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Software for ontological and collaborative online representation of knowledge
Software para representación ontológica y colaborativa de conocimiento en línea

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Resumen

Se presenta el Sistema de Marcos para el Aprendizaje Significativo (SIMAS) una plataforma multimedia en línea, de uso general en la representación de conocimiento, con base en el análisis de conceptos y sus relaciones y con capacidad para integrar información tanto cuantitativa como cualitativa. El desarrollo se basa en tecnología Open Source como MySQL, Apache y PHP para las capas de aplicación y datos. La interfaz y presentación estética que se desarrolla en HTML 5, CSS 3 y Javascript, permite una experiencia interactiva **fácil y agradable**. La programación gráfica se adapta a las necesidades y edades de los usuarios finales. Este dispositivo permite el uso de contenidos digitales en línea, su organización con base en estructuras ontológicas y soporta proyectos colaborativos. Los usuarios a quienes se orienta este ambiente son profesores y estudiantes de cualquier nivel y disciplina. El objetivo que se persigue es apoyar prácticas de representación de conocimiento que generen productos hipermediales que se puedan compartir, y apoyar las experiencias de aprendizaje que se deriven.
Descriptores: Software para representacion ontológica de conocimiento, aprendizaje de ontologías, hipermedia en el aprendizaje.

Abstract

This article introduces the software for online ontological representation of knowledge, named SIMAS -Framework System for Significant Learning. SIMAS is a high-functionality tool for representing knowledge through the analysis of concepts and their relationships; and is capable of integrating both quantitative and qualitative information. The system is developed based on Open Source like MySQL, Apache and PHP technology for the application and data layers. The interface, and the esthetic presentation created in HTML 5, CSS 3 and JavaScript, allows for an easy, enjoyable and interactive experience. The graphical programming is tailored to the needs and ages of the users. This tool permits the use of online digital contents, organizing these based on ontological structures; and also supports collaborative projects. The SIMAS software is addressed to teachers and students of different knowledge domains, learning levels, and ages, as main users. The goal is to support knowledge representation practices that result in hypermedia products as that can be shared with other people, while supporting the derived learning practices.
Keywords: Software for ontological representation of knowledge, ontology learning, learning hypermedia.

Introduction[1]

Our goal for this paper is to introduce the software named Framework System for Meaningful Learning (SIMAS), whose main role is to support online and ontology based knowledge representation. We developed this system following the current programing language tendencies, aiming towards a progressive adaptation to the specific user needs, simplifying the work processes and specializing in solutions that take advantage of the hardware capabilities; using all the available tools. For its design and development, an integration of databases and the programming languages Apache, PHP, and MySQL was conducted; resulting in robust, adaptable, responsive, secure, and effective software capable of accomplishing the administrator and target user's main objectives.

Along with the pedagogical innovation it offers, this development tries to simplify processes and provide

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friendly user experiences (UXDesign). This is accomplished by evaluating the system behavior, shape diagramming, and icon development, whose features such as size, color harmony, tone similarities are adjusted to reach the expected user perception.

Ontology and education system development

While logic has to do with the relationship between variables, ontology is concerned with the variable values (Sowa, 2000). Ontology is the study of being, of what something is. In the words of Quine (1969), an ontology is the value of a quantified variable. Formal sciences like logic, or graph theory, study structures – relation among variables – while ontology studies meaning, or variable values.

Ontology is interested in entity categories and their relationships (Hofweber, 2009) with the purpose of integrating knowledge about the systems that compose the components of the universe and, beyond that, about the universe itself, when looking into the most general categories. There are abstract entities (sets, concepts, numbers,...), concrete entities (objects, plants, planets,…), common sense entities (ways of analyzing the existence of something), universal entities (property, quality, attribute,…), mental entity (idea, reasoning, memory,…), vacuum entity (absence of matter).

According to Husserl (2005), ontology is the science of *the essences*. His approach leads to the differentiation of a formal level, which includes the most general categories of being, and a separate level including regional ontologies which correspond to specific reality domains. Sciences, as well as digital knowledge representation systems, are dealing with regional ontologies. As a consequence, ontologies are, essentially, meaning based knowledge representations. Both in philosophy and science, ontologies arise from the need of knowledge organization.

For computer science, ontologies are particularly valuable for knowledge representation in specific domains. Feldman y Sanger (2007) represent the Ontology Domain concept as the tuple O:=(C,≤ c); made of the c concepts of set C, whose elements are named *concepts,* and the partial order relation ≤ between concepts *c* of C, named hierarchy of concepts.

For as long as computer science has had to process meaning in the knowledge systems – semantic dimension – it has taken ontology systems as valuable tools. Two examples of this fact are the WorldNet[2] system and the Semantic Web. The first one is built based on synonymy relationships in the English language with more than 100,000 related items. In the Semantic Web, concepts are words with attached metadata; relating them with each other and implementing intelligent searching processes. In computer science, ontologies have several uses: for knowledge acquisition and its representation, for organizing information, in consultation and use of information, and finally to improve the same learning process that are of particular interest in this work.

Learning ontologies with the support of software tools is a process that moves on progressively (Zou, 2007), and involves identifying concepts with associated properties, naming them, learning relations, and building structures at different abstraction levels. Ontologies, in this case, have to be managed by intelligent agents and should be understandable by human users. The developments are promising, but still challenging.

Text mining is focused on finding relations among sets of words convergent in formal characterization of ontologies in specific knowledge domains (Feldman, y Sanger, 2007). In a review of methods and tools for learning from text, Gómez and Manzano (2005) find that developed tools are applied to learning relationships, while new concepts are applied to build taxonomies. In a study about the relationship between ontologies, Ibrahim *et al*. (2012) realize that this approach amplifies the possibility of relating and integrating specific domains.

Component based Software engineering integrates programs as units, with the possibility of being developed and tested separately. The organization of elements in ontological structures provides a name for each component associated to a concept; assigning specific features in such a way that conditions for intelligent software reasoning are established. This tendency has initiated the development of ontology based languages –OWL–, able to use the Semantic Web advantages (Pahl, 2007). In addition to component based reasoning, OWL supports on line collaborative software development.

Specific science domains are based on ontologies; structures formed by interrelated sets of terms which dynamically evolve as a result of research studies. One consequence of this process is the ontology standardization in every science; which for software system development signifies the requirement of programs that model ontology systems. Protegé[3], for example, is structured as a system of frames with kinds (concepts), slots (features), and perspectives (facets), (Rubin *et al*., 2007). This system is provided with a graphic user in-

2 http://wordnet.princeton.edu/

3 http://protege.stanford.edu/

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terface –GUI– for project development and is accessible online, to make the collaborative work of programmers easier. The systems developed in this type of environment support logical inference available for intelligent software agents. As a result, the information storage as well as the information retrieval is improved (Akerman y Tyree, 2006).

The use of this kind of systems is present in the sciences and in disciplines for which ontology system modeling is a challenge (Zhang *et al*., 2013; Nick *et al*. 2002). In the case of education, two pruposes are sought: on one hand, producing learning content in sciences and disciplines, and on the other hand, implementing learning systems to develop skills for handling the ontology systems of those sciences and disciplines.

The commitment of organizing content for learning specific ontologies is taken by some researchers in a similar way that word meanings are treated in the semantic web. The content units, as digital objects, are named learning objects, which are organized as elements of formal ontology structures, based on associated metadata. This approach makes logical inference feasible, easing the search and the use of components in different contexts (Sicilia y García, 2005).

The concept of ontology in specific domains has been taken as the basis for building ontology networks. In a review of studies, Pernas *et al*. (2012) describes an application of ontology in learning systems as a tool to improve the adaptability of the learning system to the student context and background. In Wang *et al*. (2012), an ontology of a specific knowledge domain is integrated with an ontology of learning objects, and one of learning strategies, in order to develop an ecological learning system. Said system is consistent with the point of view of the subject matter and both, the point of view of the learning resources and the achievement of learning skills.

In a different example presented by (Pernas *et al*. 2012), a learning context taxonomy, a learner profile ontology, a knowledge domain ontology, and a resource and tools for learning ontology are integrated, with the purpose of improving the learning system adaptability to the user conditions. In a similar approach, Knight *et al*. (2006), integrate a learning content ontology with a design process of learning object ontology, and a learning context ontology (LOCO) producing a higher level ontology using the Protegé development environment. These results provide the basis for implementing computational intelligence in the field of on line education (Vasilakos *et al*., 2004) in which the knowledge domain, the student model, the context, the learning objects and the educational model are represented using ontologies; allowing the computer to operate based on networks of meaning.

CmapTools is created as a tool for the students to elaborate graphical networks, named conceptual maps, in which concept names are the nodes, and the links show relations between pairs of concepts (Novak, 1977). In one condition, there is input information (for example, a text or a video) and the student elaborates a concept map to represent the structure of the received message; in a different condition, the student is asked to express his/her own knowledge by means of a conceptual map.

Concept maps may be used to represent hierarchical or other type of ontologies, but most of the times are applied to informal schemas (Novak and Cañas, 2006). In this direction several tools have been developed (Table 1): some like Webprotégé and SWO are oriented to build ontology based applications, but most of them are applied to represent knowledge structures informally. The table 1 shows some of the features of these tools.

Most of the software is oriented to build concept structures. However, usually they do not support a classification of relationships. The hierarchical classification is the privileged relation, but does not include other kind of systematic organization, like time sequence, systemic integration, or causal relations. Distinguishing these kind of relations helps the student to integrate specific knowledge perspetives based on the knowledge domain and specific problems.

Conceptual framework

The knowledge representation practice, as a method for building meaningful learning, is consistent with constructistic approaches in the fields of psychology and pedagogy.

Research reflected in ontological structures standardized by the academic communities is projected in education as learning content. The most widespread approach in educational practice has been the development of instructional systems, which currently tend to be based on these ontologies. Environments are also created to help students learn by means of reconstructing ontologies of the knowledge domain of study.

In a previous study, college education majors enrolled in science education courses that developed ontology reconstruction excercises for specific geography units, and futher prepared and conducted teaching practices with students. Said study showed greater inclusion of these structures in the training of their own students (Maldonado *et al*., 2001).

Learning abstract structures is usually challenging for most students. In our approach, student participa-

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Table 1. Software for representing conceptual structures. "+" means presence, and "-", absence

Application Name	Version	Source	Objective	Multimedia	Collaborative work	online	Ontology structure
Webprotégé: http://protege.stanford.edu/	1.8 beta	Stanford Medical Informatics	Suite for building ontology domain models and applications	-	+	+	+
Software Ontology (SWO): http://theswo.sourceforge.net/	No information	European Bioinformatics Institute and the University of Manchester	Describe software tools, their types, tasks, versions, provenance and data associated	-	-	-	+
MindManager: https://www.mindjet.com/mindmanager/	16.0.159	Mindjet	Organize ideas to support creativity and productivity in group meetings	+	-	-	+
WiseMapping: https://app.wisemapping.com/c/login	No information	WiseMapping	To create concept maps as classification structures. Helpful for presentation and organization of ideas	+	+	+	+
Apollo: http://apollo.open.ac.uk/index.html	01a18	Gerstner CTU Laboratory	As an ontology editor support knowledge applications	-	-	-	+
CoGui: http://www.lirmm.fr/cogui/index.php	5.3.1	LIRMM CNRS	To build Conceptual Graph, and knowledge bases represented in COGXML format, compatible with Cogitant	-	-	-	+
Cmaptools: http://cmap.ihmc.us/	5.06	IHMC	To construct, navigate, share and criticize knowledge models represented as concept maps	-	-	-	+

tion in the contruction of knowledge representations using multimedia information, and the possibility of comparing their own ontological structure with the structure prepared by the teacher, strongly anchors the student learning process. Accordingly, a better structuring of the long term memory is expected.

The SIMAS environment – presented here – evolves from previous projects (Maldonado *et al*., 2010), to configure a general structure – shell – that allows the user to perform the following functions: design an easy editing ontological structure (as a graph), automatically generate a structure navigable hypertext with a page for each node of the ontological structure and bind options to enable multi-media information for each page. It can be used by the teachers to develop their own hypertexts as learning resources, or by the students to develop their own hypertext projects both individually and collaboratively.

The software induces collaborative work online, the use of multiple digital contents prepared by different authors, and the creation of resources. Looking forward, this stage will facilitate the integration of software agents for different pedagogical functions such as generating questions, metamemory judgments activation, goal management, monitoring of learning strategies, and management of online collaborative activities.

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The software follows the contemporary developments on ontologies and systems (Sowa, 2000) and focuses particularly on hierarchical, temporal, spatial, systemic and causal relationships.

- **Hierarchical:** Corresponds to taxonomies or classifications. It has an upper node (parent), contains subclasses that are furthered divided until the lowest classification level is reached. This kind of relation supports the inheritance of properties from the upper nodes to the lower nodes, and provides conditions for logical inference. An example shown in Figure 1.
- **Temporal or Timeline**: From an origin moment, nodes are ordered horizontally at the right side, following a sequence according to the successor relationship. The simultaneity is a derived relation in this setting. An example shown in Figure 2.
- **Spatial**: The framework for this relation is the Cartesian plane. A measure unit and scale is needed. The parent node is located first and then the other nodes are placed using pairs of coordinates, quantitative like (10, 5) or qualitative like (left and up, or right and down). Both qualitative and quantitative spatial reasoning are supported. An example shown in Figure 3.
- **Systemic**: The parent node is a system. The other nodes are related to the parent node with composition relations like *composed of, part of, or subsystem of*. An example shown in Figure 4.

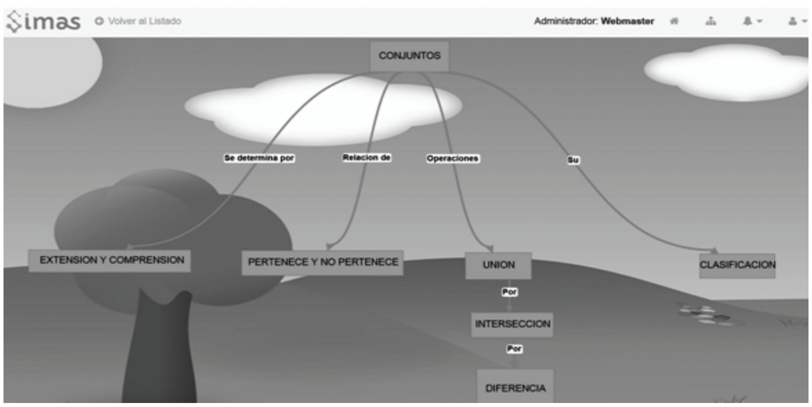

Figure 1. A representation developed by a student using the hierarchical tool

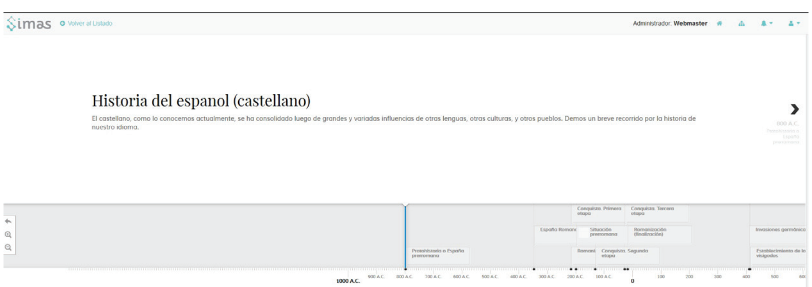

Figure 2. A representation developed by a student sing the time line tool

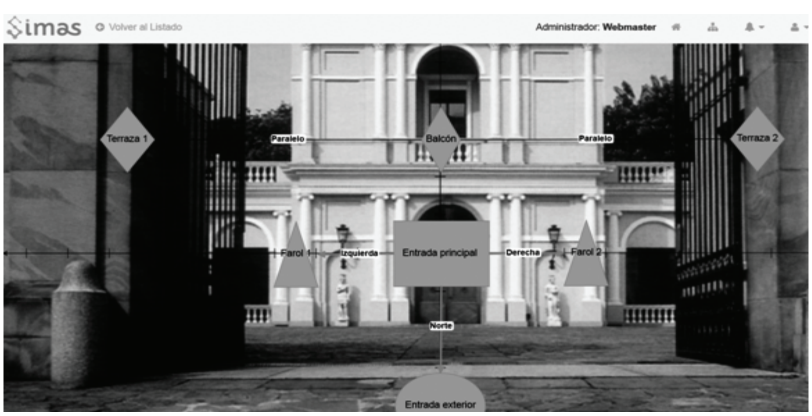

Figure 3. A representation developed by a student using the spatial tool

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- **Causal**: There is a causal relation when two elements *(A and B)*, such as A precedes B or simultaneous with *B*, and if *A* changes then *B* changes. Changes occur in the properties of the cause and effect and may be qualitative or quantitative. Causal relationships exist between pairs of elements and form chains of variable length. The general expressions are like A *causes B, B causes C, C causes D,* and so forth. A causal ontology is assembled as a causal chain. An example shown in Figure 5.

The software provides conditions for the teachers to organize online learning resources to teach specific content domains and skills. For students, the software is an environment for studying learning units provided by the teacher; or even better, for developing knowledge representation projects, guided by the teacher, in individual or collaborative conditions. As such, teacher and peer reviews are facilitated.

The SIMAS device is oriented to help the student achieve skills for knowledge representation, collaborative ontology building, long term memory structuring. Few software developments are found with these caracteristics; reason why SIMAS is considered not only a contribution for people's learning but for the structuring of communities of learning. One of the special features is the possibility of using multimedia information available on line, implementing the content learning management.

Software architecture

The architecture to develop this Web application, was implemented in three layers – representation, logical, and data layers – and two levels – application and data levels –. The logical and the representation layers belong to the application level, and the data layer, to the data level.

Layer programming is client-server architecture; which main objective is to split the business or content logic from the design logic. The "level" expression corresponds to the way the logic layers are phisically distributed.

- **The representation layer** is displayed by the system to the user. It accomplishes two complementary

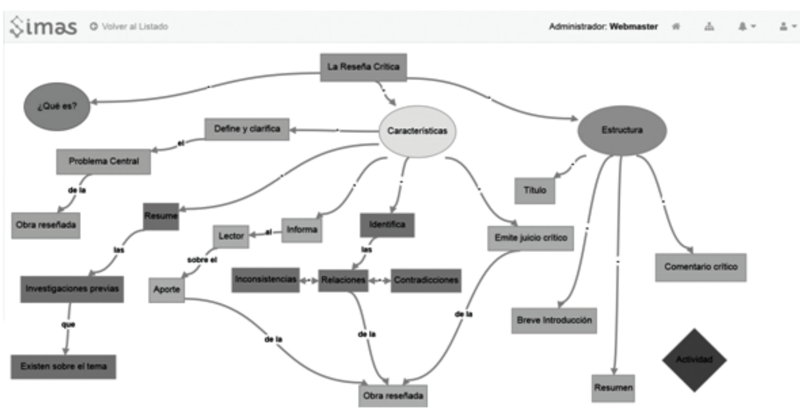

Figure 4. Representation developed by a student using the systemic tool

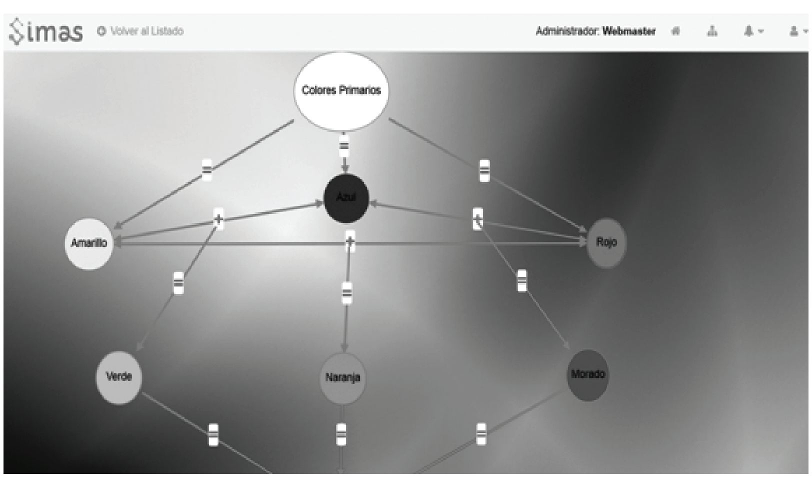

Figure 5. Represetation developed by the kinder teacher usin the Causal Tool

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functions: presenting information to the user, and capturing feedback information through the minimum number of processes. This layer is a "graphical interface", easy to understand and use (user friendly). IT communicates only with the business or content layer.

- In the **business or content layer** are the executable programs. Their roles are to receive user requests and send responses. Since rules are stated here, this process is named business logic. It communicates with the presentation layer to receive requests and report results, and with the data layer to ask the database manager for data storage and retrieval.
- The data reside in the **data layer**, which is in charge of accessing them. It consists of one or more database managers which perform the whole data storage, and receive applications for storage or retrieval of information from the business layer.

Software development

Open Source Technology used in the development of the software is Apache / PHP / MySQL. The construction of application and data layers was performed with the following versions:

- **Apache 2.2.6.** It performs a critical role since it is responsible for accepting requests for pages (or resources in general) that come from Users who access the web site, and for managing the delivery or denial, according to established security policies.
- **PHP 5.3.6**. Open source popular language, especially suited for web development, can be embedded into HTML. Instead of using many commands to display HTML (as in C or Perl), PHP pages contain HTML with embedded code that does "something". Although it appears simple to the user, it offers many advanced programming features. What distinguishes PHP from something like client-side JavaScript is that the code is executed on the server, generating HTML and sending it to the client who receives the result of running the script, disregarding the lack of knowledge of the underlying code. The web server can be configured even to process all your HTML files with PHP.
- **MySQL 5.5**. It is a relational database management system, a multithreading and multi-user database, which acts similarly when opening the URL (it owns the access code) of a web page, or when the browser reads it or turns it into something visual and it is

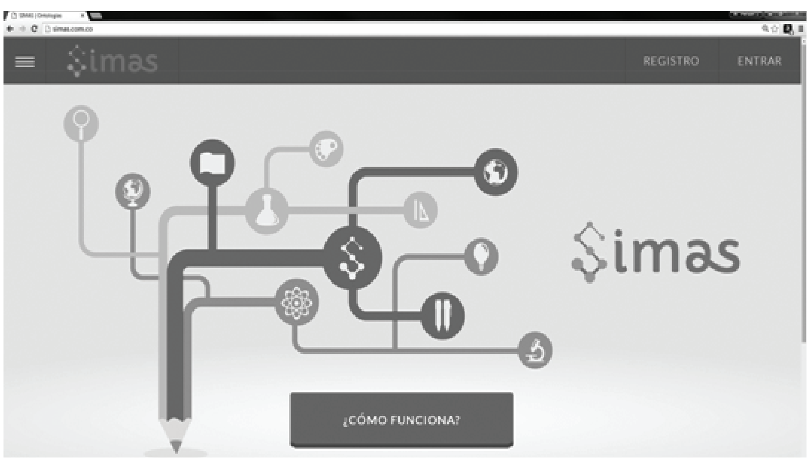

Figure 6. The main interface to enter the software (http://i3campus.co/SIMAS/)

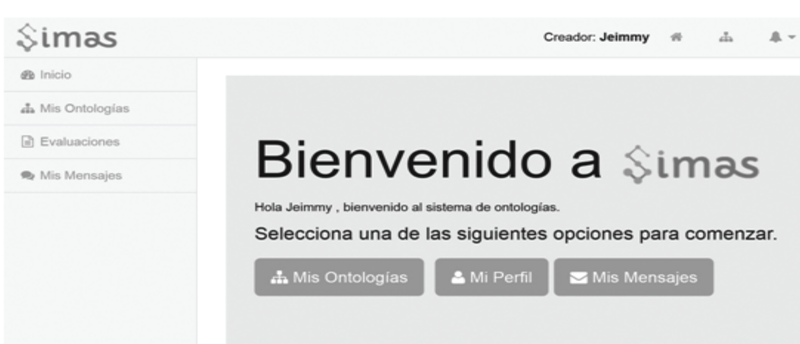

Figure 7. The wellcome page, once the user has entered the software

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understandable for everyone. This code gets support from web pages with CSS styles in order to build a visual display for the PHP programming; generating actions and process content that has to be stored in a defined way.

Here the databases appear: in the case of the web pages, one of the most used managers is MYSQL, a system that allows, through a series of sentences, to have information stored in a database and retrieve it efficiently and quickly, when needed (Figure 6).

Interface

Viewed from its shape, SIMAS is an easy access portal and a powerful device for digital content management; it has a modern design that follows current trends, consistent with the category of intended educational environment. It is implemented to create a pleasant user experience and to support the necessary conditions to keep working on the website for developing knowledge representation projects (Figure 7). Their main features are:

- *Information architecture*. The content is structured on a map that allows users to easily find what they are looking for and navigate around various components.
- *User experience*. The evaluation of the various ways in which the site can be structured evinced that the site's integral components and their sizes are visually appealing and user friendly.
- *Visual concept*. By studying colors, fonts, illustrations and graphic styles, and designing buttons and links, an easy navigation environment is accomplished. Tools are provided to integrate learning contents.
- *Content and style*. After designing the navigation map, the contents were submited for revision: spelling and writing style were revised to generate a homogeneous communication tone in the portal.
- *Content Management*. A simple system of galleries was implemented to modify contents, as well as a news section to upload images, videos and documents (Figure 8).

A set of user roles were implemented to access to the platform:

- The *administrator* role has Access to the source code that allows to enter and view information, and generate and display statistics of the software use, such as number of ontologies created and visits to each content, can view and edit all new onthologies in "onthologies" interface.
- The *creator* role is generated by the administrator from the platform or by the platform itself. It is able to open, create, save, edit and delete their own ontologies; it has the possibility of inviting potential unregistered users by email, or registered users looking for them on the platform, to participate in building ontologies. The program does not allow simultaneous editing of files between creators. While a creator is editing, this function is blocked until the changes have been saved. When creating a node, video, audio, image, text or embedded code, a Fancy Box (Popup window) is generated (Figures 9 and 10).

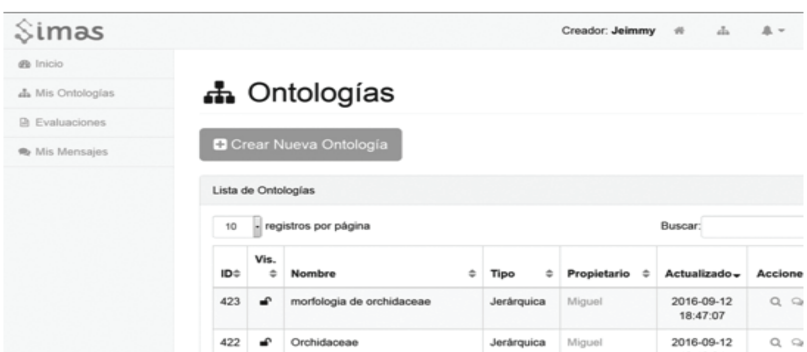

Figure 8. Interface to access an already created ontology, or to create a new representation

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Figure 9. Interface to edit a new ontology

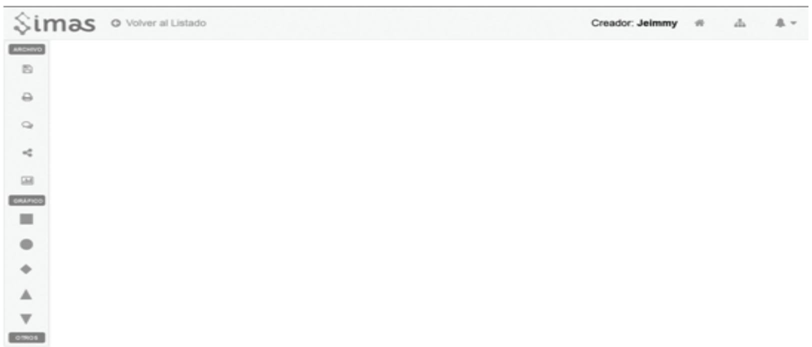

Figure10. Interface to draw a new ontology

- The *displayer* is the one who can navigate the hypertext, without editing permission. It is used to study a hypertext while preserving its structure and content.

Testing process

Once the software implementation was finished, a pilot test was conducted. Bugs were detected and fixed until a stable version was accomplished.

For an effective use of the tool, a tutorial and a manual were prepared and provided on line for the users (http://i3campus.co/SIMAS/como-funciona.php). These documents provide a detailed support for each component of the system.

With the collaboration of teachers, we observed SIMAS being used by one group of kindergarten, one group of elementary, one group of high school and one group of technical school students (Table 2). Ten observation sessions were conducted for each of the four groups and registered in field notes. At the end on this process, the teacher opinion was given explicitly trough an interview.

In a first step, the teachers built their own ontologies using SIMAS and used them to support learning strategies with the students. Different categories of ontologies were developed: hierarchical, systemic, causal, spatial, and on time line.

In a second step, the teachers asked the student to build collaboratively an ontological representation using SIMAS on a specific topic. In the case of preschool, the teacher used her own ontology to support dialogs and different learning experiences.

Table 2. Teachers and student participating in the testing process

Levels	Teachers	Number of students	Age of Students
Kinder garden	1	25	5 – 6
Elementary	1	38	13-15
High	1	37	16-18
Technical	1	18	19-24
Total	4	118	

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Table 3. The achievements and difficulties of the students using the SIMAS platform

Achievements	Difficulties
Identify concepts and select relevant information for each concept	The selection of relevant information initially is a difficulty that is progressively overcomed with the professor's guidance
Establish relationships between concepts, and express knowledge in the form of structures	At the beginning, the difficulty for relating concepts is evident. The environment helps the collaboration and provides pedagogical guidance to overcome this challenge
Compare ontological structures	Initially students tend to see only their own ontological structures. The comparison of structures among partners leads to the consolidation of accurate learning
Perform Smart Internet searches	The development of an ontology requires a minimum plan of action and criteria to identify valid information
Develop skills for collaborative projects	The initial trend is to develop individual projects, because collaboration entails the negotiation of plans and sharing of criteria, which is time consuming
Remember relevant information and use it in problem solving	Building a conceptual structure is a common challenge; however as long as this difficulty is surpassed, the skill for remembering relevant information is achieved
Integrate multimedia information based on relevance and aesthetic criteria	Initially the products are criticized for shortcomings in the organization and aesthetics. Dialogue leads progressively to improve these dimensions of the product
Communicate knowledge efficiently	Communication initially appears disintegrated, but as it progresses,it improves the ability to use ontologies to make structured and coherent presentations

Table 3 summarizes the main results according to the observer field notes and the interviews with the teachers.

Observers reported verbal interaction relevant to the assigments when using the SIMAS platform. A proactive attitude on the part of all groups were also found and an emergent sense of satisfaction with the teaching-learning process mediated by ICT.

All the teachers expressed that the software was easy to use. The performance of the systems was also good enough to support the different kind of practices they developed. The interest of this particular study was not to compare the student results, but the software performance in the different activities that the teachers could implement. For example, the kindergarden teacher developed an ontological representation of the colors to support observation activities; the elementary teacher help the students to organize historical events on the time line tool; high school and technical school students search and organize information using specific ontological approaches.

The different tasks have different degree of difficulty; however the teacher reports show that in each kind of task the software was usefull, and easy so use. The student satisfaction was a common feature of the reports.

Result analysis and discussion

The observation of users working with SIMAS in real learning activities shows the platform's great capabilities of supporting meaningful learning. The users may produce digital objects as inputs for building the meaning of an ontological representation of knowledge, but they also can integrate information available on the web. Consequently, users have a tool for the effective management of digital learning content. Positive user motivation and the improvement of long term memory skills are some of the outstanding effects reported by teachers.

Although SIMAS was designed as an application with several modules, many of them with a graphic interface for working, significant processing of information is required. Consequently, stable Internet connection is a must, in order to prevent data loss and quality decay of graphics when the user is creating ontologies.

Therefore, for subsequent versions, SIMAS would be implemented as an enriched internet application so as to reach a better performance in the following aspects:

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1. *Complexity*: contributions in the collaborative work could be accomplished simultaneously, avoiding turns between user participations.
2. *Offline*: The system saves the user production locally until direct connection to the server is achieved. In this way it could be possible to counteract any intermittent Internet connection
3. *Performance*: Although today's browsers are very robust, most applications do not use the power of the end user's machine to enhance information processing. With the installation of plug-ins or mini applications it is possible to take advantage of the processor in the computer where the browser is housed. This strategy allows applications to be processed locally on the client PC and avoid trips to the server to increase the system performance. With this approach it may be possible to have real-time experiences.

SIMAS is a revolutionary application in its domain of use, and has a good performance for an early stage. These considerations are made thinking of later versions that expand its use to areas with low connectivity and difficult conditions.

Conclussion

The current version of the software for ontology knowledge representation on line – SIMAS – exhibits the following features and capabilities:

- It is an innovative software of high functionality and benefitial for the representation of knowledge in several knowledge domains; allowing an easy, enjoyable and interactive experience for most potential end users.
- It was structured based on technology Open Source MySQL, Apache and PHP for application layers and data, and the aesthetics for the presentation layer are accomplished in HTML 5, CSS 3, and JavaScript.
- Its development is consistent with the trends in programming languages today, with a high degree of adaptability and specialization in the solution of the user needs, specifically the representation of knowledge by teachers and students.
- The five concept structures that can be developed with the software are useful to assimilate and encode knowledge, defining concepts and relationships. Ontology management improves the consistency of the knowledge representation made by the teachers and strengthens student skills to manage formal structures and give them meaning. It is therefore a device aimed at the development of meaningful learning.
- The architecture for the development of this web application was performed using three (3) layers and two (2) levels: presentation and logic layers correspond to the application tier and the data, at the level of data layer. In this sense it follows the trend of the contemporary developments of the semantic network.
- SIMAS is an easy access portal for handling hypermedia content. It features a modern design following the current trends of generating an enjoyable experience for the user and good working conditions on the site. It is an environment that facilitates the use of content arranged in cyberspace, so that teachers and students enrich the educational experiences.
- Access to the platform is performed by three (3) roles of users: *administrator, creator* and *displayer*, complying with the pedagogical and educational expectations under which the software was designed. In this way, different levels of collaboration are organized. This approach encourages the development of online hypermedia projects by groups of both teachers and students working together. At a time when education systems encourage the use of digital content online, this software facilitates the process in a much easier way than the traditional digital classrooms.

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