DigiDocMap conceptual maps editor and Topic Maps norms

Cristòfol Rovira

Cristòfol Rovira. *DigiDocMap conceptual maps editor and Topic Maps norms* [on line]. "Hipertext.net", num. 3, 2005. <http://www.hipertext.net/english/pag1005.htm>

1. Introduction

The interest for the graphic representation of ideas or concepts has become of great interest thanks to the Web development. The navigation maps show the web site page structure and allow guiding the browsing by means of this "physical" structure, but they are unable to represent the conceptual structure of the contents of those pages. To provide guidance though the semantic structure of the contents of a web the use of conceptual maps is necessary. At this moment there is some confusion on what a conceptual map is, and how to implement it on the web. Two supplementary instruments are being implemented, but these are different for the creation of maps made up by concepts and relationships with the purpose of facilitating access to the represented information: conceptual maps and *Topic Maps* .

This article is structured in two parts, in the first part the differences and similarities between the conceptual maps of the Novak proposal (19984) and the *Topic Maps* standard (ISO/IEC 13250) are analysed. This analysis is the result of the experience in the development of the DigiDocMap application, an editor for the creation of conceptual maps. In the second part of the article, the three versions created by this editor are described, analysing the features of each one of them and the reasons that caused the inclusion of the main changes.

In this article the results of a wider research project, whose objective is the development of methods, processes and tools in the context of a Semantic Web are presented. This is a project funded by the Ministry of Education and Culture of Spain (National Plan R&D& I reference HUM2004-03162/FILO).

2. The origins

The origins of the conceptual maps have to be placed in the works of Joseph D. Novak in the mid Sixties in the context of a research project of the psychology of learning. Novak (1982, 1984, 1988) researched the learning of children based on Ausubel (1989) theories, and created conceptual maps as an instrument to make the type of acquired learning visible. Novak never thought, at any moment of Internet, amongst other reasons because it did not exist when he created the conceptual maps. It was later when the extensive use of this type of instrument as information access tool in digital environments, as there are hypertext links to the map concepts has been seen.

On the other hand, *Topic Maps* is an international standard (ISO/IEC 13250) to express concepts and its relationships. Its origin has to be placed at the beginning of the Nineties by the Davenport group, the electronic book producers. The *Topic Maps* standard was formulated in its origin in SGML language, but in 2001 the first version in XML was published called XTM, that can be applied in the development of applications for Internet.

Although Novak's proposal, and the *Topic Maps* standard, coincide in the presence of concepts with its semantic relationships and the architecture of these relationships is the same, (directed graph), these are realities with different origins, functions and objectives.

3. Conceptual maps versus Topic Maps

Neither the conceptual maps are *Topic Maps* nor are the *Topic Maps* conceptual maps. A conceptual map is a technique (strategy, tool or resource) to represent and organise knowledge using concepts and linking phrases between these concepts (Novak, 1984). On the other hand, *Topic Maps* is an international rule to express in a computer readable format concept (topics), relationships between information concepts and resources linked to these concepts.

A conceptual map, in accordance with Novak's proposal is a group of propositions on a certain subject ordered in the shape of a tree. In the nodes of this tree the concepts are placed and in the nodes connections the linking phrases would be placed expressing the relationship between the connected concepts. Usually the concepts are the substantive part of the sentences, and the verbs or prepositions make up the linking phrases. There is always an initial concept (root) from which the relationship tree develops. The concepts are usually represented within boxes or ovals and the linking phrases act as labels of the lines linking one or more of these concept boxes.

The conceptual maps and the *Topic Maps* standard are instruments with different origins, functions and objectives. On the one hand, the conceptual maps have their origin in an academic context, their initial function was to improve learning and their main objective was the representation of knowledge in a graphic way. On the other hand, the *Topic Maps* is an international standard promoted in its origins by the producers of electronic books with the objective of storing and processing information in a standardised format.

Table: Conceptual maps in relation with *Topic Maps*

Characteristic	Conceptual maps (Novak)	Topic Maps (ISO/IEC 13250)
What is it?	Technique to structure knowledge in concepts and connection phrases to then represent it graphically	An international standard to structure the information in SGML and XML format
Origin	Novak research in psychology of learning based on Ausubel (1989) theories	Davenport Group (forum of electronic book producers) with the objective of creating a standard for the fusion of printed book indexes.
Functions	Facilitate and improve learning	Storage and processing of information
Objectives	Represent the structure of student knowledge to know the type of learning that has achieved	Represent the structure of knowledge
Date of origin	1984, publishing year of Novak, J. D.; D. B. Gowin. Learning How to Learn. New York, Cambridge: Cambridge University Press, 1984	1993 year when the drafting of the first standard was proposed
Basic constituent parts	Concepts	Topics

	Linking phrases Linking in the concepts	Associations Resources
Applications	Representation of knowledge Training	Representation of knowledge Data storage Data exchange Information retrieval ....
Structure of the implicit information	Directed Graph	Directed graph
Allows crossed references	Yes	Yes
Map orientation	Mainly from top to bottom	Not determined
Is a root concept necessary	Yes	No
Requires graphic representation	Yes	No
Allows multi-hierarchy	Yes	Yes
Allows links from the concepts/topics to external resources	No (in its initial formulation)	Yes
Allows relationship with direction	Yes	Yes
Allows relationship without direction	Yes	Yes
Allows bi-directional relationship	Yes	Yes

Once the differences have been established, we should highlight the points in common, which are a few. As we have said, both realities correspond to the same theoretical model: directed graph. We will not provide details in the description of the peculiarities of this type of structure, but simply highlight that in both cases there are nodes (concepts, topics) related with connection phrases making up a network of characteristics that are the same.

This coincidence enables Topic Map to be a conceptual map storage format, that is to say, using the *Topic Maps* standards a conceptual map can be created in a very natural way.

A conceptual map concept would correspond to a Topic, a linking phrase to an Association and the accessible resources by means of links associated to the concepts that would correspond to the Occurrences of the *Topic Maps* format. Although Novak did not propose linking hyper-textual links to the concepts, this is trivial when the conceptual map appears implemented in a web page.

The visualisation of the information included in a *Topic Maps* in the shape of a conceptual map is only one of the possible ways of showing its contents. Moreover, the *Topic Maps* format and the conceptual model implied can be employed for other purposes such as, for example, the retrieval of information on the basis of automatic inferences. We should also highlight that a conceptual map can be modelled with increased efficiency using a no-standard format with a finer adjustment avoiding the inconsistencies between the two implicit models as we shall see below.

Table: how to model a conceptual map with the Topics Map standard

Conceptual map	Topic Maps
Concept	Topic
Linking phrase	Associations
Hyper-textual links associated to the concepts	Occurrences
Direction in the linking phrase	Roles
-	Scope note
-	Names
-	Scope
-	Type/instance

4. Differences between a conceptual map and the Topic Maps format

The map models implicit in Novak's proposal and in the *Topic Maps* format have inconsistencies that should be mentioned. In the first place, some elements of the *Topic Maps* standard that are not present in a conceptual map will be analysed. We will then see the opposite case, the components of a conceptual map that would be interesting to store and that there are no elements in the *Topic Maps* format to express them.

4.1. Types

One of the basic elements of the *Topic Maps* is the type and/or instantiation relationship. The Topics (concepts) of a *Topic Maps* can be classified by types. For example, in a *Topic Maps* on Mediterranean cuisine the Topics can be classified by ingredients, tools and procedures, A "tomato" would belong to the "Ingredient" class, or in other words, a tomato would be one of the instances of "Ingredient".

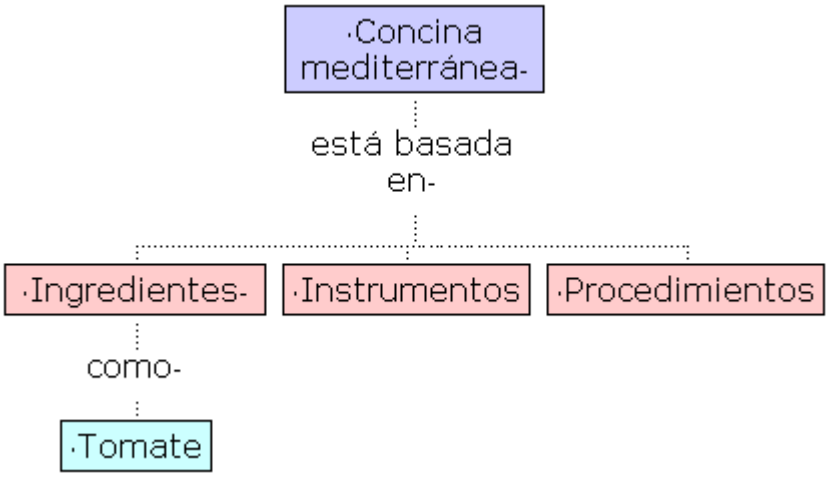
```
<topic id="12345">

<instanceOf>

<topicRef xlink:href="#ingredient"/>

</instanceOf>

<baseName>
```

<baseNameString>tomato</baseNameString>

</baseName>

</topic>

This concept classification in classes is not present in the conceptual maps and does not seem necessary given its functions and objectives, unless we trivially classify the elements of a conceptual map in the types of "concepts" and "linking phrases". Another issue would be if we were to show in a conceptual map that a tomato is an ingredient using a linking phrase. Formalising this situation with *Topic Maps* we would apply the Association element.



This map translated to the *Topic Maps* terminology, "Ingredients" and "Tomato" would be Topics, the linking phrase "as" would be an Association. As shown, no instantiation acting parallel to the explicit relationships between a map Topics would be applicable.

4.2. Names

Another important difference is that a Topic can have various names, each one associated to a certain scope. These elements are usually applied to store the translation to various languages or the expression of a Topic in an optimum way for various publics. "Tomate" would be the name for the "Spanish" context and "tomato" for the English context. There is only one Topic but various ways of showing its denomination.

<topic id="1234">

<baseName>

<scope><topicRef xlink:href="#spanish"/></scope>

<baseNameString>tomate</baseNameString>

</baseName>

<baseName>

<scope><topicRef xlink:href="#english"/></scope>

<baseNameString>tomato</baseNameString>

</baseName>

</topic>

In a conceptual map there are no alternative names or contexts. Another question would be if, when formalising the conceptual map with *Topic Maps* , we were to include these elements to allow, for example, a map to be translated. But Novak's proposal does not include this possibility; it could not be in any other way as there are details of a machine readable format itself, and not of a didactic activity proposal.

4.3. Roles

A Topic can have an associated role, especially when intervening in an Association. For example, when in a *Topic Maps* on opera, the relationship between Puccini and Lucca would be on the basis of the person and place roles (Pepper, 2002: 11). The role attribution only has the correspondence in the conceptual maps when a linking phrase implies a relationship with direction expressed with an arrow pointing towards the final concept. A way of expressing these cases in the *Topic Maps* format would be assigning the roles of "start" and "final" to the members of the relationship.

4.4. Occurrences

The Occurrence element contains relevant additional information for the Topic and can be of two types, resource reference when it is a hypertext link to those contents, and resource data when the relevant information is included in the Topic Map.

As we have indicated, the conceptual maps formulated by Novak did not include the references to additional resources. Nevertheless, if this possibility is considered, the formulation of *Topic Maps* is insufficient as it is not planned the indication of basic elements of any bibliographic reference, such as author, title, or date of creation.

4.5. Typography and coordinates

The *Topic Maps* format is not designed specifically for the visualisation of information and does not have components to store information relative to typography (types of font, size...), the distribution of elements (coordinates x and y) or the possible style sheets. When a conceptual map is exported to a *Topic Maps* format it unavoidably looses all these elements.

In conclusion, the flexibilisation of the implementation of the *Topic Maps* format in XML, and the great similarity between the two implicit models makes it possible for the *Topic Maps* to be applied relatively successfully to formalise a conceptual map. Nevertheless, it has superfluous components (Types, Scopes) and lack elements relative to visualisation (typography, coordinates). These drawbacks would make it advisable to use, in certain occasions, a more adjusted non-standard format.

4.6. Data exchange

The fact that *Topic Maps* is a standard format supported in an ISO standard makes it an ideal candidate for data exchange between various platforms processing conceptual maps. Nevertheless, the imbalance mentioned between the Novak map models and *Topic Maps* can be solved in various ways. Therefore, it is not sufficient with the application of the ISO/IEC 13250 standard in its formulation in XML (XTM) to be able to ensure compatibility, the application of this format should be agreed upon.

5. DigiDocMap Editor

DigidocMap is an application for the creation of conceptual maps in accordance with Novak's proposal requirements. The users use the editor inputting the information on concepts and linking phrases in forms in a typical user interface, created in a web page. The editor generates a HTML page including the map graphically.

DigiDocMap is part of a group of tools developed by and for the Digital Documentation Online Master that are offered as freeware tools to be used by documentalists, biblioteconomists, librarians, web site creators and innovation professionals of digital culture in general:

- DigiDocMap conceptual map editor
- DigiDocMenu pull-down menu editor
- DigiDocIndex indexer and generator of local search engines

Available at the Digital Laboratory of the Master:

http://www.documentaciondigital.org/master/laboratorio.htm

The motivation to start the project of the creation of an application to edit and create conceptual maps took place during the first teaching years of the Digital Documentation Online Master (Rovira, 2001). In the design of the didactic material for this course the need to include additional elements to allow navigating through routes guided by semantic criteria was detected. The architecture of the Master digital room promoted navigating through links of a structural type (such as, for example, from the course to the module, and from the module to the didactic unit), but hypertext connections were not explicitly shown as having supplementary elements.

At the beginning we had considerable difficulties in creating this type of transversal links. A specialist that usually does not know in depth the contents of the master to link its contents with other units was in charge, (and is in charge), of each didactic unit. On the other hand, it is delicate and difficult to negotiate the inclusion of links to the original received documents. Our decision was to assign this task to the Master coordinator. We decided not to include these links in the articles, but we drafted an additional instrument, in an independent page, to synthesise in a compact way these semantic connections between the contents of various course didactic units. This instrument was none other than conceptual maps.

To include the maps in the course digital room, we needed an application allowing the creation and edition of maps in a HTML format. Additionally, it was essential for the concepts included in the map to have a list of associated links as this was the main objective. At the moment when we started on this project there was no application meeting these requirements. In the following years, some editors available in the Net added the lists of hypertext links associated to concepts.

Although the initial motivation was, as we say, the addition of navigating alternative routes in the digital room of the Master, new features were made later on evidence making the conceptual maps a tool of great use in training environments. Specially, we should highlight the capacity of being able to show didactic contents summarised, and its extraordinary efficiency when used as a learning activity. It is very illustrative to observe a map created by a specialist, but it is more interesting and instructional to create our own map. No en vain, the origin of this type of instruments is the investigation of the psychology of learning (Novak, 1984). Finally, we should highlight the use of conceptual maps not directly related with this origin: its application as presentation system for conferences or master classes. For this purpose some additional interactivity features were added to DigidocMap, such as fold and unfold the branches of a concept tree, show areas of the map, or change typographic attributes, such as the size of font.

Table: The three DigiDocMap versions

- Version 1 http://www.mapasconceptuales.com/v1/
- Version 2 http://www.mapasconceptuales.com/v2/
- Version 3 http://www.mapasconceptuales.com/V3/

Characteristic	Version 1	Version 2	Version 3
Date of creation	September 2002	September 2004	April 2005
Latest update	February 2003	July 2004	April 2005

Data in format	XTM (*Topics Map*)	Array JavaScript Array java	Array JavaScript Array java
Import options	No	From the previous version	From the previous version From XML-Topic Map
Export options	No	No	To Topic Map
Multi-hierarchy	No	No	Yes
Possibility of inserting graphics in the concepts	No	No	Yes
Distribution of the maps	Automatic	Automatic	Automatic and manual
Map interactivity	-	Fold/unfold Highlight/mitigate Show/hide menu	Fold/unfold Highlight/mitigate Show/hide menu Select and drag
Theoretical model of the structure	Tree without direction	Tree without direction	Directed graph
Printable link list	Yes	Yes	Yes
Save map	Copying and pasting a fragment of code	Automatic in C:/temp	Automatic in any drive and directory
Configuration menu	No	Yes	Yes
Cross references	No	Partially	Yes
Map orientation	Top-bottom	Top-bottom Left-right	Top-bottom Left-right Any orientation
View definition	No	Yes	Yes
Free use to install in local	No	Yes	Yes
Free use in Web	Yes	Yes	Yes
Programming language	JavaScript	JavaScript and Java	JavaScript and Java

Operative in browser	Internet Explorer 5.0 or higher	Internet Explorer 5.0 or higher Mozilla 5.0 or higher	Internet Explorer 5.0 or higher Mozilla 5.0 or higher

6. Version 1

The first version of the map editor was created at the end of 2002, fully developed in JavaScript language and, in order to save the maps carried out, the editor provided a HTML and JavaScript code fragment (installation code) that the user copied and pasted on a HTML page. The maps were stored in XTM format (Topics Map in XML) and the browser directly processed this data using the data isle feature only available in the Internet Explorer browser. In this first version the editor was a service available in Internet; it could not be installed in the user local computer.

Installation code to create a map (DigiDocMap Version 1.0)


```
}
if(document.all)capesMapaEditor()
function empaquetarMapa(){
 var temp = '';
 for(var indexPle in arrayValorsMapa){
  if(arrayValorsMapa[indexPle].length<37){arrayValorsMapa[indexPle][36] = 'normal'}
  if(arrayValorsMapa[indexPle][0]!='esborrat'){
   for (i=0; i<37 ; i++){
    temp += arrayValorsMapa[indexPle][i] + '@';
   }
   temp = temp.substring(0, temp.length-1);
   temp += 'æ';
  }
 }
 temp = temp.substring(0, temp.length-1);
 return temp;
}
function posaEnUnDobleArray(temporal){
```

6.1. Version 2

The second version was created two years later to include more interactivity features; access to the user local drive and save the map, improve compatibility with various browsers and allow its installation in a local computer.

Due to the imbalance between the conceptual map characteristics (Novak 1984) and the *Topic Maps* format, the exclusive use of XTM for data exchange between applications by means of import and export options was decided. As from this version 2, the data was stored using JavaScript and java data structures, more adjusted to the requirements of conceptual maps.

On the other hand, the editor collects the data the users input by means of forms and generate the conceptual map placing each element in an automatic way. The position of each element is determined by the corresponding algorithm and the user can decide the order of the concepts or linking phrases but not on which coordinates these will be shown. As we shall seen in version 3, these limitations were overcome with the inclusion of features allowing the selection and dragging of map elements, both at the moment of its creation as well as after, when the user interacts with a ready-made map.

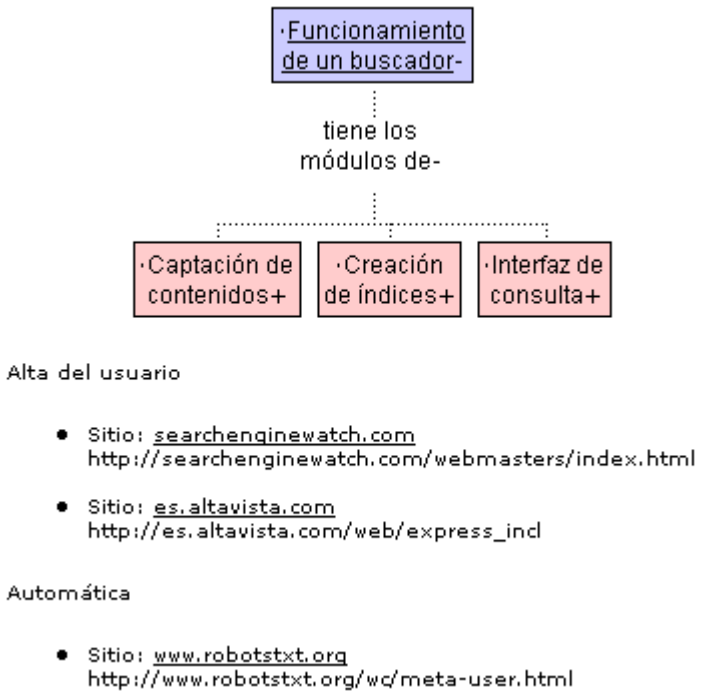
Another significant change in this second version was its development in java, which allowing the saving of the carried out maps in the user's drive. In the first version the editor was an exclusive service available in Internet, from the second version, the possibility to install the editor in the user computer as freeware application was additionally provided.

During the two years the first version was used for the potential use of the conceptual maps for presentations in master classes or conferences was made clear. To promote this new and unforeseen use several interactivity features were developed. For example, buttons for the various branches of the tree to fold and unfold, to highlight or mitigate concepts or even to orient the map from left to right instead from top to bottom were added, being shown by default.

In this second version a menu on the top part of the maps was added, to control the presentation and be able to modify the interactivity elements, typography and other features, such as the presence of the menu itself.

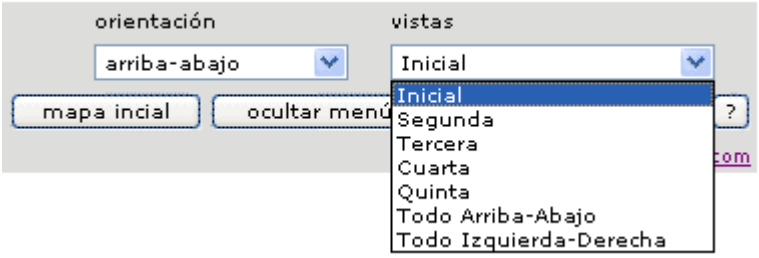
The links list is a characteristic of the editor already present from the first version and that was the solution to a problem detected when a map was printed. When a concept has associated resources a link is shown allowing opening an additional window in the URL list toward these resources. This way of implementing navigating has the advantage of being able to include a large number of links in a map without this causing an overload of information in a reduced space. The drawback of working with additional windows is that the printing of the map does not include the information on the links. The problem was solved including a global list of all the links in the map.

Links list in a map (DigiDocMap Version 2.0)



Version 2 had as a significant innovation the definition of views. A view is one of the possible ways of showing a map depending on typography, mitigation, folding and orientation. In this way, a map has infinite views depending on the selection we make of each of these concepts. The editor allow saving this group of characteristics with a name to then apply them to the map at once. The top menu has a pull-down list with the defined views.

Pull-down list to select a view (DigiDocMap Version 2.0)

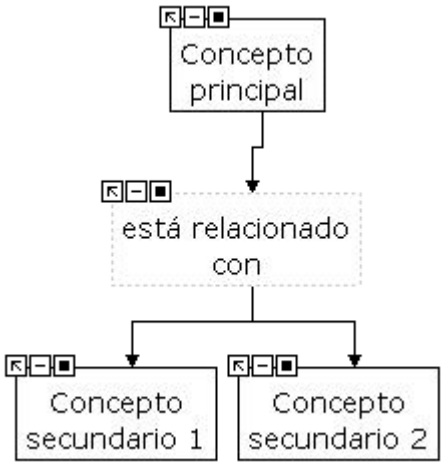


Novak advises the inclusion of crossed references to relate various knowledge domains present in the conceptual map. In practice, creating a crossed reference involves relating concepts in different branches of the concept tree structure. With the presence of cross references the complexity of the algorithm for the automatic distribution of elements in the map increased exponentially, so in the second version these were only partially supported.

6.2. Version 3

Two factors were determinant to take the decision of developing a new version of the DigiDocMap editor: the need to create options to export to XTM and the desire to overcome the limitations regarding the crossed references. Although this second factor may seem insignificant, it determined a radical change in the internal configuration of the map evolving from the tree structure to a graph structure.

DigiDocMap version 3



In the first two versions of the editor, the maps obeyed an internal tree structure in such a way that starting from an initial node (root concept) the map had branches by means of linking phrases and new concepts. The creation of multi-hierarchical relationships was not possible, nor the full establishment of crossed references between concepts of different branches.

To overcome this limitation the algorithms relative to the automatic distribution of the map elements breaking the limitations of the tree structure when adding the poly-hierarchy. Additionally, the possibility of the manual distribution of the components of the map with selection and dragging, establishing a mixed process, automatic-manual, to create its final aspect. The representation of the relationships including arrows to indicate, if necessary, the direction of the linking phrases was improved, and the possibility of inserting graphics in the maps as concept illustrations was added.

Regarding the import - export options, the third version included the possibility of using the XTM format for the exchange of data using the specification of the standard carried out by CmapTools http://cmap.ihmc.us/ .

7. Conclusions

This article has summarised some reflections between the model of conceptual maps proposed by Novak (1984) and the model implicit in the *Topic Maps* standard (ISO/IEC 13250) on basis of the experience in the development of the DigiDocMap map editor.

The specification of the standard *Topic Maps* in XML (XTM) allows expressing conceptual relationships in an adequate way for the web environment. The representation of these networks in the shape of conceptual maps is only one of the possibilities that this standard has. Taxonomies, ontologies and thesauri can also be formalised using the XTM standard and integrated in the web as implicit knowledge. The Semantic web will be a reality if this implicit knowledge resident in *Topic Maps* provides new possibilities for a more intelligent processing applicable to the retrieval or

visualisation of the information on the Net.

8. Appendix: conceptual map editors

Below a list of the computer programmes for the creation and edition of conceptual maps is shown:

Axon Idea Processor http://web.singnet.com.sg/~axon2000/index.htm

CmapTools http://cmap.ihmc.us/

ConceptDraw http://www.conceptdraw.com/en/products/mindmap/main.php

Decision Explorer http://www.banxia.com/demain.html

DigiDocMap http://www.mapasconceptuales.com/

FreeMind http://freemind.sourceforge.net/wiki/index.php/Main_Page

Inspiration http://www.inspiration.com/

Kdissert http://freehackers.org/~tnagy/kdissert/

Knowledge Manager http://www.conceptmaps.it/default-esp.htm

Mind Graph eBook http://www.mind-graph.net/mind-graph.htm

MindGenius http://www.mindgenius.com/

MindMan http://usuarios.iponet.es/casinada/32mind.htm

MindManager http://www.mindjet.com/eu/

MindMapper http://www.mindmapperusa.com/

MyMindSimple http://www.sebastian-krauss.de/software/

NovaMind http://www.nova-mind.com/

OmniGraffle http://www.omnigroup.com/applications/omnigraffle/

Shared Space http://www.shared-space.net/

Smartdraw http://www.smartdraw.com/

ThinkGraph http://www.thinkgraph.com/

VisiMap http://usuarios.iponet.es/casinada/21vmap.htm

VisualMind http://www.visual-mind.com/

VYM http://www.insilmaril.de/vym/

9. Bibliography

D.P. Ausubel; J.D. Novak; H. Hanesian. Psicología educativa. Mexico: Trillas, 1989.

Noemi Betancort Cabrera; Lidia Chozas Mahillo Tesauros, Mapas Conceptuales

Noemi Betancort Cabrera; Lidia Chozas Mahillo Tesauros, Mapas Conceptuales y Topic Maps

http://es.geocities.com/naolig/tesauros-mapas-conceptuales-topic-maps.htm [Consulted: 15/03/2005]

Michel Biezunski. Understanding Topic Maps. 2005. http://www.infoloom.com/whitepaper.htm [Consulted: 3/03/2005]

CmapTools http://cmap.ihmc.us/ [Consulted: 03/03/2005]

Lluís Codina. Posicionamiento Web: Conceptos y Ciclo de Vida. Hipertext.net, núm. 2, 2004. http://www.hipertext.net [Consulted: 3/03/2005]

Lluís Codina. La web semántica: una visión crítica. El profesional de la información, vol. 12, núm. 2, 2003.

Lluís Codina. Internet invisible y web semántica: ¿el futuro de los sistemas de información en línea. Tradumática núm. 2, 2003.

Juan C. Dürsteler. Conceptual Maps. 2004-03-01 http://www.infovis.net/printMag.php?num=141&lang=2 [Consulted: 3/03/2005]

Yusef Hassan Montero. Diseño de Arquitecturas de Información: Descripción y Clasificación. http://www.nosolousabilidad.com/articulos/descripcion_y_clasificacion.htm [Consulted: 15/03/2005]

Lars Marius Garshol. Metadata? Thesuari? Taxonomies? Topic Maps! Making sense of it all. 2004. http://www.ontopia.net/topicmaps/materials/tm-vs-thesauri.html [consulta 03/03/2005]

Lars Marius Garshol. What Are Topic Maps?. September 11, 2002. http://www.xml.com/pub/a/2002/09/11/topicmaps.html [Consulted: 3/03/2005]

J. D. Novak. Teoria y práctica de la educación. Madrid: alianza, 1982.

J. D. Novak; D. B. Gowin. Learning How to Learn. New York and Cambridge, UK: Cambridge University Press, 1984.

J. D. Novak; D. B. Gowin. Aprendiendo a aprender. Barcelona: Martínez Roca, 1988.

ISO/IEC 13250:2000 Topic Maps. 19 may 2002. http://www.y12.doe.gov/sgml/sc34/document/0322_files/iso13250-2nd-ed-v2.pdf [Consulted: 3/03/2005]

Jan Lanzing. The Concept Mapping Homepage. [1997]. http://users.edte.utwente.nl/lanzing/cm_home.htm [Consulted: 03/03/2005]

Marcos Mora, Mari Carmen. Interacción en interfaces de recuperación de información: conceptos, metáforas y visualización. Gijón: Trea, 2004.

Master Online en Documentación Digital. http://www.documentaciondigital.org [Consulted: 03/03/2005]

J. A. Moreiro; S. Sánchez Cuadrado; J. Morato. Panorámica y tendencias en topic maps. Hipertext.net, núm. 1, 2003. http://www.hipertext.net [Consulted: 04/03/2005].

J. A. Moreiro et al. De los tesauros a los Topic Maps: nuevo estándar para la representación y la organización de la información. Encuentros Bibli: Revista electronica de Bibliotecnomia e Ciencias da informaçao. Num. 18-2, 2004.

A. Ontoria. Mapas conceptuales una técnica para aprender. Madrid: Narcea, 1992.

Joseph D. Novak. The Theory Underlying Concept Maps and How To Construct Them. http://cmap.coginst.uwf.edu/info/printer.html [Consulted: 3/03/2005]

Steve Pepper. The TAO of Topic Maps finding the way in the age of infoglut. http://www.ontopia.net/topicmaps/materials/tao.html [Consulted: 15/032005]

Cristòfol Rovira. El disseny de navegació i l'organització de continguts en l'hipertext per a l'ensenyament - aprenentatge. Tesis Doctoral, Universitat de Barcelona, 2001.

Cristòfol Rovira. Mapas conceptuales para la representación del conocimiento. En Cristòfol Rovira; Lluís Codina (dir.). Documentación digital. Barcelona: Sección Científica de Ciencias de la Documentación. Departamento de Ciencias Políticas y Sociales. Universidad Pompeu Fabra, 2003. http://www.documentaciondigital.org [Consulted: 3/03/2005]

Cristòfol Rovira, Lluís Codina. La orientación a objetos en el diseño de sedes web: hipertextos y representación de la información. Revista española de documentación científica. Vol 26, num. 3, 2003

Rovira, Cristòfol; Codina, Lluís; Marcos, Mari Carmen; Palma, María del Valle. Información y documentación digital. Barcelona: IULA; Documenta Universitaria, 2004.

Techquila. http://www.techquila.com/topicmaps.html [Consulted: 3/03/2005]

XML Topic Maps (XTM) 1.0. 2001. http://www.topicmaps.org/xtm/1.0/ [Consulted: 3/03/2005]

Cristòfol Rovira is member of the DigiDoc Group of the University Institute of Applied Linguistic of the University Pompeu Fabra and the Scientific Section of Information Sciences of the Department of Political and Social Sciences of the University Pompeu Fabra . This article presents a part of the results of the HUM 2004-03162/filo project of National Plan I+D+I of the Ministry of Education and Science (Spain)

Esta obra está bajo una licencia de Creative Commons