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A Knowledge Structure Visualization for Supporting Exploratory Learning in Hyperspace

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Abstract: This paper discusses how to help learners reflect on what they have explored domain concepts/knowledge in hyperspace. The approach presented here is to visualize a knowledge structure that the learners would construct in exploring. In this paper, we address the following important problems to be resolved towards the knowledge structure visualization: (1) how to get learners' exploration processes, (2) how to help the learners keep and achieve exploration in hyperspace, and (3) how to visualize the knowledge structure understandably.

1. Introduction

Hypermedia/hypertexts generally provide learners with hyperspace where they can explore domain concepts/knowledge in a constructive and self-directed way [2,4]. Such exploration often involves making cognitive efforts to construct their knowledge with the contents they have explored, which efforts would contribute to enhancing learning [1]. However, it is not so easy for learners to get good results in the exploratory learning since what and why they have explored so far often become unclear as the exploration progresses. To what extent learning has been carried out then becomes unclear. An intelligent assistance is consequently required, which encourages learners to reflect on what they have learned.

Current work on hypermedia/hypertext systems has provided a number of aids for supporting the reflection [7]. The representative aids are to provide learners with hyperspace maps or concept maps, which can visualize the learners' exploration history as the partial structure of hyperspace/domain concepts [3,6]. Such visualization can inform the learners where they are, what they explored, and to what extent they explored [7]. However, these maps are not always informative since the learners may not learn about the structure of hyperspace. In addition, the learners would not always construct the same knowledge structure as the partial structure of domain concepts created by hypermedia/hypertext designers. It is consequently more helpful as a reflection support to visualize a knowledge structure that learners would shape in hyperspace.

2. Exploratory Learning in Hyperspace

Hyperspace consists of nodes and links, which compose the contents to be learned. Learners generally start with a learning purpose, then exploring from one node to others by following the links among the nodes. When they explore one node, they would have a local purpose called exploration purpose to search the next node that fulfils it.

A prime exploration process can be viewed as the one of achieving an exploration purpose. This process can be represented as a link from the starting node where the exploration purpose occurs to the terminal node where the purpose is fulfilled. An exploration purpose sometimes has several terminal nodes with one starting node. We currently classify exploration purposes as shown in Table 1. Each purpose is represented as verb that means how to develop/improve domain knowledge obtained in the starting node.

The exploration purpose produced in visiting a node is not always fulfilled in the next node. In this case, learners would need to keep the purpose until they find the terminal nodes. In addition, another exploration purpose may occur. They would accordingly achieve several exploration purposes. Keeping and achieving a number of exploration purposes make the exploratory learning more difficult.

Table 1. Exploration Purposes and Visual Representation.

Exploration Purposes	Visual Representation
Supplement	Inclusion
Elaborate	Set or Part-of tree
Compare	Bidirection arrow
Justify	Vertical arrow
Rethink	Node superposition
Apply	Arrow

Starting node Terminal node

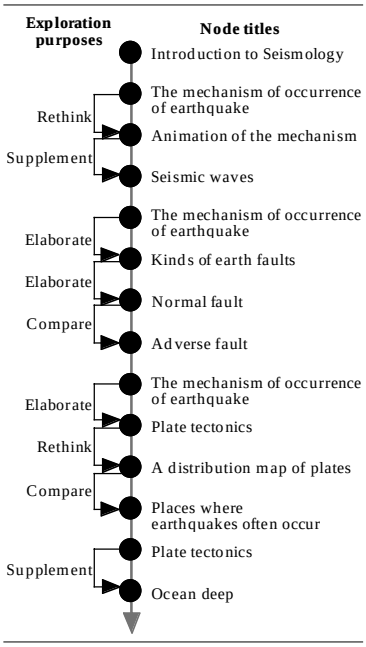

Figure 1. An Exploration History.

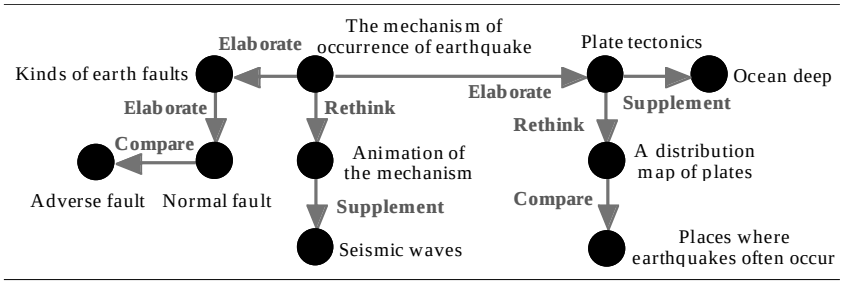

Figure 2. A Knowledge Structure.

The exploration process also has an influence on how to shape a knowledge structure. In this paper, we accordingly represent it as semantic network that consists of a number of prime exploration processes. The semantic network gives an overview of domain concepts/ knowledge that learners have explored, which would be substantially fruitful for their reflection.

Let us give an example of exploratory learning where a learner uses a hyperdocument on a WWW server with the learning purpose of learning the occurrence of earthquake. In this example, the learner explores a number of nodes (WWW documents) with exploration purposes. Figure 1 gives the exploration history, which shows the sequence of the nodes visited and prime exploration processes. For example, the learner visited the node of "Animation of the mechanism" in order to rethink the description in the node of "The mechanism of occurrence of earthquake". He/she then visited the node of "Seismic wave" since he/she encountered an unknown term, which is seismic wave, in the node of "Animation of the mechanism. Figure 2 represents a knowledge structure to be shaped in the exploration process.

3. Learning Assistance

Let us next discuss the important issues towards the knowledge structure visualization and our approach. The first problem is how to get exploration purposes to be produced in exploring. It is too hard for computer to infer the purposes which learners set up in their mind. We accordingly provide the learners with a list of exploration purposes, and require them to select one from the list when an exploration purpose occurs. The learners are also asked when they find the terminal nodes. Although requiring such information during exploration may be troublesome for learners, it enables them to explore more constructively and attentively.

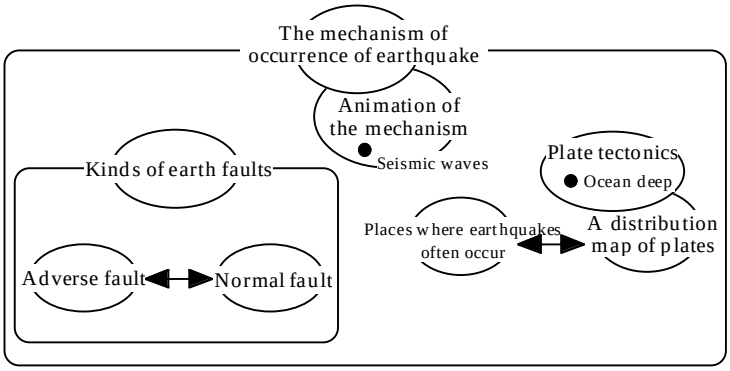

Figure 3. A Knowledge Structure Visualization.

The second problem is how to assist learners in keeping and achieving several exploration purposes. Solving this issue requires displaying an exploration history, which shows the nodes sequenced in order of time learners visited and the exploration purposes. The starting node of each purpose is linked with the corresponding terminal nodes. Learners can look at the history on their demand, and forward exploration without cognitive overload.

The third problem is how to visualize a knowledge structure so that learners can understand without difficulty. Although semantic network representing the knowledge structure is easy for computer to use, it is not so easy for learners to understand. We have accordingly made a table shown in Table 1 describing the correspondence of exploration purpose to representation that visualizes the relationships between the starting node and terminal node. The semantic network is transformed into the visual representation by following this table. Figure 3 shows an example of the knowledge structure visualization with the semantic network as shown in Figure 2. In this figure, for example, the exploration purpose of elaborating is visualized with a set like a Venn diagram which represents the starting node as a total set and also represents the terminal node as the subset.

4. Conclusions

This paper has proposed a learning assistance for exploratory learning in hyperspace, which encourages learners to reflect on what they have explored so far. In order to facilitate such reflection, a knowledge structure, which the learners would construct in exploring, is visualized according to their exploration process. The knowledge structure visualization can be viewed as a challenging work in the field of learning with hypermedia/hypertext.

We are now implementing a learning assistance system that accomplishes the knowledge structure visualization [5]. In the future, we need to evaluate and refine the knowledge structure visualization with the learning assistance system. We would also like to classify exploration purposes in detail to represent learners' exploration process more precisely.

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