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Multi-layer Map-oriented Learning Environment for Self-directed/ Community-based Learning

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Abstract: The main topic addressed in this paper is how to combine self-directed learning and community-based learning using Web-based learning resources. In this paper, we proposed a multi-layer map model which provides learners with the structure of resources explicitly and to share the suitable resources via map representations. We also describe a learning environment, based on the model proposed and Topic Maps standard, enables not only individual learners can easily organize related learning resources as personal topic maps but also they can share the community topic map which merges the personal topic maps created by community members.
Keywords: Web-based Learning, Topic Maps, Self-directed Learning, Community-based Learning

Introduction

There is currently enormous number of information serving as learning resources on the Web. Therefore, it has become possible to overcome the restrictions of time and place for self-directed learning. Such learning has been demonstrated to enhance the learning process [8], but often requires learners not only to navigate Web pages to construct their knowledge but also to control the navigation and knowledge construction processes [5]. As a result, Web-based self-directed learning has become an important research issues in the recent decade. On the other hand, community-based learning also attracts much attention along with the fast development of the Web technology, in which learners have informal community-centered communications [2]. However, it is difficult for the learners to get feedback to their learning process from community-based learning without suitable communication platform. In order to solve this problem, we propose a multi-layer map-oriented learning environment based on Topic Maps which relates the actual Web contents to semantic structure. The key ideas of our approach are: (1) the learners make their personal topic maps by conducting self-directed learning; (2) they make communications through the maps collected from community members as community-based learning. In this paper, we describe the design of the learning environment which constitutes multi-layer maps and combines self-directed and community-based learning seamlessly.

1. Issue Addressed

1.1 Self-directed Learning

On the Web, learners can navigate a vast amount of Web-based learningresources to achieve their learning goals. Such resources usually provide them with hyperspace so that they can navigate in a self-directed way by following links among the pages as shown in Figure 1. Especially, it is expected to encourage their information literacy by selecting suitable resources, each of which usually has different credibility and standpoint about the similar topic.

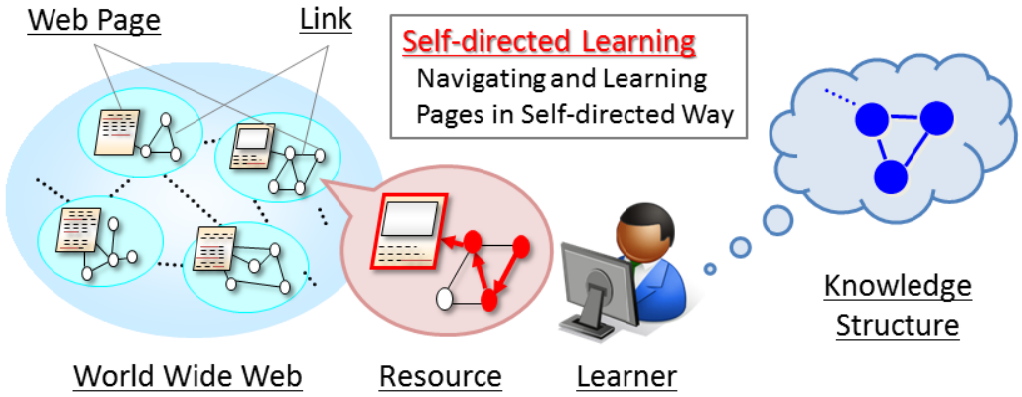

Figure 1 Self-directed Learning

1.2 Community-based Learning

In this paper, community-based learning means a process of communication by the community members with the similar learning goals for the purpose of encouraging each self-directed learning activity. Such process involves not only sharing resources but also performing peer-review for knowledge learnt. Ordinarily, it is not so easy for self-directed learners to get adequate supports since their learning resources and processes are varied from learner to learner. However, community-based learning makes it possible to conduct informal communication as feedbacks for the individual self-directed learning processes.

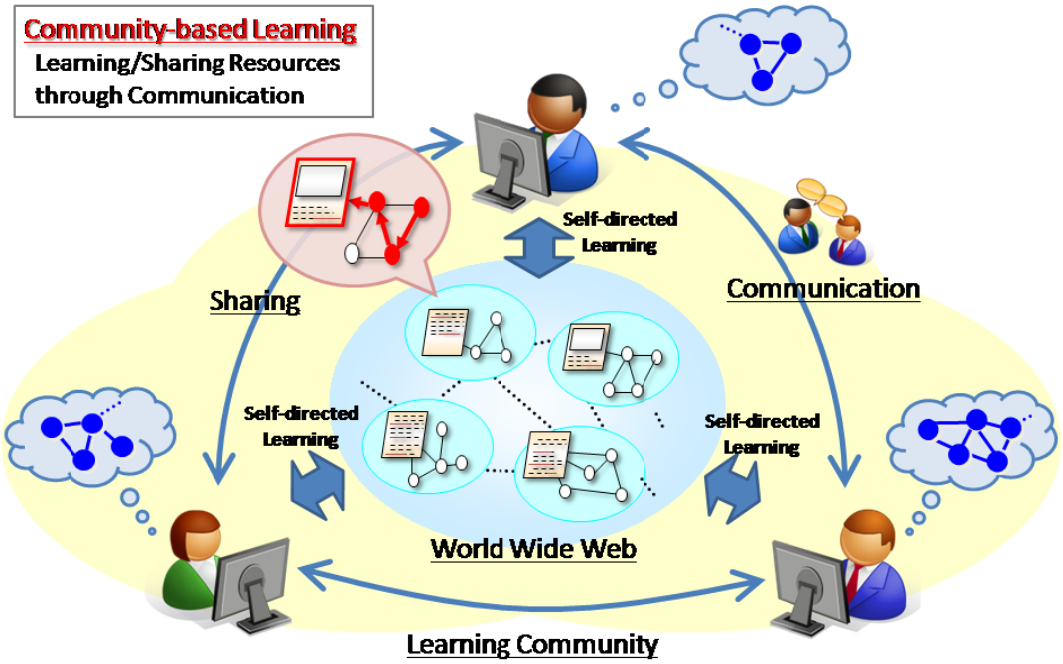

Figure 2 Community-based Learning

1.3 Difficulties in Self-directed and Community-based Learning.

First of all, the large amount of available information on the Web makes it very difficult for learners to locate suitable resources about particular topics of interest. Traditional search engines only order list of pages ranked according to a particular matching algorithm. The learners therefore often have to click into certain Web pages to find out whether they are fit or not to achieve their learning goals, and may miss the chance of learning after two or three useless clicks since it could be a time-consuming job as previous step of self-directed learning. If the learners finally successfully locate sufficient learning resources from several URLs as learning hyperspace; moreover, they have to organize these resources and to construct their knowledge structures by navigating the hyperspace. Beginners at self-directed learning sometimes lose sight of their learning goal because of the complexity of the hyperspace. Such navigation problems are major issues, and have been discussed regarding the developments of educational hypermedia/hypertext system [1]. From an aspect of community-based learning, it is difficult to pass learning achievements and get feedbacks with each member of community who has the similar interests about the certain topics.

2. Approach

2.1 Topic Maps

Topic maps are a new ISO standard for describing knowledge structures and associating them with information resources [4]. While it is possible to represent immensely complex structures using topic maps, the basic concepts of the model—Topics, Associations, and Occurrences (TAO)—are easily grasped[7].

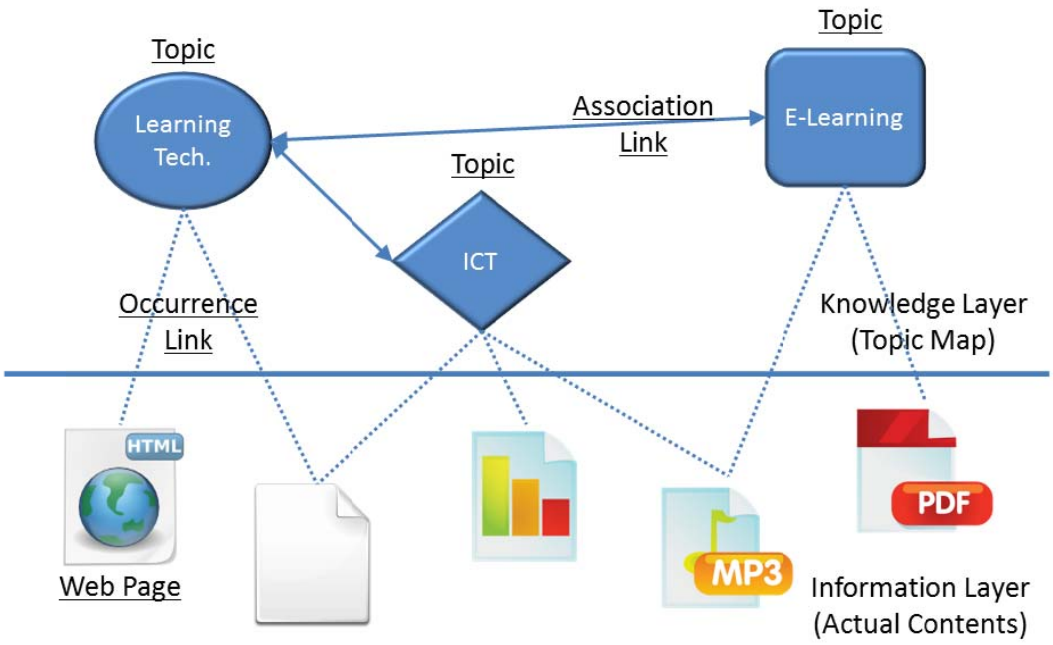

Figure 3 Basic Concept of Topic Maps

Figure 3 illustrate how the three key concepts relate in the Topic Map standard. Topics represent concepts of a certain field to the learners' interests. Association links represent hyper-graph relationships between topics. Occurrence links represent actual Web contents relevant to a particular topic.
Topic maps can be used to qualify the content and/or data contained in information objects as topics to enable navigation tools and to link topics together with multiple, concurrent views on sets of information objects.

2.2 Multi-layer Map Model

Multi-layer Map Model is the core of the learning environment proposed which is intended to perform as a GUI for self-directed and community-based learning. Figure 4 shows the four layers model with different functions yet dependent on the services provided by their nearest layers. The model provides the community members with communication basis via superposed map representations. It mainly focuses on visualizing the structure of learning contents in term of resource maps, and then enables learners to edit or reconstruct personal maps according to their learning processes. Moreover, this model includes community map where the personal maps are merged, viewed and used by other community members that have the similar interests. The following sections will describe the basic concept of each layer respectively.

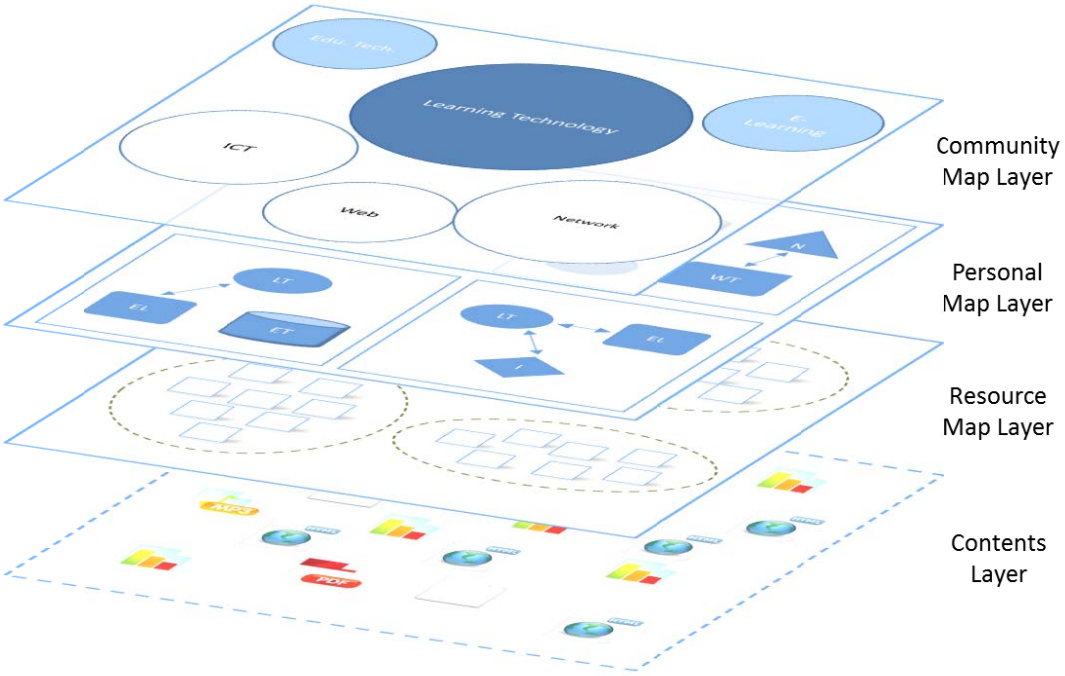

Figure 4 Multi-layer Map Model

3. Design for Multi-Layer Map

3.1 Contents Layer and Resource Map Layer

Contents layer is the lowest layer of this model. It means the actual Web contents such as Web pages, documents, and media files of the Web-based learning resources. This is just a conceptual layer for the model.
Resource map layer is the place to visualize structures of the Web contents by the learning resources in one-to-one manner as shown in Figure 5. This map provides the learners with an overall perspective of the resources used by the community members. Every node used by community members is cashed crawling contents information and labeled with typical words such as title of the Web page occurred. The learning behaviors on the environment, like searching for resources, selecting real contents, and taking memo, are conducted at this layer.

3.2 Personal Map layer

Personal map layer is aimed to support learners' self-directed learning. It helps the learners to edit and reconstruct their personal topic maps based on the spatial maps created at the resource map layer. At this layer, learners are capable of defining topics, adding/deleting occurrence links between topics and contents, making the structure among topics by association links, and navigating resources.

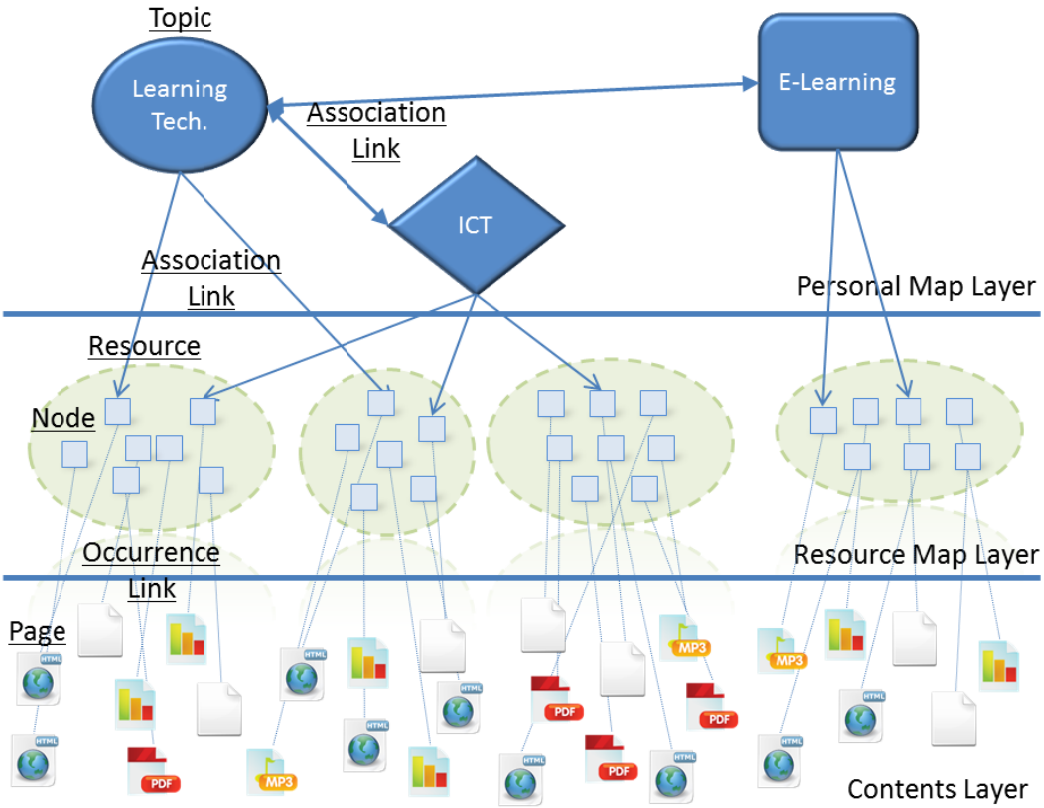

Figure 5 Relationship Diagram among Personal Map, Resource Map and Contents

3.3 Community Map Layer

For the purpose of sharing learning achievements in the community, community map layer merges the personal topic maps with that of other community members by displaying bubble form charts based on their features and relations as shown in Figure 6. The size of each bubble represents the number of occurrence links in each topic. The relative position between bubbles is calculated by the number of association links among topics, and the color density

of each bubble represents the number of learners interested. In these ways, all the personal topic maps are classified into groups at this layer to be better viewed and share in community learning. This map also provides glossary, taxonomy, thesaurus of community by enabling the community members to edit different topics having the same meaning.

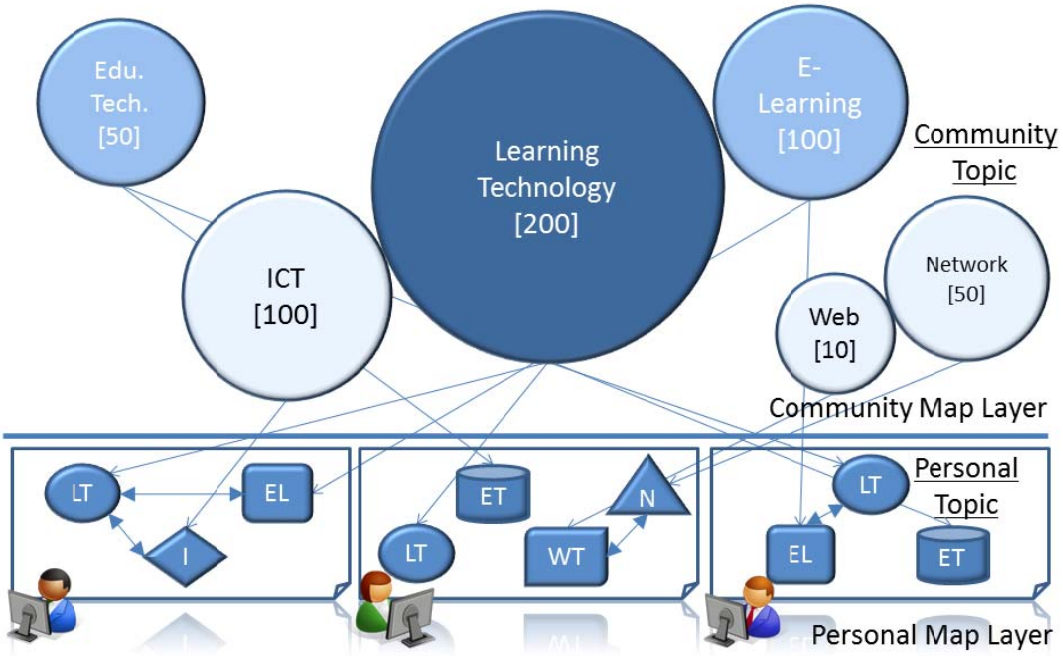

Figure 6 Examples of Community-based Map

4. System Architecture

Figure 7 shows a block diagram of the whole learning environment. This section describes distinctive functions of the system.

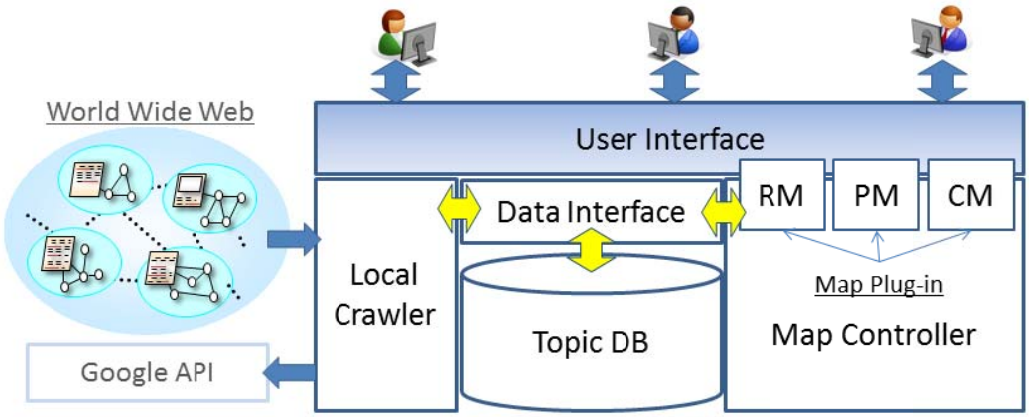

Figure 7 System Architecture

4.1 Local Crawler

As we already know that the traditional search engines like Google is the first thing we can think of using when it comes to searching information. Therefore, in order to find related lists of URLs, it is necessary to embed some common search engines into this learning environment in case the learners decide to make their own topics. As soon as the embedded search engine outputs a bunch of related URLs, the learners can select several links with most relevance. Local crawler gathers information of chosen links to a much deeper level. The depth can be decided by common experience which must ensure the real stuff will come up after average times of crawling. The key point should be remembered when constructing the crawler is that the strategy of adaptive focused crawling [6] is better to be followed in order to find the information with the most relevance with the searching keywords input by learners. In database module, the gathered information is stored by XML forms according to Topic Maps format.

4.2 Map Controller

Map Controller is responsible for map editing and visualizing functions through layers of the resource, personal, and community map. As for maps created at the upper three layers have their own features, each layer has their own plug-in map controllers. Resource map plug-in generates spatial maps automatically based on the results crawled by the local crawler. It shows the structure of the crawled URLs in form of links and nodes representing actual contents. By clicking each node, the learners can access the real contents behind it. Personal map plug-in drafts the personal topic map initially. The learners can edit their own personal topic maps like adding or deleting certain nodes, building association and occurrence links, taking notes and etc. Several association types are defined in the plug-in such as super-sub (is-a), related term, synonym, antonym, etc. Community map plug-in merges the personal maps in the community members and represents them with conclusive bubble charts. It also provides associative search and community filtering functions for the purpose of sharing their learning achievements.

4.3 How to Construct Topic Maps

At beginning, learners input keywords into search engine APIs in order to get related search results so that they can look for the topics of interest under certain field at the content layer. If the learners select interesting Web resources from search results, the local crawler gathers information of the Web pages from the resources selected and stores it to the database.

Then, the learners create their own topic maps by trimming occurrence links defined by the initial maps and improving upon relations among topics while learning the pages in self-directed way; meanwhile they can add notes and restructure relationships among topics and nodes.

As community-based learning, the learners search topic maps created by other learners associatively and modify them into forms of their own. As for beginners of Web-based self-directed learning, it could be helpful getting informed with useful learning resources organized by community members with similar interest. The community map of each field of interest would become more and more complete and sophisticated by progress of community-based leaning.

5. Conclusion

This paper has described the multi-layer map-oriented learning environment for self-directed and community-based learning in hyperspace provided by Web-based learning resources. The key idea is to provide community learners with communication basis via superposed map representations. This paper has also presented the system architecture, which aims at visualizing vast information resources on the Web and at creating informative topic maps by community learners in a piecemeal growth process. Although there are restrictions like the change of the learner's interest, the correctness of the information of web pages, in completeness as the teaching materials, this method of self-directed learning on the web is still worth pursuing.

In the near future, we will develop the environment proposed as practical Web application and design some map plug-in functions with personalization or adaptation such as the form of visualization for topic maps, suitable crawling methodology for local crawler, etc. And other existing functions for supporting self-directed learning can also be integrated, e.g., the tools for learning path planning and knowledge reflection [3].

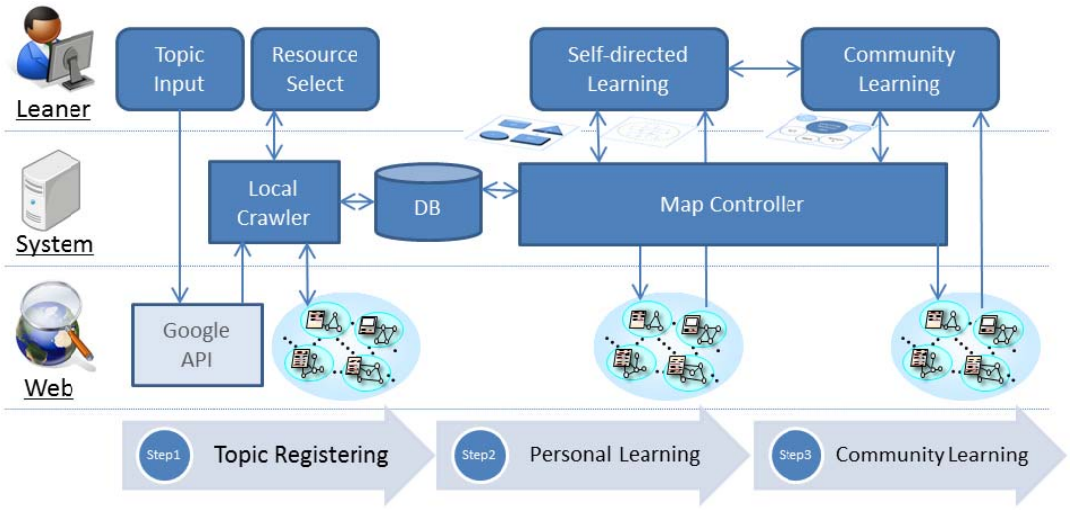

Figure 8 Flowchart for Constructing Topic Map

Acknowledgements

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