranking from simple educational itineraries to complex learning processes including personalization and collaborative working capabilities. Despite of IMS LD is still not widely used in real learning scenarios, the number of papers addressing research issues related to its use, limitations and possible improvements is increasing. An IMS LD ontology plus a competency ontology described in Goal 4 is assumed to be the basis for the application of rules regarding instructional design.

Finally, two possible scenarios have been designed in order to test the possibilities of the personalization system. These two scenarios cover the two main activities that learners perform during the learning process related to content discovery and consumption. The first scenario is directly related to the learning object repository, with the aim of helping learners to find the most appropriate content. The second scenario reproduces the typical use of the personalization system in an online course. Both scenarios will be developed as part of Goal 5.

- Related publications: [22], [16], [20], [4], [17], [15], [36], [28].

2.2 Goal 2: learning object repository (WP3, WP4)

For the description of learning contents, IEEE LOM, Dublin Core and MPEG-7 have been selected for the description of LO, digital library contents and multimedia learning resources, respectively. It is allowed that a given learning content could have different descriptions (for example, in the case of multimedia contents, one description conforming to LOM and another conforming to MPEG-7). The connection to other standards, for example between IEEE LOM and IMS QTI (Question and Test Interoperability) has also been studied.

Following the recommendations from WP2, a learning object repository has been designed in order to store all learning resources that will be used by learners but also by the personalization system for building adaptive learning itineraries. The learning object repository is supposed to be integrated in the learning process, but learners do not use the learning resources as teachers expect them to do it. On the contrary, most students download all learning resources at the beginning of the academic semester and they never go back to the learning object repository. Because of UOC institutional policy reasons (mainly integration with the UOC Virtual Campus), the selected repository architecture is DSPACE, which is known to be not optimal for being used as a learning object repository. The use of DSPACE has also caused some delays in the original scheduling because of the necessary integration with the UOC Virtual Campus.

The combination of repositories with ontologies has resulted in two fully implemented *semantic metadata repositories*, SLOR[1] and ont-space[2]. Such kind of repository stores only metadata, and thus can be combined with any of the other content repositories (as DSPACE), provided that they offer a mechanism for uniquely identifying resources (as a permanent URL or similar). Even though these metadata repositories do not have built-in mechanisms to store user profiles, ontologies of competencies provide a link to learning need expressions that enable linking to competency–based user profiles. A paper with the latest results in the ontologies of competencies engineered is now under review. The following specifications have been taken into account : LORI (Learning Object Repositories Interoperability), IMS-DRI (IMS Digital

[1] SLOR is the result of Ph.D. work, see below http://slor.sourceforge.net/

[2] ont-space (http://sourceforge.net/projects/ont-space/) is a porting from WSML to OWL of the LOMR developed in project LUISA, http://luisa.atosorigin.es/www/.

Repositories Interoperability) and LTSC LTSA (LTSC Learning Technology System Architecture). As a result of the complementary project SUMA (see below), ont-space now features an OKI `Repository` OSID for interoperability[3].

- Related publications: [8], [2], [9], [1], [19], [23], [29], [21], [37], [38], [24]

2.3 Goal 3: ontology formalization (WP4)

In the case of WP4, the development of ontologies has been carried out at several levels:

- At the level of learning resource metadata, ont-space includes ontologies of IEEE LOM, Dublin Core and IMS LD (in this latter case adapted from the work of Amorim et al. at the Universidad de Santiago de Compostela). The link with MPEG-7 of these ontologies has been also described.
- At the level of expressing learning needs, a flexible competency schema has been developed allowing competency gap computation, including competency relationships and decomposition of competencies in declarative, procedural and attitudinal sub-components.
- At the level of the learning process in itself, part of instructional design theories have been formalized with a combination of OWL restrictions and SWRL, using the IMS LD ontology as the base for representing activity sequencing with associated resources (learning objects). This is a particularly innovative result of the project, which has been also accepted for publication.

The combination of the three ontologies provide the elements required to personalize learning itineraries based on IMS LD. All the abovementioned ontologies have been engineered in a combination of OWL+SWRL. In addition, an OpenCyc compatible IEEE LOM ontology is included in the already mentioned SLOR repository, and the discussion of the design particularities of representing LOM in OpenCyc has been also published.

An additional level has been the structure of the activities involved in the preparation of learning experiences (as courses), formalizing the interaction among different learning technology components (as learners, repositories, calendars, communication spaces, etc.). This is the central piece of the Ph.D. work of Angels Rius [34] and has been connected with the aims of project SUMA (see below), providing a way to realize with workflow or business process languages the interaction patterns included in the learning scenario ontology.

- Related publications: [31], [32], [33], [34], [35], [30], [36], [7], [28], [38], [37], [24]

2.4 Goal 4: usability evaluation (WP7)

One of the most interesting possibilities in any virtual environment is tracking user navigational behavior for analysis purposes, as it may help to discover unusual facts about the system itself. For example, having a user navigational model may be used to perform an automated usability evaluation, detecting whether the system web interface was properly designed or not, and where users find obstacles and difficulties to reach out their objectives. It can be also used to detect

[3] http://www.okiproject.org/

bottleneck problems or web areas not used by most users. In the case of a virtual e-learning environment, several analysis levels can be determined, and different research questions can be answered with the aid of web mining tools. Instructional designers, teachers but also web designers need powerful tools for visualizing all the information collected in a virtual e-learning environment in order to improve the learning process and, thus, user experience and satisfaction, by means of an adaptive environment: monitoring and interpreting the activities of its users, inferring user requirements and preferences, and acting upon the available knowledge on its users.

To achieve this goal a methodology of analysis has been proposed. This methodology is based on a three level approach that allows covering the goals and motivations of the users in different periods of time. More precisely, the proposed methodology of analysis allows obtaining new and relevant information about the students' navigation in a virtual learning environment, understanding that they visit not only the main areas and services of the virtual campus, but the contents, activities and educational resources of the courses, as well as other courses that are included in their program or formative offer. That is, at different levels in different points of time. This goal is based on the need to know the students' interactions with the virtual environment, to be able to improve the usability of the system and their experience of use, and to collect information to build a user model which allows embedding elements of personalization in the learning process. The obtained results constitute new evidence about the UOC, its virtual learning environment and its users, and provide relevant information for the design of the new virtual campus and to improve and personalize the learning process.

The integration of repository search (WP5.2) is currently being tested in the framework of the AVANZA project SUMA. In addition to that, UAH has developed a prototype extension of the open source IMS LD Reload tool that allows introducing queries to the ont-space repository from inside the `Environments` of IMS LD activities. This prototype is still not reported in the list of publications provided.

The integration of ontologies and rules (WP5.4) has been done by using the php/Java bridge[4] to bridge Moodle code and the code of a rule executor using the Protege libraries[5]. This integration has been difficult since the bridge is still not stable software and debugging was harder than expected. Now the code of the integration is being prepared to be delivered as open source. The implementation allows the execution of SWLR rules using the Protege-Jess bridge to change the sequencing of Moodle lessons. This prototype is still not reported in the list of publications provided, a journal paper is under review.

- Related publications: [27], [25], [15], [13], [14], [12], [26]

2.5 Goal 5: proof of concept (WP5, WP6, WP7)

In WP2 two possible learning scenarios showing the possibilities of personalization have been designed. As part of WP6, these two scenarios are currently now under development. One of them will use a learning object repository of statistical resources in order to analyze the way learners browse and search for learning resources as part of their learning process. The other is directly related to analyze how learners build their own adaptive learning itineraries and the kind of support that must be provided by the personalization system.

[4] http://php-java-bridge.sourceforge.net/pjb/
[5] http://protege.stanford.edu/

Regarding WP7, it was possible to perform a preliminary experiment for gathering real usage data and get some feedback from students taking the Computer Graphics course. This course was redesigned in order to be the skeleton of the proof of concept for one of the learning scenarios designed in Goal 1. Therefore, although it does not exactly follow the classical UOC pedagogical model, it was considered to be an interesting innovation worth to be tested. The course was offered only online with no textbook or CD support, and students were asked to actively participate in a survey once the course is finished. Following the recommendations from WP2, learners were given the possibility of creating their own itineraries with almost no restrictions. In this preliminary experiment, the personalization system gathers data about the itineraries followed by learners but it does not uses any reasoning for adapting these itineraries.

Regarding integration with learning design tools, the use of the ontologies described above for practical purposes have been subject to prototyping. Concretely, a prototype that integrates OWL+SWRL inside the RELOAD LD editor and player for a simple case has been developed. However, a more significant implementation has still not been achieved because of the complexity and relative inflexibility of RELOAD tools. The alternative use of ReCOURSE[6] is currently been explored.

Finally, as part of WP1, a project web site has been set up, containing all the project publications, executive summaries of the main research activities and other resources related to the project development. The web site can be found here: `http://personal.uoc.edu`.

- Related publications: [6], [11], [5], [10], [3], [18]

3 Project evaluation

3.1 Scientific outcomes summary

During the first two years of the project, the main scientific outcomes have been presented in both national (11 publications) and international conferences (17 publications) and in some journal papers (9 publications) and one book chapter. Currently now, some of these results are undergoing a major revision in order to be published in form of several indexed journal papers during 2009 and early 2010, once the project had been finished. All publications that can be considered outcomes of this project are listed at the end of this report.

3.2 Technological transfer

The results of the PERSONAL(ONTO) project have been used and integrated in the Campus Project[7]. The goal of this project was to develop a higher education platform in open source software and its key aspects were what make it unique in the field of e-learning. First, the virtual campus supports up to 10,000 users connected at the same time. Second, the product design follows a user-centered design approach. Third, the user interface follows usability and accessibility principles and standards. The learning scenarios designed in WP2 are also going to be tested under this framework during 2010, as part of the final testing.

[6] http://www.tencompetence.org/ldauthor/
[7] http://www.campus.cat

The semantic repository technology developed in the project is currently in integration in the framework of project SUMA. Project SUMA[8] is funded by the Ministry for Tourism Industry and Trade, as part of PROFIT-the Avanza Plan's Industrial ICT Policy, and consist in a consortium combining Universities (including UOC and UAH), research centers and companies. The principal aim of SUMA is integrating different technological pieces by using standards interfaces based on OKI[9]. The project is now developing case studies at UOC, UFV, IDEA and InterOnline. This would provide demonstrators that are both useful for the companies in the consortium, and also for other companies that could reuse the same technology and knowledge. Two open source frameworks for semantic metadata repositories have also been developed: SLOR and ont-space.

For the UOC group, two complementary projects involving the use of learning object repositories have been started, one funded by the Catalan Government and the other by a "Estudios y Análisis" project (E-MATH++) with the aim of analyzing the impact of a learning object repository for mathematical resources in the learning process. Both projects use the previous research carried out in the PERSONAL(ONTO) project with the aim of expanding the research and innovation in the use of learning object repositories.

For the UAH group, the activities of the project have been closely associated with the activities of EU project LUISA[10], which successfully closed in October 2008. Dr. Miguel-Angel Sicilia was the technical coordinator of the project, which was mostly complementary to PERSONAL(ONTO), but focusing on the distributed architecture based on Semantic Web Services. Part of the efforts in improving the repository technology spent in projects LUISA and PERSONAL(ONTO) are now being used in the ongoing e-Content+ EU Project Organic.Edunet[11], featuring an international federation of repositories.

3.3 Human development

The PERSONAL(ONTO) project serves as a research framework where several project researchers have had the possibility of developing their research careers, especially those who started their Ph.D. when the project also started. Since then, two Ph.D. dissertations have been already presented:

- "Capture and Analysis of Student Behavior in Virtual Learning Environments. The UOC Case". Enric Mor Pera (supervisor: Julià Minguillón Alfonso). Universitat Oberta de Catalunya, June 2008. Abstract: This thesis makes a contribution to the areas of e-learning and human-computer interaction, related to obtaining information about the users and about how they use interactive systems. A methodology of analysis has been proposed and allows obtaining new and relevant information about the students' navigation in a virtual learning environment. The obtained results constitute new evidence about the UOC, its virtual learning environment and its users, and provide relevant information for the design of the new virtual campus and to improve and personalize the learning process.

[8] http://www.ines.org.es/suma/en/index.php
[9] http://www.okiproject.org/
[10] Learning Content Management System Using Innovative Semantic Web Services Architecture, code FP6-2004-IST-4 027149
[11] http://www.organic-edunet.eu/organic/index.html

- "Mecanismos semánticos orientados a la flexibilidad de los repositorios para objetos de aprendizaje" ("Flexibility-oriented semantic mechanisms for learning object repositories"). Jesús Soto Carrión (supervisors: Salvador Sánchez-Alonso and Elena García Barriocanal). The thesis deals with the design of flexible semantic learning object repositories. Its most innovative contribution is a fully developed repository called SLOR[12] that makes uses of the OpenCyc [13] knowledge base for the annotation of the learning objects.

In addition, several more are expected to be finished during 2009 (during the execution of the project) and other two are expected to be finished early 2010, as follows:

- "Integration of educative metadata in common sense ontologies". M. Elena Rodríguez (supervisors: M. Ángel Sicilia Urbán, Elena García Barriocanal). Abstract: The objectives associated to this PhD work can be summarized as, first, checking and validating IEEE LOM standard, as well as finding possible improvements (extensions and resolution of semantic ambiguities) and, second, establishing a correspondence between the LOM metadata and common sense ontologies. This will improve semantic interoperability of LOs and services among learning systems. Expected dissertation date: September 2009.

- "Specifications of automated learning scenarios in enhanced e-Learning". Àngels Rius Gavídia (supervisors: M. Ángel Sicilia Urbán, Elena García Barriocanal). Abstract: This thesis deals with the development of specification techniques for formal, normative and automated /semiautomated processes based on web-technology with the aim of being supported by standardized e-learning systems. Expected dissertation date: September 2009.

- "Learning object sequencing, adaptation and generativeness", Miguel Zapata Ros (supervisors: M. Ángel Sicilia Urbán, Salvador Sánchez-Alonso)The thesis deals with the integration of adaptiveness in instructional design, extending David Wiley's LODAS method, and mapping the instructional design method to IMS LD. Expected dissertation date: September 2009.

- "Personalising virtual learning process based on competencies using standards and ontologies under the EHEA paradigm". Ana Elena Guerrero Roldán (supervisor: Julià Minguillón Alfonso). Abstract: The main goal of this research is the personalization of the virtual learning process based on student previous competencies and those that student has to acquire during a training action. For the creation of adaptive learning paths we are studying standards and specifications related with learning resources and using mainly LOM for didactical resources and IMS-LD for activities and learning paths. A system of rules will establish conditions and the relationships between all the elements described in the learning process will be created using an ontology for virtual learning based on competencies. This will hit in the capacity of personalization of the training process in a virtual environment. Expected dissertation date: Spring 2010.

- "The information behaviour of the students of a virtual university in the academic, professional and private sphere: study of the transferability of information competencies".

[12] http://slor.sourceforge.net/
[13] http://sourceforge.net/projects/opencyc/

Núria Ferran Ferrer (supervisor: Julià Minguillón Alfonso). Abstract: The main goals of this thesis are, first, to describe the information behaviors related to the use of information of UOC students in the academic, professional and private spheres and, second, to find out the relationship between the information behaviors and information competencies associated with each one. Expected dissertation date: Spring 2010.

In the UAH, visiting professor from Central University of Venezuela, María Gertrudis López López has compared their LO repository development called AMBAR[14] with the repository technology developed in the framework of PERSONAL(ONTO), resulting in directions for combining the two technologies. Further, Dr. López has participated in ontology engineering tasks of PERSONAL(ONTO) while visiting UAH.

In addition, several Ms.C. students have gain knowledge and collaborated in activities related to the project, in the framework of two official Ms.C. programmes related to e-learning:

- Education and ICT Ms.C.[15] offered by UOC.
- Informatics Ms.C. (*digital teaching and learning* track[16]) offered by UAH.

Some of the members involved in the project have participated and are participating in teaching activities at undergraduate courses ("Proyectos Fin de Carrera") in both Computer Science and Information and Communication Science degrees, at both UOC and UAH.

3.4 Project coordination

Both project partners, UOC and UAH, maintain a continuous activity of collaborations in several areas, ranging from teaching to research. PERSONAL(ONTO) has contributed to strengthening the research links between UOC and UAH, and of both groups together as the backbone of a broader pluri-disciplinary network at the national level (REDAOPA). Both groups have maintained project coordination meetings taking advantage of other events, such as the national symposium SPDECE, the thematic network REDAOPA, the SUMA project or even UOC academical meetings. Currently now, both groups (altogether with two other groups) are preparing a new project proposal which will be submitted to the next "Programa Nacional de Proyectos de Investigación Fundamental (Plan Nacional de I+D+i 2008-2011)" call. This new project will use some of the results of the PERSONAL(ONTO) project in order to study the possibilities of personalization techniques for supporting open social learning communities built around a specific service, such as a learning object repository or a wiki, for example.

3.5 Project collaborations

The UOC group is in contact with several international researchers, such as Brian Lamb, from the Office of Learning Technology at the University of British Columbia, who was invited for discussing the development of the learning object repository. Prof. Erik Duval also joined the discussion and provided other project examples (MACE) which could be used as alternative

[14] See http://www.um.es/ead/red/19/gertrudis.pdf
[15] http://www.uoc.edu/masters/oficiales/master_oficial_educacion_TIC/master_oficial_educacion_TIC_plan.htm
[16] http://www.etsii.uah.es/master/home1.htm

user interfaces for providing personalized access to learning object repositories. The UAH group has collaborated with several other teams in the course of projects LUISA, Organic.Edunet and SUMA, which have been abovementioned.

3.6 Dissemination

At the national level, the results of the project have been disseminated at the SPDECE event series. SPDECE is an annual pluri-disciplinary event organized by the thematic network REDAOPA, that has received funding from the Ministry of Education as a complementary action in the last years. The Spanish Thematic Network of Activities and Objects for Learning (REDAOPA, red temática sobre objetos y diseños para el aprendizaje) was born with the objective of promoting research in the field of learning objects and encouraging the use of good practices through them in educational centers. Given the complex nature of the scientific fields in which knowledge from one branch is unable to advance without contributions from other branches, multidisciplinary participation provides an advantage because of the expanded focus and even holistic goal that can be achieved. That is the reason why REDAOPA (http://www.cc.uah.es/ie/projects/redaopa) was established as an open network made up of researchers and teachers ranging from Computer Science to Pedagogy and Psychology.

Finally, it is especially remarkable that UOC and UAH have a clear leading role in the community of researchers that meet at SPDECE. In the 2008 event held in Salamanca, one of the papers reported a study about the bibliometrics of the contributions to past SPDECE events. This is an excerpt translated to English:

> [...] meta-analysis has shown significant indicators of the structure of influences of SPDECE, at least as it is perceived from the articles, in which the University of Alcalá and the Universitat Oberta de Catalunya stand out as catalysts of the collaborations between organizations [...]

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