ROLE OF SEMANTICS, ONTOLOGIES ON MODERN EDUCATIONAL SYSTEMS

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Abstract: The author describes his experience with students interacting with some websites he made for didactics and how this led him to an appreciation for the need for better searching tools and strategies for education. The students' difficulties emerging from the above observations were a special case of the more general problem evidenced from people while searching information on the web. Semantic web is then discussed as a way to help people overcome their difficulties in using the web to gain knowledge.

The paper describes some models for knowledge construction and analyzes them in terms of their suitability as instruments for the introduction of semantics on the web. The paper then provides evidence regarding some limits for the systematic use of semantic search engine and ontology domain systems in everyday teaching and knowledge construction. Finally, the paper reports and explains a hypothesis of an information system for building communities of practice and letting them work on the construction of domain ontology. The paper concludes that this construct is well adapted to the model for knowledge construction firstly hypothesized, and can give good results in teaching-learning planning and carrying out and in helping scientists and scholars to analyze scientific paradigms and to find new trends for research.

Keywords: information system, knowledge construction, learning objects, ontology, semantic web, units of learning

1. Introduction

A variety of systems are used to support teaching-learning activities in the school and the university and to satisfy lifelong learning needs,

mostly with the help of the Web. Examples of these systems are: Content Management Systems (CMS), Learning Management Systems (LMS) and Computer Supported Collaborative Learning Systems (CSCLS). The first two types of systems are primarily content oriented (i.e., scientific and disciplinary topics and teaching-learning activities are their main focus); the last type of system is based on social and situated learning experiences and uses ICT to let students communicate and build social environments for knowledge construction. Furthermore, the comparison of the features of different e-learning platforms (both open source and proprietary) and the evaluation of their performances (*Colace & Vento 2003)* it shows the importance of systems having all the above features to the success of e-learning contexts in education.

It is also important to note that analysis and explanation of knowledge construction and evolution have great relevance not just for education; corporate and firms are, in fact, strongly interested in the creation of systems for the capture, analysis and development of knowledge and skills, both on an individual and a social basis (communities of practices). The motivation for this interest is the increase in the acquisition of new markets and good performance that organizations can achieve by means of knowledge discovery and knowledge audit systems, knowledge mapping systems, decision support systems, data warehouse and data mining systems, or, in other words, by means of knowledge management systems.

Finally, it has to be noted that special problems or particular needs that emerge in disciplines and in scholars' studies and research can lead to the creation of Web sites and systems for the management of data, information and knowledge. These systems, which are usually self made and can be based on the use of proprietary and/or open source general purpose software, have a relevant place in the management of scientific knowledge together with the above well structured and suitably made platforms.

2. The Experience:

The "Educational" web site was planned and implemented to let students attending technical lessons easily access and use various kinds

of educational materials (*Cartell 2005)*. It consists of three sections, which are described below, and is still evolving and growing by addition of different documents. Within it one can find: **a) Plates**, **b) Texts**, **c) Works in progress**, where special documents are placed; they are mostly devoted to work group experiences. These documents are in fact managed by all students attending the course and collect their exercises, analyses and suggestions.

The first and third sections contain materials to be used mostly for everyday work; in the second section texts mostly used for the professor's lectures can be found. New plates and texts are continuously inserted in the site for the enrichment of the scripting reference examples or for reporting the results of studies and research. Texts are summarized or extracted from books and proceedings of conferences and are made available with the authors' approval. Recently there has been an increase in the number of scholars and researchers who propose papers to be published in the site (*Cartell 2005)*.

The system was created and has been used since the teachers to support his lectures and manage his everyday teaching. On the other hand, while involved in the construction of the site, the author of the paper could analyze and study students' behaviors when they interacted with this new system and could observe how their ways of using site materials changed over time. This last work was very easy to accomplish due to the small number of students involved each time in running of the course. (The academic year 2004-2005 had the biggest class with 19 students attending the lessons. In other academic years, there were from 6 to 17 students attending the lessons.)

We note that how students' educational materials in the site have changed over time: **a)** The students accessing the site in its first stage, **b)** Now, with more than 72 documents and 211 plates available in the site, students mostly limit their reading to the texts the teacher suggests during the lessons and do this only when they are explicitly invited to do so.

When asked for the reason for their behavior, most of the students state they have difficulty in finding the "right documents" to study or to

analyze; in other words, they explain, when they need some information for solving a special problem or studying a particular topic, they go to the site, try to locate the right section, and start reading the document they suppose to be useful. Very often they are forced to read more than one document before finding the right information and, sometimes, this time consuming job prevents them from ending the research and finding what they were searching for. Students experience this difficulty despite the site tree structure (reproducing the structure of the discipline topics), the index pages clearly indicating the available texts, and the systematic use of thumbnails (icons) for giving a preview of plates and other images.

A short survey made at the beginning of the academic year 2005-2006 on students (before lessons started) led to the same results. The students were given a limited time and instructed to browse the site to find documents concerning one or more special topics that were suggested by the experts. Only 25% of them successfully found the right pages in the appointed time, 42% found them after the deadline and 33% did not succeed in finding them and stopped their research after having looked through only a few pages. Table 1 shows the number of students with the percentages.

Tab. 1 – Distribution of students successfully accessing the right pages in the site

Success in accessing the right document in a fixed time	**N. of students**	**%**
Succeeded before the deadline	3	25%
Succeeded after the deadline	5	42%
Didn’t succeed in finding the right document	4	33%

3. Data Analyses

When search engines were first introduced in the web, people thought that the finding of information would be very easy and that all the above problems were solved. Now, with the increase of the amount of information and the growth of the number of search engines (very different among themselves for their features), we know that things are not so easy and the above problems are far from being solved. The

main reason for the difficulties that are reported is the fact that word matching (actually used all over the web to find HTML pages) doesn't guarantee the right result for a given search. Recently, because of its features, the semantic web has been proposed to offer a good solution to the problem.

To give the semantic web a pedagogical perspective, within which to consider the effects the web can have on individuals' knowledge construction and development, two themes will be deeply analyzed in the following paragraphs: 1) instruments for giving semantics to the web and their possible educational application, 2) models for knowledge construction and evolution in mankind and their consistency with the semantic web.

4. Semantic Web

Until now the basic idea of the semantic web has been relatively straightforward: to let the web evolve to enable the automatic processing of its content so that data can be shared and processed both by humans and software to reach this goal requires instruments and strategies for enabling computers to 'understand' web pages (*Berners & Fischetti 1999*). Users can then be helped in searching for relevant information, in making inferences and calculations, and in combining information in new ways. The reverse side of the coin is that authors must provide explicit and domain specific meaning ('semantics') to allow automatic machine- interpretation.

While looking at the use of the above instruments in teaching and learning activities systematically analyzed the trend in instructional design deriving from their use. He stated that the introduction of the above instruments in education aimed at: (a) increasing the effectiveness of education, (b) increasing the flexibility and accessibility of education, (c) increasing the attractiveness of education and (d) decreasing the workload for educational staff (or more in general: decreasing the institutional costs). On this basis he proposed an educational semantic web, i.e., a strategy representing a course in a formal, semantic way so that it could be interpreted and manipulated by computers as well as humans (*Koper 2001*).

5. Knowledge Development Models, ICT and Teaching

Human knowledge has been studied since mankind's origins. First of all, philosophy has played a relevant role in interpreting human knowledge; later, especially during the last century, human sciences intervened in explaining phenomena both on an individual and a social perspective. Nowadays many scholars look at constructivist hypotheses as the more suitable ones for the explanation of knowledge construction and evolution in people interpretation of phenomena. Together with the numerous theories on human knowledge many models for its construction and evolution have been developed over time. In what follows a special model will be analyzed in greater detail, not only because it is very recent, but also for the relevance that ICT plays in it (*Cartelli 2005*).

Figure 1 shows the tri-partition of knowledge phenomena in the model; it shows the importance that different levels of human socialization have on knowledge construction

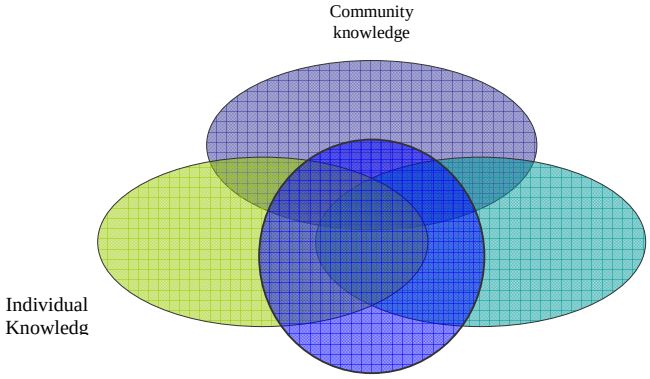

Fig. 1 Hypothesis for structure of human knowledge

There are at least three different kinds of knowledge in the model:

5.1 Individual or personal knowledge, i.e., the knowledge a subject has and builds at a given moment, due to his/her interaction with reality.

5.2 Community knowledge, i.e., the knowledge resulting from the interaction of the members of a community; it is the sum and the

expression of know how and the best practices of all the subjects in the community.

5.3 Social knowledge or culture, i.e. the expression of the history and tradition of the society the subjects belong to among various elements in this type of knowledge scientific and discipline knowledge play a special role.

It is perhaps too early to say if the above model has the right requisites to be adopted for the description of all knowledge phenomena and for the planning and carrying out of teaching-learning activities. Nevertheless, the increase in the importance of informal education (coming, for example, from subjects' interaction with media, IT and ICT) with respect to formal and non-formal education (school, association etc.), and the influence of other factors all depending from complexity of today society, are showing the inadequacy of old educational models with respect to knowledge society needs. The experiments for the finding of new didactical strategies and the proposal of new regulations for schools all over the world are a good proof, in the author's opinion, for the new emergence in education. (*Cartelli, A. (2006)*.

The main consequence of the above considerations is once again the difference between knowledge representation and knowledge construction. It is clear that when passing from knowledge representation to its construction, of the above instruments no single one is transversal to the model discussed above (i.e., none can be adopted for all the knowledge construction units in the model).

6. Semantic Web and Information Systems

In one of the above sections it was mentioned that the semantic web, and ontology systems with it, can synthesize and represent knowledge in a given domain with all the concepts and the relations existing among themselves. Furthermore it has been shown that as regards the planning and carrying out of effective didactical activities and the help that people can receive in building the right and meaningful knowledge, there are two different positions on those systems: a) They are supposed to help teachers in their everyday work due to their features; b)They don't meet the features of a special knowledge construction and

development model and further studies are needed for finding the better way for their introduction in teaching-learning activities.

On the other hand, it has to be noted that information systems never appear among the instruments leading to semantic web also if, in the author's opinion, they can play a relevant role both in introducing semantics in the web and in building effective educational experiences.

In other words, in the author's opinion, a suitable information system, with its databases and selected accesses, can create a semantic network on a given knowledge domain (based or not on pre-existing web pages or any kind of document and bibliography) while integrating in itself the knowledge construction model reported above. The proposal of such an information system letting individuals, communities and disciplines (sciences) analyze and create knowledge follows.

7. The Information System

As usually happens with all information systems the explanation of the whole project and the description of the system itself both involve the following elements: a) data and their structure, b) subjects and their interactions, c) data flow and processes description.

As regards data (to be managed by a RDBMS) the following elements are hypothesized:

7.1 System administrator/s, which can create accounts for scientific administrators and students/ contributors and manage all information and data in the database,

7.2 Scientific administrator/s, who assign scientific topics to students/contributors for the management of data (compilation of entity and relationship cards) and verify the correctness of the work made by contributors (they are entrusted with the task of validating compiled cards),

7.3 Students/contributors, containing personal data of people cooperating to the construction of the system (including identification and access data; i.e., ID code and password),

7.4 Entities, where concepts, instruments, people, places and times, concerning the topics in the knowledge domain, can be found,

7.5 Relationships, where the links between entities are included; they also contain the description of the links and the references to documents, they can be mono-directional or bidirectional (depending on the type of the connection between entities),

People interested in the information contained in the data base and in accessing the ontology domain have two different query systems. First, they have a page containing most relevant topics in the domain; if they select one of the items they find a description of the topic and of the links to related arguments, instruments, people etc. When a scientific administrator is enabled he/she can input the data for one or more students/contributors and make them access the system; he/she can also input the topics to be chosen / assigned to the contributors and can input by him / her self the entity, relationship and bibliographic cards. When the contributor/s can access the materials to work on they can compile the cards. Finally the cards are analyzed and revised from the administrator/s so that they can be read by general users. Figure 2 shows what the various users can do.

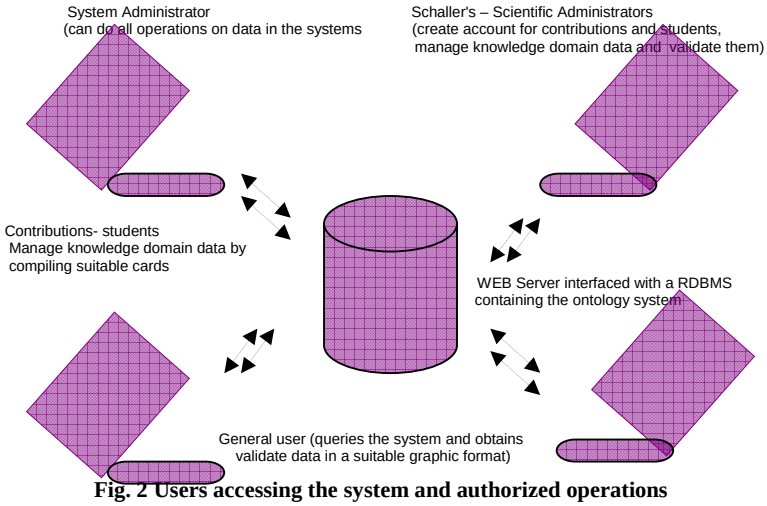

Fig. 2 Users accessing the system and authorized operations

The key for the success of this system is in the communication subsystem (the electronic blackboard), letting people involved in the creation of the database share their experiences and knowledge, finding support and help from better skilled subject, and so on. As can be easily shown, the system agrees with the knowledge construction model discussed in the above sections: individual, community and social (science) components of the model are in fact interested in the knowledge construction and evolution process.

Figure 3 synthesizes knowledge construction at the three different levels: individual, community and society.

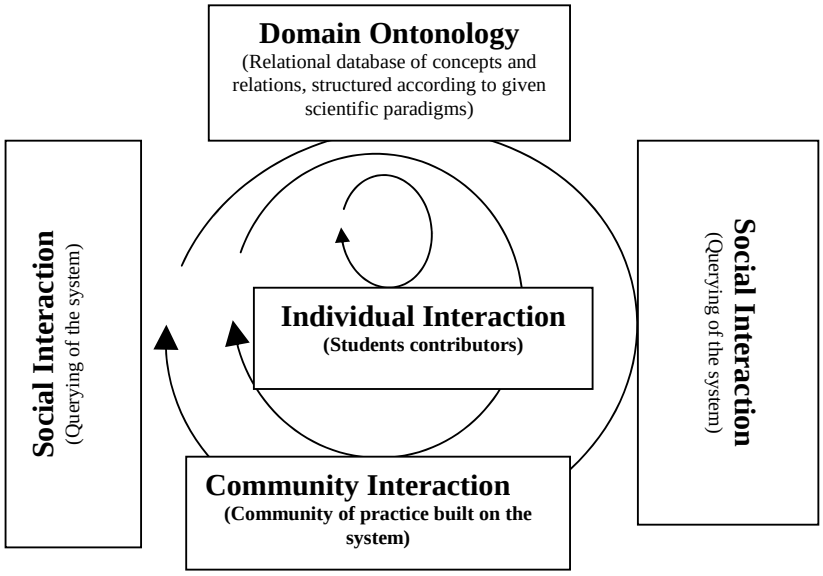

Fig.3 Model of knowledge construction according to systems access

Conclusion

Introducing semantics into the web for automatic representation of knowledge is no easy task. But it can be very useful in education for its continuous involving subjects at all their levels of knowledge construction. The author's experiences led to an information system around which communities of learning and of practices were built. The results of the experiences up to now agree with the knowledge construction model reported in the paper; they led to the introduction of a new element in the SECI knowledge evolution model (*McGuinness*

& Van Harmelen 2003) showed the importance of social-constructivist instruction strategies in today education. As a conclusion it seems possible that the hypothesized system will be useful for improving teaching-learning strategies even if it will not lead to the automatic management of documents on the Web.

References

1. *Berners-Lee, T., & Fischetti, M. (1999). Weaving the Web: The original design and ultimate destiny of the World Wide Web by its inventor. San Francisco: Harper.*

2. *Cartelli, A. (2005). ICT and Knowledge Evolution in Learning Organizations the Lesson from Paleographers Community of Learners. In (F. Malpica, F. Welsch & A. Tremante ed.s) Proceedings of EISTA International Conference, Vol. 2, pp. 275-280.*

3. *Cartelli, A. (2006). ICT, Knowledge Construction and Evolution: Subject, Community and Society. In (A. Cartelli ed.) Teaching in the Knowledge Society: New Skills and Instruments for Teachers, pp. 33-53. Hershey (PA): Idea-Group Inc.*

4. *Colace, F., De Santo, M., & Vento, M. (2003). Evaluating On-line Learning Platforms: a Case Study. In Proceedings of the 36th Hawaii International Conference on System Sciences (HICSS'03), retrieved online March 05, 2006 from http://csdl2.computer.org/comp/proceedings/hicss/2003/1874/05/187450154c.pd*

5. *Cover, R. (2003). (XML) Topic Maps. Retrieved December 11, 2004, from http://xml.coverpages.org/topicMaps.html*

6. *Graf, S., & List, B. (2005), An Evaluation of Open Source E-Learning Platforms Stressing Adaptation Issues, retrieved on line March 05, 2006 from http://moodle.org/other/icalt2005.pdf*

7. *Jennings, N. R. (1998). A Roadmap of Agent Research and Development. Autonomous Agents and Multiagent Systems, 1(1), 7-38.*

8. *Koper, R. (2001). Modelling units of study from a pedagogical perspective: the pedagogical meta-model behind EML. Heerlen: Open University of the Netherlands. Retrieved November 14, 2005, from: http://eml.ou.nl/introduction/docs/ped-metamodel.pdf*

9. *Koper, R. (2004). Use of the Semantic Web to Solve Some Basic Problems in Education: Increase Flexible, Distributed Lifelong Learning, Decrease Teachers' Workload. Journal of Interactive Media in Education, 6. Retrieved November 14, 2005, from: http://www-jime.open.ac.uk/2004/6*

10. *Landauer, T. K., & Dumais, S. T. (1997). A solution to Plato's problem: The Latent Semantic analysis theory of the acquisition, induction and representation of knowledge. Psychological Review (104), pp. 211-240.*

11. *McGuinness, D. L., & Van Harmelen, F. (2003). OWL Web Ontology Language Overview (W3C Candidate Recommendation 18 August 2003). Retrieved November 14, 2005, from http://www.w3.org/TR/owlfeatures/*

12. *Nonaka, I., Takeuchi, H. (1995). The knowledge-creating company: how Japanese companies create the dynamics of innovation. New York (NJ): Oxford University Press. RDF (2003). Resource Description Format (RDF). Retrieved November14, 2005, from http://www.w3c.org/RDF/*