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A Resource Organization System for Self-directed & Community-based Learning with A Case Study

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Abstract: The main issue addressed in this paper is how to improve the learning situation of self-directed learning on resource finding and organization from the Word Wide Web. In this paper, we have firstly proposed a multi-layer map model thatvisualizes basic learning behaviors when using the internet for locating and organizing learning resources. It provides learners with the structures of the found resources, the tools for their semantic management, and also an easy way to share the resources via the map representation. A system based on the proposed model has also been developed, that enables individual learners to easily locate suitable learning resources from the Web by referring resource maps and also to organize them as personal topic maps. By referring to a community topic map which merges all the personal topic maps created by individual self-directed learners, the learners can share their own resources and collect those of other learners into their learning topics. As a result, the learners re-organize their personal topic maps by taking the resource from the community topic map, and at the same time contribute to the community topic map through their personal topic maps. A case study conducted to evaluate the effectiveness of the system produced several positive results which validated our hypothesis.

Keywords:web-based learning, self-directed learning, community-based learning, resource organization, topic maps, multi-layer map model

1. Introduction

With the rapid development of the internet, 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 (Thuering, Hannemann, and Haake, 1995), but often requires learners not only to navigate Web pages to find proper resources but also to control the navigation and knowledge construction processes (Kashihara and Hasegawa, 2005). As a result, Web-based self-directed learning has become an important research area in the past decade. In order toaddress this issue, our approach is to integrate self-directed learning into community-based learning through which learners are able to have informal community-centered communications (Fujimoto, Hasegawa, Miura, and Kunifuji, 2006). Community-based learning also attracts attentions along with the fast development of the Web technology. However, it is difficult for the learners to access suitable learning resources from community-based learning without a suitable communication platform. In order to address this problem, we have designed the proposed model, the Multi-layer Map Model (Li and Hasegawa, 2010) based on an ISO standard named Topic Maps. This model enables learners to visualize common learning behaviors employed by web users, such as locating learning resources, categorizing found resources and sharing the resources among community members. We have proposed a resource organization system (Li, Hasegawa, and Kashihara, 2012) which connects Web contents and learning topics by means of multi-layer map visualization. A case study intended to determine whether potential learners could improve the efficiency of their self-directed learning was conducted to assess the effectiveness of this system. After analysis of the experiment data, some encouragingconclusions were drawn which indicate that through topic map representations provided by the system, learners were able to locate appropriate learning resources faster, organize learning resources in a more meaningful way, and share and collect learning resources inside their learning community more easily and effectively.

2. Issue Addressed

2.1 Self-directed Learning

Learners can navigate a vast volume of Web-based resources to achieve their individual learning goals. Such resources usually provide them with hyperspace which enables them to navigate in a self-directed way by following links among the pages (as shown in Figure 1). Self-directed learning is expected to enhance their information literacy by encouraging the selection of suitable resources, each of which may have a different credibility and/orviewpointof the same topic(Hasegawa, Kashihara, and Toyoda, 2003).

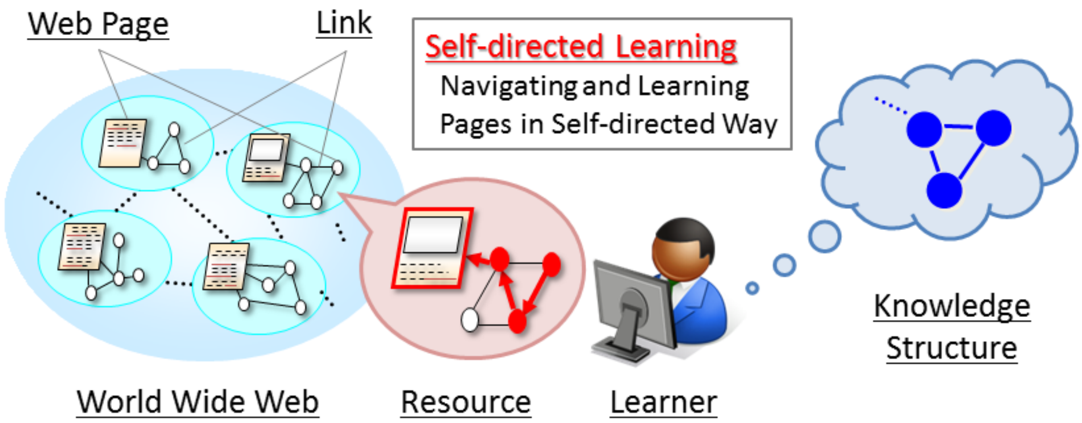

Figure 1. Self-directed learning

2.2 Community-based Learning

In this paper, community-based learning is defined asthe process of communication by community members who share the similar learning goals for the purpose of encouraging each other's self-directed learning activity. Figure 2 shows the process involves not only sharing resources, but also performing peer-review ofresources found. Ordinarily, it is not so easy for self-directed learners to obtainadequate support since learning resources and processes vary from learner to learner (Ota, Kashihara, and Hasegawa, 2005). However, community-based learning makes it possible for the learners to engage in informal communication as feedbacks ontheir individual self-directed learning processes.

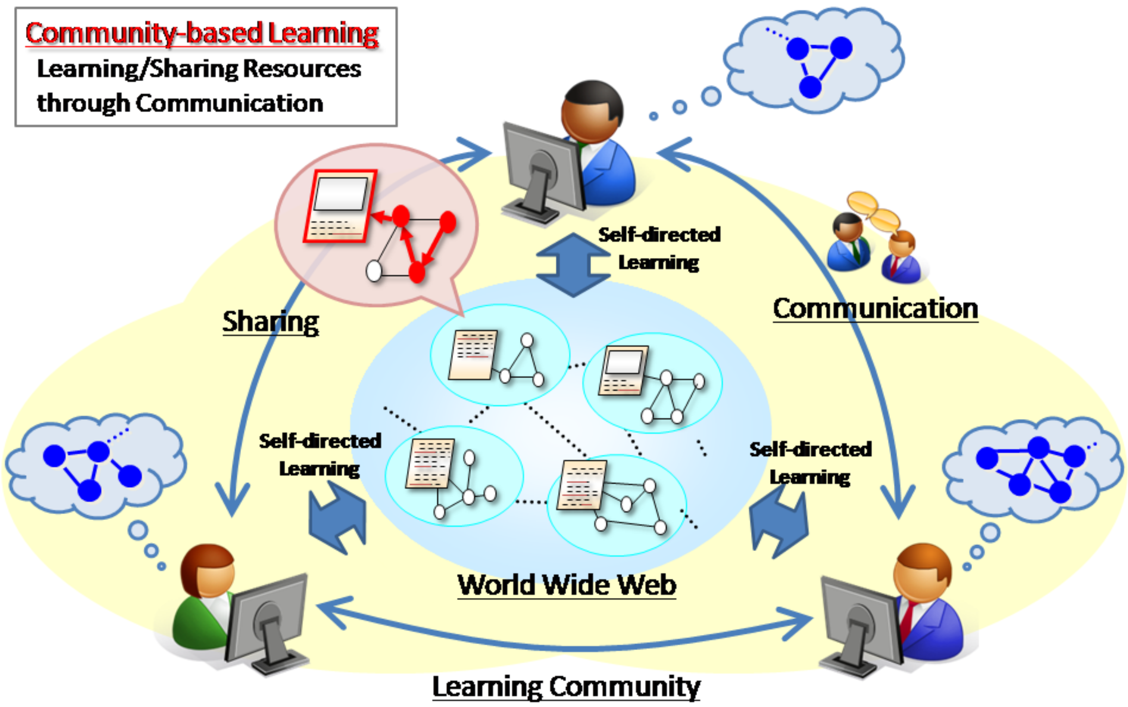

Figure 2. Community-based Learning

2.3 Difficulties in Self-directed and Community-based Learning

The large amount of information available on the Web makes it very difficult for the learners to locate suitable learning resources for particular topics of interest. Traditional search engines only generate lists of pages ranked according to a matching algorithm. The learners therefore often have to click into certain Web pages to find out whether they are appropriate or not to achieve their learning goals, and may miss the opportunityto learn if, after two or three useless clicks, they give up.If the learners do finally successfully locate sufficient learning resources from several URLs as a learning hyperspace, they have to organize these resources and to construct their knowledge by navigating the hyperspace. Inexperience self-directed learners sometimes lose sight of their learning goals because of the complexity of the hyperspace. Such navigation problems have been recognized as major issues, and have been discussed in the context of educational hypermedia/hypertext system development (Brusilovsky, 1996). From the perspective of community-based learning, it is difficult to pass on learning achievements and get feedback among members of the community who share similar interests in certain topics.

2.4 Requirements

To summarize what was described in 2.3, there are three major difficulties when it comes to self-directed learning on the Web. Firstly, it is difficult to locate suitable learning resources on the internet; secondly, it is difficult to organize the found learning resources in a way which can help the learners better build knowledge structures; lastly, it is difficult to share their learning resources and collect those of others insidetheir learning communities. By analyzing these three difficulties and the contextsin which they regularly occur, we come up with threecorresponding requirements, which if satisfied, could greatly enhance the current learning situation. These requirements are:

1. More semantically structured representations for internet resources in order to locate the candidates oflearning resourcesmore swiftly and correctly.
2. More sophisticated methods of resource organization. Learners often use internetbrowsers for information management by simply adding interesting links to their favorite lists; however this does not facilitate later learning activities such as reviewing to build knowledge structures.

3. A visual space where not only the status of other learners' resource collections can be explicitly represented, but where sharing resources and exchanging feedback can take place.

The following sections discuss how difficulties arising from the three requirements can be effectively addressed.

3. Approach

3.1 Multi-layer Map Model

The Multi-layer Map Model is the core of the proposed learning environment, which is intended to perform as a GUI for self-directed and community-based learning. Figure 3 shows the four layers of the model;each has different functions, yet is dependent on the services provided by their nearest layer. The contents layer is the lowest layer of this model, where actual Web content in various digital forms is located. The resource map layer is the place where structures of the Web contents are visualized as learning resources. The personal map layer is where users engage in their self-directed learning. They can define topics, build up connections between topics, and include the learning resources represented on the resource map layer in the topics they create.The community map layer merges personal topic maps with those of other community members by displaying bubble charts based on their features and relations.

The model provides members of the community with a communication basis via superposed map representations. It primarily focuses on visualizing the structure of the learning contents in term of resource maps, and then enables the learners to edit or reconstruct their personal maps according to their learning processes. Moreover, this model includes acommunity map where the personal maps are merged, viewed and used by other community members who have similarinterests. This model is based on the concept of Topic Maps which is explained in the next sub-section.

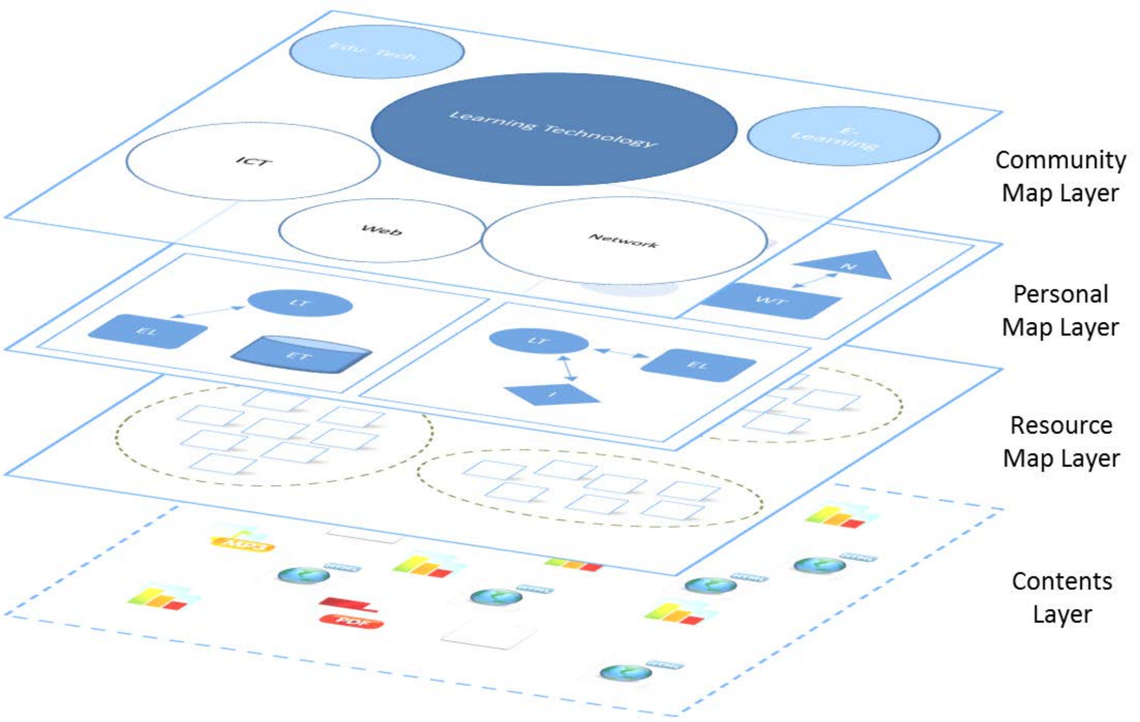

Figure 3. Multi-layer Map Model

3.2 Topic Maps

Topic maps are an ISO standard for describing knowledge structures and associating them with information resources (ISO/IEC 13250, 2002). 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 (Pepper, 2000).

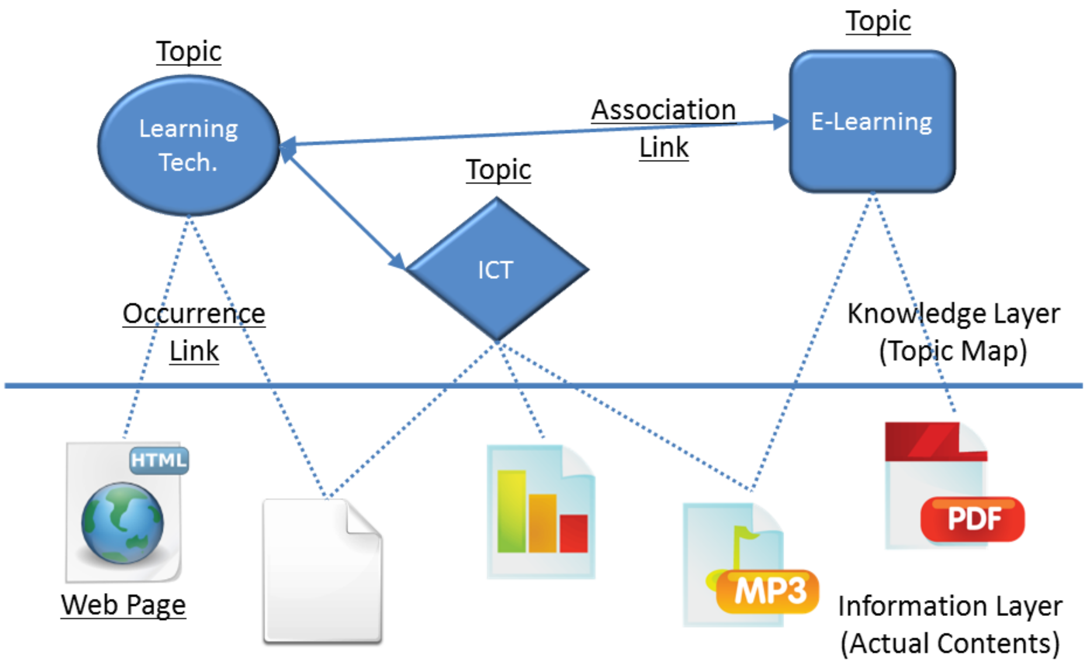

Figure 4. Basic Concepts of Topic Maps

Figure 4 illustrates how the three key concepts relate in the Topic Map standard and how this concept is applied to our research. Topics represent concepts of a certain field in which a learner is interested Association links represent hyper-graph relationships between topics. Occurrence links represent actual Web content 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. Li and Hasegawa (2010) provide a detailed discussion of how the concept of topic maps is applied in every layer.

4. Resource Organization System for Self-directed & Community-based Learning

Figure 5 shows interfaces and workflows of the pilot version of the Resource Organization System for Self-directed & Community-based Learning (ROS). The learners first use the embedded search engine API to select links with the most relevance to their interests from the Web. A local crawler next gathers URLsand titles containedin selected links.ROS subsequently generates spatial map as the resource map automaticallywhich visualizes the structures ofweb pages not only within a learning resource but also among learning resources, based on the results gathered by the local crawler(as for details of how resource maps are being generated, please refer to our previous paper (Li and Hasegawa, 2010)).On one side of the window it shows the structure of the crawled URLs in form of nodes labeled with page titles, and the actual webpage of the selected link on the other side. By checking the real webpages and their semantic representations at the same time, this arrangement is intended to increase the speed and accuracy of learners' comprehension of the main contents of the links. On one hand, the learners can access the contents by clicking on a node, while on the other hand they can generate the corresponding resource map on the right correspondingly by clicking a link on the left. ROS thus enables learners to collect nodes of their interests, and the learners can edit their personal topic maps simply by dragging and dropping selected nodes. ROS next merges necessary information (number of learners under a same topic, number of learning resources under every topic, and number of shared learning resources among topics) of the personal topic maps and presents them in the form of a community topic map. Relevance to topics of the current learner (colors of bubbles), with other topics in the community topic map (distance between bubbles) and the number of learning resources under one topic (size of each bubble) give the learners hints for choosing learning resources of interest. We have applied a spring model for placing bubbles (Hasegawa and Li, 2012) which represents all the topics created in the learning community.After clicking a bubble, learning resources will be presented in term of nodes of a different shape labeled with their titles, which also can either be collected or graded by the current learner. As a result, the learners create their personal maps by referencing both the resource map and the community topic map. Learners' personal topic mapscontribute to the community topic map as well.

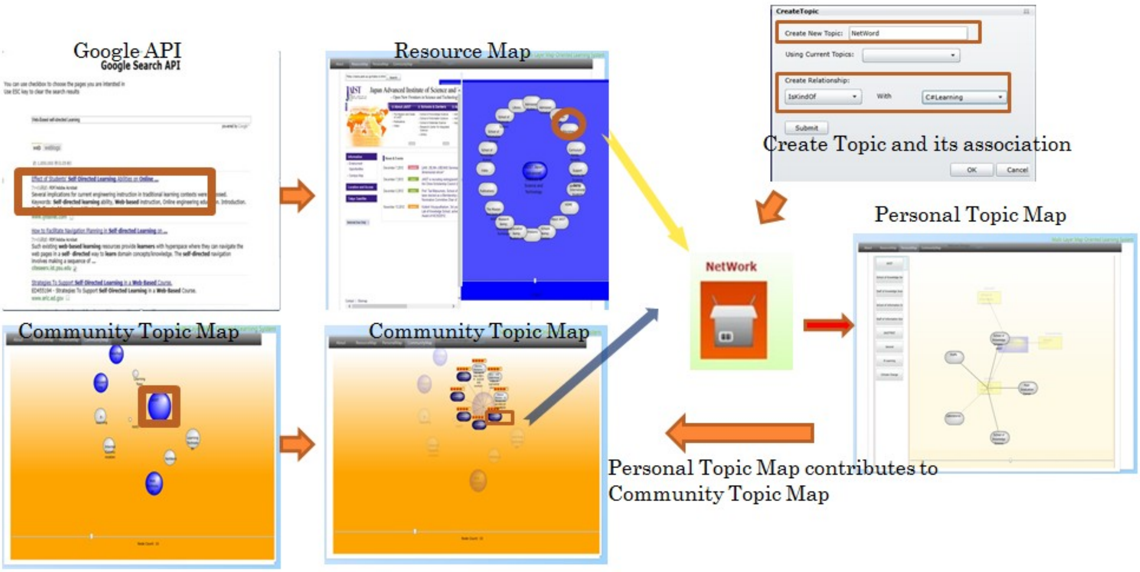

Figure 5. System Flow

5. Evaluation

In order to assess the effectiveness of this pilot system,especially by referencing the three requirements proposed, we conducted a case study as an important component of this research. 16 graduate studentsparticipated in the case study. Since the experimental environment(UI and experimental resources) is written in English, they are also expected to have the similar level of English proficiency.

5.1 Evaluation Method

Given that many self-directed learners are accustomed to using Microsoft Internet Explorer (IE) to search, organize and learn information on the internet, we designed a contrast evaluation plan in order to compare the advantagesofusing ROS versus IE for resource searching, organizing and sharing activities. The experimental subjects were required to use both IE (control condition) and ROS (experimental condition) respectively to conduct web-based self-directed learning on two different learning themes--- E-learning and Environmental Protectionfrom two websites (previously prepared, working as learning resources) within a fixed amount of time (30 minutes each). In order to provide similar conditions, 20 keywords working as subthemes were prepared for each learning theme. There were at least 10 webpages on average for each subtheme, which makes a total of more than 200 webpages in each websites, ensuring the subjects' impossibility to read though all pages within 30 minutes.Each subjects was first required to learn the one learning resource (E-learning or

Environmental protection) with either condition (ROS or IE) and then to learn another resource with the other condition. The order of the learning resources and conditions were assigned for considering counterbalance to ensure adequate data samples were obtained.Since time for instructionfor participantsand the refreshment time between phases was required, an extra 30 minutes was added to experiment time,requiring a total of 1.5 hours for a complete session. As a result, each subject was asked to conduct self-directed learning by using either IE or ROS under the themes of both E-learning and Environmental protection within 1.5 hours.

5.2 Experiment Procedures & Evaluation Factor

The learning goals for each subject were: finding webpages and creating knowledge structure based on the webpages found. The subjects were first asked to find webpagesthey thought appropriate from the two websites provided by using IE and ROS separately. In the case of IE, the found pages needed to be saved in the favorite list under the name of the subject.In the case of ROS, by reviewing the webpages and their resource maps simultaneously, the subjects were ask to save the found pages in terms of personal topic maps by dragging and dropping the nodes to the topics created by themselves. Based on the contents stored in the IE favorite list or system's personal topic map, the subjects were asked to draw keyword maps on a paper;thekeywords written were either extracted from storedcontent or generatedby the subjects while reviewing the webpages they had found.Here, we want to emphasize that those topics in the personal topic maps were created by the subjectfor categorizing found webpages;and that the keywords writtenfor keyword maps were thoseextracted or summarized from the webpages stored to describe the learning content of the subject. Finally the subjectswere asked to review the webpages collected by the community members and add new keywords into the keyword map they had drawn previously. Here, in order to provide similar conditions, instead of using the community-based learning resources gathered by all the subjects in ROS, we previously prepared Urls corresponded to the 20 subthemes from E-learning and Environmental protection. In IE, the Urls were represented in term of bookmark lists, and in ROS they were represented in term of community topic maps. As a result, only the advantage ofusing community topic maps was evaluated in this experiment, not the function for generating community topic maps, which will be considered in a future study. In summary, the subjects were asked to conduct three procedures for the learning of the two themesrespectively while using IE or ROS.The three procedures are:"Finding learning resources (Procedure 1)"→Drawing Keyword Map (Procedure 2) →Supplementing Keyword Map (Procedure 3)",there were evaluation factors indicating the learning effectiveness of the corresponding processes for each of these procedures.

Number of Webpages Foundin Procedure 1: this evaluation factor was chosen based on the first requirement listed in Section 2.4. The semantic representations of resource map offered by ROS is supposed to help the subject more swiftly and accurately locate potential learning resources, and the number of webpages found in a fixed time can best illustrate the efficiency of doing so.

Number of Keywords drawn and Webpages Viewed in Procedure 2:The second requirement listed in Section 2.4 suggests that learners need a more sophisticated way to organize and review found learning resources than using the favorites list of an internet browser. The personal topic maps in ROS provide the subject with a more semantic management and a representation of learning resources, which are intended to facilitate later review. Therefore, the number of keywords drawn by reviewing the found resources is believed not only to filter out the irrelevant pages accidentally stored due to the rush, but also to evaluate the accessibility of the found learning resources. Moreover, by counting the number of webpages viewed from which the keywords were written, we could evaluate the efficiency of reviewing found webpages when using IE or ROS. One point that needs to be stated is that it must be the number of pages from which keywords are drawn, not only those viewed without keywords having been extracted.

Number of Keywords Added and Webpages Viewed in Procedure 3: Based on the third requirement listed in Section 2.4, we designed the third procedure as community-based learning. The community topic maps in ROS give the subject overviews of the status of resource collections of other learners and the ratings (number of stars) as feedback for each learning resource. We considered the number of keywords newly added into the keyword map created previously and the webpages viewed for writing these new keywords valuable evaluation factors, in evaluating the efficiencies for resource sharing and searching in a learning community via map representation.

Number of Keyword Islands Drawn within Keyword Map Eventually:This evaluation factor wasnot initially considered. However, when viewing the keyword maps drawn by all the subjects, we found that the number of keyword islands (cluster of keywords) by using IE and ROS were very different. This might best describe the difference between the knowledge structures generated while using IE or ROS.

5.3 Data Analysis

Details are shown in Table 1. From the average data itself, we could easily see the difference in the use of IE and ROS in each group of data. However, we useda T-test to determine whether the means of the two groups were statistically different from each other and to assesswhether the difference was meaningful or not. We could easily see from this table that *t Critical two-tail* < |T stat.|and $p<0.01$ from every group of data indicated thatdifferences within each group werestatistically significant.

Table 1. Experiment Data with T-test

	Ave.(ROS)	Ave.(IE)	T Stat	TCritical two-tail	P(T<=t) two tail
WebpagesFound	64	17.875	19.654	2.131	4.06E-12
Keywords / PagesViewed	48.312/ 14.437	21.6875 /6.75	10.052/ 11.181	2.131/ 2.131	4.67E-08 1.13E-08
KeywordsAdded/ PagesViewed	35.437/ 12.5	16.1875/ 6.5625	7.066/ 6.188	2.131/ 2.131	3.83E-06/ 1.74E-05
Islands	1.812	4.8125	-7.745	2.131	1.28E-6

5.4 Discussion

Based on the results of the data analysis, the following conclusions have been drawn:

ROS enables the subjects to find more suitable webpages.This conclusion indicates that the visualization of the explicit structure of selected links and enhanced semantic representation of its contents on ROS enabled the subjects to overcome the complexity and obtain learning resources appropriate to their learning goals faster and more correctly.

ROS enables the subjects to write more keywords from more webpages viewed.Due to the limitations of organizing information using browser’s favorite lists, ROS simplified the process by enabling the subjects to create personal topic maps, to which interesting webpages (Occurrences) were added and relationships among topics (Associations) were built. The data suggests that, due to its easy accessibility and meaningful structure, the personal topic map played a positive role in the process ofreviewing resource and constructing knowledge structure.

ROS enables the subjects to write more keywords from more webpages viewed in community-based learning. The community topic map on ROS gave the subjects overviews of all the learning topics and the learning resources of their learning community, which enabled the subjects to quickly locate the necessary learning resources, and because of which, as the result indicated, more keywords had been written.

ROS enables the subjects to draw less keyword islands eventually.This result was unexpected and thus had not been considered as an evaluation factor at the outset. However, when examining keyword maps drawn by every subject in aggregate, we found that the number of keyword islands was 62% fewer when using ROS than that of using IE, as shown in figures 6 and 7. Not only that, the average number of keywords in every keyword island created using ROS was 26.66, greater than that of keyword islands created using IE which was only 4.50.There were relatively few connections among main keywords in the drawings created by IE users; however, when the meanings of most keywords were considered, it seemed reasonable to think that connections should have been made. Comparatively, ROS users performed well as indicated by the number of connections thathad been drawn and the number of keywords added,This change, after consulting each subjects about the reason those connections were being made, is due to the structure of personal topic maps where the basic connections (Associations among topics) were already present. They were conducting self-directed learning with the awareness of the connections among topics; therefore the connectionswere made among keywords extracted in their learning. Take the example created by one subject (as shown in figure 7). In his personal topic map in ROS, there are topics of E-learning, Adult learning, M-learning, and Distancelearning. E-learning is the main topic and the others are ones related to it. We can see these connections among these topics in his keyword map, and the keywords around these topics were extracted from webpages stored in these topics in his personal topic map.This accident finding indicates that semantically structured representation of learning resources can give the leaners positive impact while reviewing their learning materials for knowledge construction.

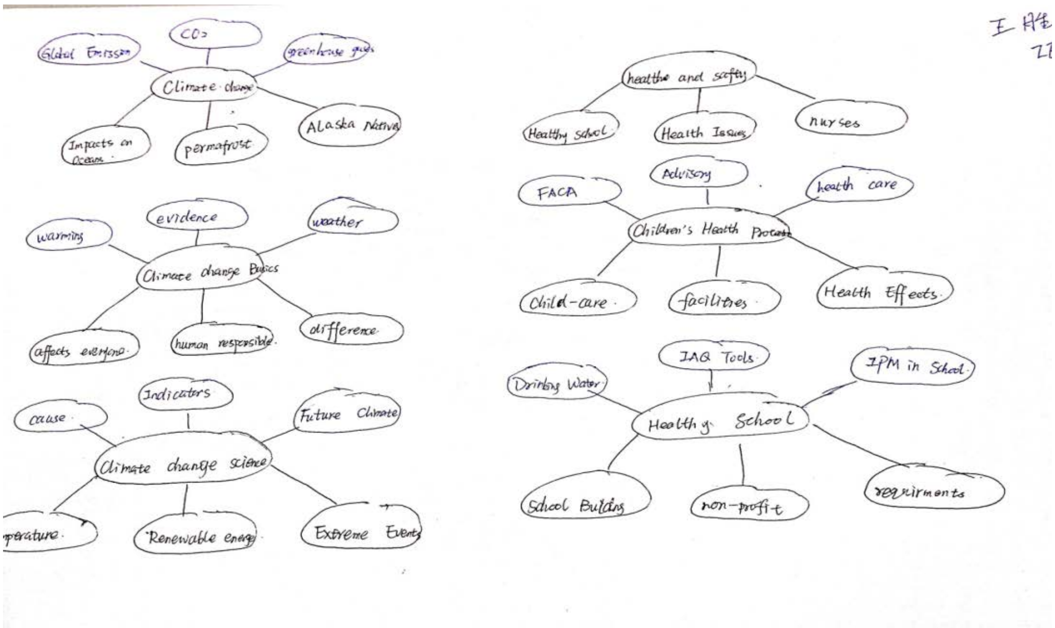

Figure 6. Example of Keyword Map When Using IE

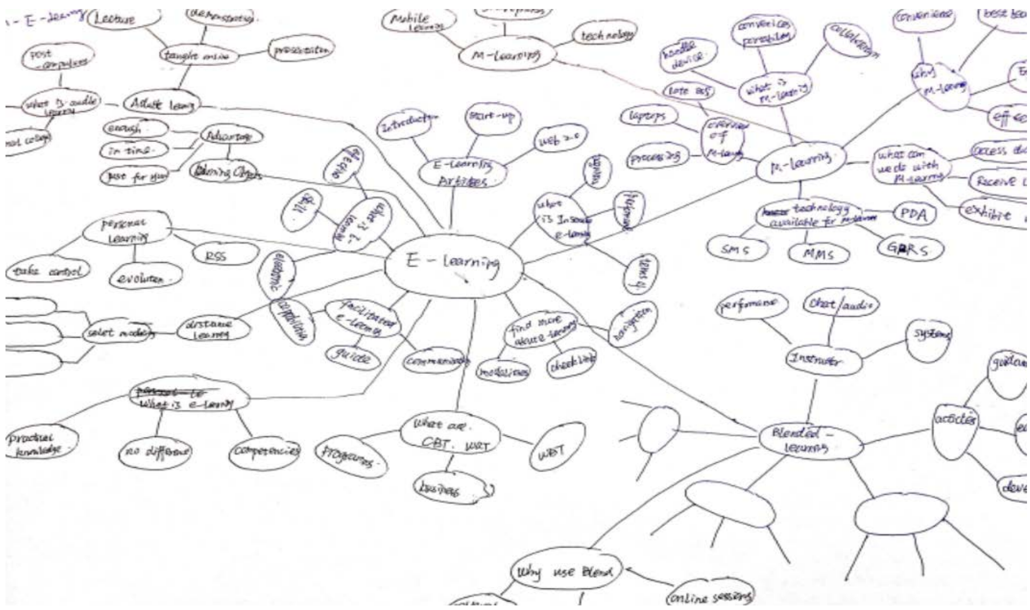

Figure 7. Example of Keyword Map When Using ROS

6. Conclusion and Future Work

This research proposed a Multi-layer Map Model by employing the methodology of Topic Maps to addressseveral difficulties in web-based self-directed learning. We also developed a resource organization system by using Microsoft.Net and Silverlight which enabled the visualization of the basic learning behaviors of searchingfor and organizing information from the internet. Based onthe results of the case study presented, we are able to conclude that learners using the proposed model performed better on tasks that required them tolocate and organize learning resources. We can also tentatively state thatbuilding connections among learning topics not only provides a better means of resource management but also is subconsciously helpful in thecreation of knowledge structures.

In the future, while improving the current model`s functionality, we also want to focus more closely on CBL (Community-based Learning). Community here means a group of people sharing similar learning interests but with different knowledge levels and learning goals. Such diversity inside the community makes interactionamong community memberspossible; if such interactions could be better utilized and community knowledge or skill shared and inherited, each individual's learning activity can be expected to improve.However, the current learning environment does not enable learners to take complete advantages of CBL activities, as communications cannot be passed promptly, advanced learning skills cannot be properly observed, and community-level knowledge structure is difficult to recognize.Combined with the results of current research, we want to emphasize more on factors of CBL, which is expected to play an important role in people's learning activities.

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