. The evolution that the World Wide Web has undergone in the last few years has had a decisive impact on training tools, processes and methodologies. The web has in fact acquired a "social" dimension that places the user at the centre both with regards to accessing services and in genuine web-delivered training programmes. Concept maps, which have always favoured the cooperative construction of knowledge, have anticipated this phenomenon and in view of this they work well with the new tools of the so-called . The maps created and made available on the web, though accessible, are difficult to find. In this paper we put forward a methodology which enables us to integrate concept maps into a general framework of social bookmarking, to allow them to be logically aggregated into a virtual, widespread repository, as well as being catalogued and searchable by semantic criteria. We also put forward a toolkit of Open Source tools which will aid in creating them.

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In recent years the World Wide Web has become the tool *par excellence*, for communications, interaction and training. In particular it has acquired a "social" dimension that places the user at the centre both with regards to accessing services and contributing to content creation, and with regards to genuine web-delivered training programmes. Concept maps have anticipated this phenomenon, thanks to their ability to foster the construction and cooperative development of knowledge. In this paper we put forward a methodology which enables us to integrate concept maps into a framework of social tagging, to allow them to be logically aggregated into a virtual repository, as well as being catalogued according to semantic criteria. We also put forward a toolkit which will aid in creating them. In this paper section 2 illustrates the characteristics of *Web 2.0* and *E-learning 2.0*; section 3 briefly recalls concept maps and CmapTools; section 4 presents social bookmarking and section 5 presents the actual methodology for tagging the maps. Section 6 is the conclusion and illustrates possible future directions for the project.

From its origins to the present, the growth in size of the internet has been accompanied by an evolution of services, in terms of quality, which is even more significant. In recent years we have seen the break which has led to the second generation of the internet, the so-called *Web 2.0*, a term which came into being during the O'Reilly Web 2.0 Conference held in 2004 and subsequently defined in a more official way (O'Reilly, 2005). *Web 2.0* key points affect e-learning, giving rise to a new generation, *E-learning 2.0*, based on principles which we hereby propose to integrate into concept maps. To quote O'Reilly, the key points of *Web 2.0* are the web as platform, harnessing collective intelligence, the architecture of participation, data control and management, end of the software release cycle and software above the level of a single device.

The most relevant aspect for e-learning applications and the extension of concept maps is without a doubt the creation of this "social" dimension fostered by the direct involvement of the user/student as creator of contents, including educational contents, and a distributed, widespread participation architecture. E-learning entails the use of technology to support the processes of learning and teaching. Typical tools are Learning Content Management Systems (LCMS) which enable us to create a virtual learning environment specialised in the creation and management of didactic contents. Many LCMS host tools which allow students and teachers to interact, and foster peer contacts, which is the basis of collaborative learning. In any case LCMS are based on a course structure, broken down into teaching modules and units (learning objects). This metaphor for the processes of learning and teaching has a number of limits, in the sense that Novak states (Novak, 2004): "Today cognitive learning theories have

essentially replaced behavioral theories, although much school learning still proceeds on behavioral learning principles, such as repetition and reinforcement". Being part of the knowledge society not only means utilising technology, but requires new skills, that the new generations are already exhibiting (Downes, 2003): "I think that skills are evolving, that students are learning new skills, that these skills are not being taught in schools, and that these skills are not being measured. [...] I think they are learning an entirely new language, and with it, consequently, new ways of thinking, of inference". Along with   , the so-called   is developing. The idea is that   regards using the tools of   , such as blogs, RSS, wiki and tags, to share didactic contents and foster interaction, putting the learner at the centre of the educational process. The evolution of these tools, increasingly aimed at fostering collaboration and the shared construction of knowledge, cannot be separated from knowledge representation systems such as concept maps, and tools such as CmapTools which are characterised by the potential for constructing maps in a collaborative way.

It can be observed that concept maps are not only a significant methodology in terms of "meaningful learning" (Ausubel, 1963), but also in view of the fact that they have anticipated the trends emerging now in *E-learning 2.0*, both in terms of methodology and from the point of view of tools for the cooperative construction of knowledge. There are various tools which enable us to construct and edit concept maps, but here we will focus on CmapTools software (Cañas et al., 2004) in view of two major features. CmapTools promotes:

- through the CmapTools client, collaboration between users in the creation of maps, adding in resources to complement the contents present in the maps, publishing them on servers (CmapServers) which can be accessed by other users, as well as a text-based search facility among the maps present on these servers.
- by browser, web-based access to an HTML version of the maps automatically generated on the server, and to the resources connected by hyperlink.

This software also possesses an integrated text-based search facility which works in a variety of ways. While powerful and sophisticated, this search mechanism only partly covers potential requirements in terms of cataloguing and searching, and presents the typical problems faced even by developed full-text search engines, such as searching for a word and not a meaning, and the difficulty of isolating the more relevant elements. To get around these problems, boost the visibility of concept maps and facilitate semantic search mechanisms, here we put forward a model of integration of web-accessible concept maps with the social tagging tools which are typical of   , leading to the construction of a virtual repository of concept maps, which can be searched semantically without having to handle metadata or weigh down the creation of the maps with the use of predefined, rigid taxonomies. The model put forward is based on social tagging, widely used for generic web resources.

"Social bookmarking" is one of the new frontiers of *Web 2.0*. Taken from the definition offered by Wikipedia, the Free Encyclopedia (http://www.wikipedia.org/wiki/Social_bookmarking): "*Social bookmarking* occurs on web based services where shared lists of user-created Internet bookmarks are displayed. Social bookmarking sites generally organize their content using tags and are an increasingly popular way to locate, classify, rank, and share Internet resources through the practice of tagging, and inferences drawn from grouping and use of such tags. [...] They also categorize their resources by the use of informally assigned, user-defined keywords or tags (see folksonomy)".

The fundamental concepts of this definition are   and   . To quote Wikipedia once more: "A   is a keyword which acts like a subject or category. A keyword is used to organize webpages and objects on the internet. Each user "tags" a webpage or image using his/her own unique tag." while the freedom each person has to choose the tags to adopt to catalogue his or her bookmarks led Thomas Vander Wal to coin the term   , as opposed to taxonomy or also to a certain extent, ontology: "A   is a collaboratively generated, open-ended labeling system that enables Internet users to categorize content such as Web pages, online photographs, and Web links. The freely chosen labels, called tags, help to improve search engine effectiveness because content is categorized using a familiar, accessible, and shared vocabulary. The labeling process is called tagging".

This system, originally designed to gather and organise bookmarks on the web, soon acquired very different applications characterised by a strong social dimension. It presents numerous advantages with respect to traditional software for gathering and cataloguing information such as search engines. Resources are classified by human beings who understand the meaning of the contents of the resource and consequently select the tags. There are a few problems with this approach: there is no standard set of keywords, no grammar rules when forming tags, no spellchecks, nor clarification if the meaning of the tag is ambiguous. However these problems are outweighed by the advantages that this new approach presents. For a more in-depth discussion, please see (Hammond, Hannay, Lund, Scott, 2005; Graeme, 2006). Here it will suffice to mention the following two services: del.icio.us and Flickr.

- Del.icio.us (http://del.icio.us) is the best known web service which admits social bookmarking. Created by Joshua Schachter in 2003, it has become the key site in terms of collective cataloguing of links to web resources, each of which has one or more tags chosen by the person who inserted the link (Muir, 2005).
- Flickr (http://www.flickr.com), founded by Stewart Butterfiled and Catarina Fake, is the most popular system for cataloguing and storing images and digital photographs.

Some Flickr users have set up a rudimentary system for cataloguing concept maps, naturally in the form of images of photographs (http://www.flickr.com/photos/tags/conceptmap). A quick search of   produces the following results (approximate and rounded): Google 1,500,000, del.icio.us 100 and Flickr 30. While on Flickr these are images, in the other two cases they are articles, software, web pages and publications which regard concept maps in some unspecified way. It is practically impossible to search for actual concept maps, especially if you want to base your search on the meaning of the contents of the map. In the next section we therefore put forward a model for cataloguing maps and performing semantic searches.

We put forward a methodology for using standard social bookmarking tools to tag concept maps created on public, CmapServers, with two aims: to establish a virtual, distributed repository of concept maps and to make it accessible by means of a standard web-based system, in order to be able to carry out semantic searches, the results of which are concept maps, and only that. We are restricted by the characteristics that we want the system to have: easy, immediate cataloguing of maps and creation of tags, easy integration with CmapTools, semantic search based on standard tools of *Web 2.0*, common usage guidelines for all users. This toolkit we propose using, which every creator of concept maps should be in possession of, comprises:

- an account on del.icio.us (http://del.icio.us)
- the CmapTools client (http://cmap.ihmc.us)
- access to a public CmapServer
  - the Mozilla Firefox browser (http://www.mozilla.com)
  - the del.icio.us plug-in (http://del.icio.us/help/firefox/extension). Once this is installed in Firefox, it adds two buttons, the first of which enables the user to access his or her own area on del.icio.us directly and the second to assign a tag to the page currently being visualised by the browser.

Once a map has been created on a CmapServer, the idea is to proceed systematically to attributing tags and cataloguing it on del.icio.us. To do this the following steps are necessary:

- open the map present on the server using CmapTools. In the lower part of the window is the URL of the HTML version of the page, as well as the View button which lets you access it via browser
- activate Firefox to visualise the corresponding HTML page, using the View button
- from Firefox, using the Tag button, activate the window that lets you assign tags to the resource on del.icio.us.

Obviously the choice of tags and matching them up to the concept map is the most important aspect. Only with a systematic usage of tags will it be possible to organise references, make cataloguing consistent. In-depth exploration of the criteria for selecting tags is beyond the scope of this article. We therefore suggest, as an exception to the complete freedom of choice regarding tags in social bookmarking, agreeing on, circulating and systematically using a particular tag which would identify the resource as a concept map, created using CmapTools, and not any

kind of resource linked to maps in some way. This tag, for example   , would be added to the tags identifying the map. The link to the map is automatically entered on del.icio.us in the personal area of the person saving it, thus contributing to the construction of a distributed repository of concept maps. The repository comes into being from the aggregation of single bookmarks identified by the agreed tag, using the search mechanisms typical to del.icio.us. Different types of search can be carried out. For instance:

- at http://del.icio.us/smargarita/poweredbycmaptools, we get a list of all the maps stored by the user
- at http://del.icio.us/tag/poweredbycmaptools, we get a list of all the maps with the tag
- at http://del.icio.us/tag/poweredbycmaptools+   , we get a list of all the maps with the   tag.

   This method combines a simple, rapid cataloguing process with the power of standard search methods offered by social bookmarking services in general and del.icio.us in particular. It naturally entails the adoption of common conventions by the community of users of CmapTools, but we believe that it represents an interesting added value in terms of the visibility and accessibility of the concept maps created.

The services of *Web 2.0*, which lend a social dimension to the creation and organisation of contents, offer new possibilities for cataloguing, storing and searching for information based on folksonomies and tags. In this paper we