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Self-Directed Reconstruction of Learning Scenario forNavigational Learning

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Abstract: After navigational learning on the Web, learners often reach an unstable understanding of knowledge learned since it is difficult for them to properly recall and reproduce the process of how they have constructed their knowledge. Our approach to the knowledge unstableness is to encourage them to reconstruct their learning scenario in a self-directed way, which represents a sequence of constructing their knowledge. Such scenario reconstruction enables them to reflect on their knowledge construction process. This paper demonstrates an interactive learning scenario builder, iLSB for short, that helps learners reconstruct their own learning scenario. We also discuss the future direction.

Keywords: Learner-reconstructed Scenario, Self-directed Learning, Reflection, Hyperspace

Introduction

In recent years, Web resources fruitful for learning/education have increased, which bring about a lot of opportunities for learners to learn in a self-directed way [1]. Such self-directed learning requires them to search for resources that are suitable for their learning goal. It also involves navigating the Web pages to construct knowledge [2][3]. Such navigation with knowledge construction is called navigational learning.

The navigational learning process does not always follow the scenario the authors of the resources provide. The learners would often self-regulate their navigational learning process to construct their own learning scenario. On the other hand, the navigational learning process often results in an unstable understanding of knowledge constructed. In other words, learners cannot always reproduce their constructed knowledge after the navigational learning process, and cannot fully grasp relationships among pieces of the constructed knowledge. This gives evidence that the constructed knowledge is not stable. We call this issue knowledge unstableness. In order to resolve it, the learners are required to reflect on the knowledge construction process to stabilize the constructed knowledge [2].

This paper addresses the issue of knowledge unstableness occurring from self-directed learning in hyperspace provided by hypertext-based resources on the Web. One promising approach to this issue is to enable learners to reconstruct a learning scenario in a self-directed way, which represents a sequence of knowledge construction process carried out in hyperspace. Self-directed reconstruction of the learning scenario could activate reflection on their knowledge construction process in hyperspace [2].

However, it would be not so easy for the learners to reconstruct the learning scenario [4]. In this paper, we describe an interactive learning scenario builder, iLSB for short. iLSB assists learners in reconstructing a learning scenario from learning history generated with Interactive History (IH for short), which we have developed for scaffolding self-directed knowledge construction process in hyperspace [5]. iLSB automatically generates the learning scenario with the learning history, and then helps the learners edit it. In addition, iLSB presents information on the Web related to the learning scenario, which assists the learners in reinforcing the scenario with the related information. Such learning scenario reconstruction enables learners to stabilize their knowledge constructed from their self-directed learning in hyperspace.

1. Learning Scenario Reconstruction

1.1 Navigational Learning in Hyperspace

Before discussing the learning scenario reconstruction, let us first consider self-directed learning process in hyperspace.

Hypertext-based resources on the Web generally provide learners with hyperspace where they can navigate the Web pages in a self-directed way. The self-directed navigation involves constructing knowledge for achieving a learning goal, in which the learners would make semantic relationships among the contents learned at the navigated pages [4][6]. They could also carry out the knowledge construction process in an individual way, in which the constructed knowledge could be individualized. Such navigation with knowledge construction is called navigational learning.

Self-directed navigational learning process, on the other hand, often finishes with incomplete knowledge [7]. It is also hard for learners to become aware of the knowledge incompleteness, which we have addressed in our previous work [8][9]. Even if they constructed their own knowledge from hyperspace, in addition, understanding of the constructed knowledge tends to be unstable. In other words, the learners could not always reproduce the constructed knowledge, and also could not fully grasp relationships among pieces of the constructed knowledge. How to resolve the knowledge unstableness is the main issue addressed in this paper.

1.2 Learner-Reconstructed Learning Scenario

Self-directed navigational learning with hypertext-based resources does not always follow the scenario the authors provide [4]. Learners would construct a learning scenario as they navigate and construct their own knowledge in the hyperspace. The learning scenario represents the sequence of learning in hyperspace for achieving the learning goal. In this work, we focus on the learner-constructed scenario. When learners learn in hyperspace, they always browse the pages in a linear order to implicitly construct their learning scenario and their knowledge. Their knowledge would result in a structural form not in a linear form. In order to review or reuse the knowledge constructed after the learning process, it is necessary for the learners to recall the learner-constructed scenario for reproducing their knowledge structure since the scenario includes the context of how they have constructed their knowledge. However it is not so easy for them to recall it only from their knowledge structure. That is the main reason why they could not reproduce the constructed knowledge and why the constructed knowledge could be unstable.

One promising approach to resolving the knowledge unstableness is to encourage learners to reconstruct the learner-constructed scenario from the constructed knowledge. Such learning scenario reconstruction involves sequencing the constructed knowledge, which represents the knowledge construction process carried out in hyperspace. Such sequencing allows the learners to reconsider and raise awareness of the relationships among pieces of the constructed knowledge and to have a clear overview of it, which would activate their reflection on the knowledge construction process. Such reflection is useful for them to stabilize understanding of the constructed knowledge. The learner-reconstructed learning scenario could be also useful for the learners to reproduce and review their knowledge after self-directed learning.

However, it is difficult for learners to recall the knowledge construction process by taking a look at the constructed knowledge as learning results and to sequence their constructed knowledge. We have accordingly developed iLSB that helps learners reconstruct their own learning scenario.

2. Framework for learning scenario reconstruction

2.1 Learning phases

Let us here explain the framework for iLSB.iLSB assumes a model of self-directed learning as shown in Figure 1, which consists of the following two phases: knowledge construction in hyperspace, and learning scenario reconstruction.

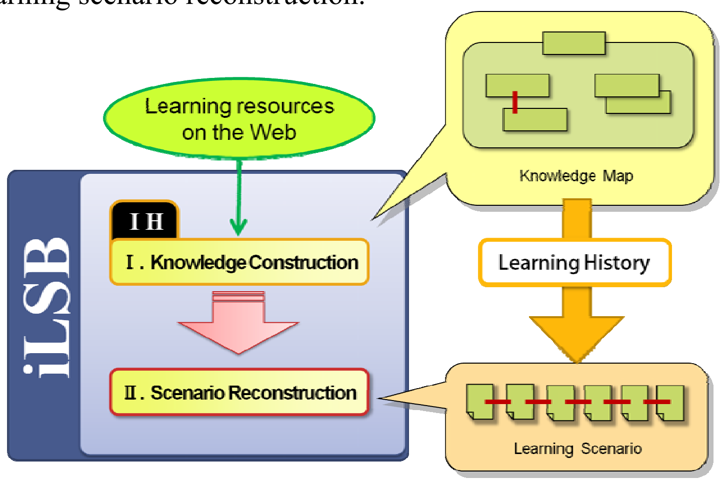


Figure 1. Framework of Learning in iLSB

Learners can have fruitful opportunities to reflect on their knowledge in the process of the learning scenario reconstruction phase, which contribute to the knowledge stabilization.
In the following, let us explain each phase in iLSB.

2.2 Knowledge Construction Phase

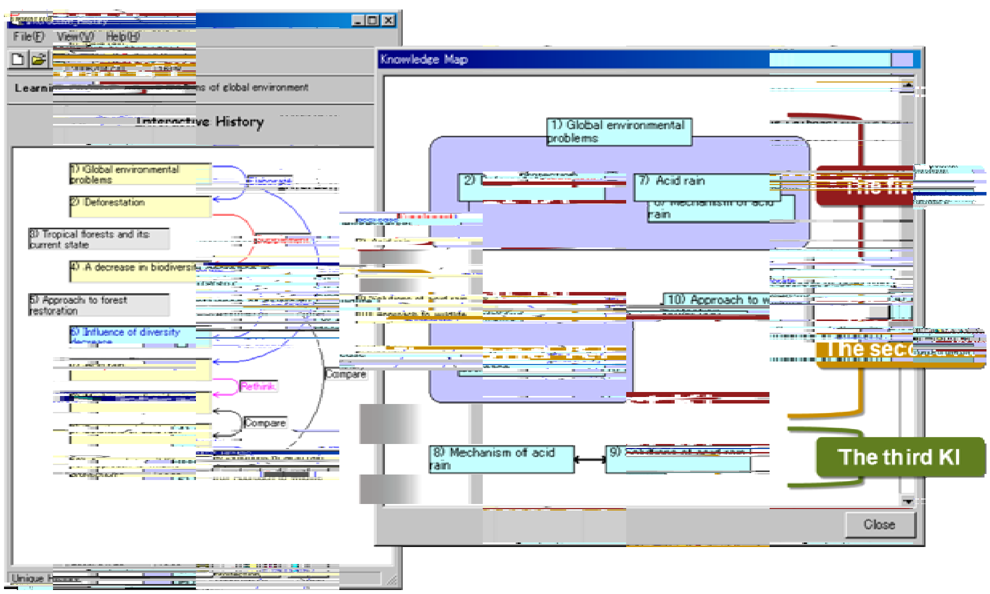
In navigational learning process, learners generally start navigating the pages for achieving a learning goal. The movement between the various pages is often driven by a local goal called navigation goal to search for the page that fulfills it. Such navigation goal is also regarded as a sub goal of the learning goal. The navigational learning process includes producing and achieving a number of navigation goals.

We currently classify navigation goals into six: Supplement, Elaborate, Compare, Justify, Rethink, and Apply. For instance, a learner may search for the meaning of an unknown term to supplement what he/she has learned at the current page or look for elaboration of the description given at the current page. We refer to the process of fulfilling a navigation goal as primary navigation process. This is represented as a link from the starting page where the navigation goal arises to the terminal page where it is fulfilled. Navigation goal signifies how to develop or improve the domain knowledge learned at the starting page.

The knowledge construction process can be modeled as a number of primary navigation processes. In each primary navigation process, learners would integrate the contents learned at the starting and terminal pages. Carrying out several primary navigation processes, learners would construct knowledge from the contents they have integrated in each primary navigation process.

In order to scaffold such knowledge construction process, we have developed IH. In the knowledge construction phase, learners are expected to learn hypertext-based resources with IH [5]. As shown in Figure 2, IH enables them to annotate a navigation history, which includes the pages sequenced in order of time they have visited, with primary navigation processes carried out. Figure 2(a) shows an example of annotated navigation history. IH monitors learners' navigation in the Web browser to generate the navigation history in the annotated navigation history window. Each node corresponds to the page visited. The learners can annotate the navigation history with the primary navigation processes that they have carried out. They can also take a note about the contents learned at the starting or terminal pages, which could be copied and pasted from the corresponding portions of the pages. The note is linked to the node in the annotated navigation history.

When the annotated navigation history includes more primary navigation processes, the learners have more difficulty in understanding the semantic relationships among the pages included in these primary navigation processes and in constructing their knowledge. When the primary navigation processes are overlapped each other, in particular, it is hard to understand the relationships among the pages included. In order to reduce such difficulty, IH second generates a knowledge map by transforming primary navigation processes into visual representation. (See [5] for detailed generation mechanism.)



(a) Annotated Navigation History (b) Knowledge Map

Figure 2. User Interface of IH

Figure 2(b) shows an example of knowledge map. The knowledge map is generated from the annotated navigation history shown in Figure 2(a), which is obtained from the learning goal of learning problems of global environment. Viewing this map, for example, the learner can visually understand that he/she elaborated the contents of Global environmental problems by referring to Deforestation and Acid rain, and so on. The knowledge map generally consists of several islands including some primary navigation processes. We call them Knowledge Islands (KIs). The knowledge map shown in Figure 2(b) consists of three KIs.

Although IH enables the learners to reflect on what and how they have constructed so far in hyperspace, it is still hard for them to reproduce the constructed knowledge with IH after the navigational learning process.

2.3 Learning Scenario Reconstruction phase

Figure 3 shows the user interface of iLSB, which consists of scenario editor, page viewer, and note editor.

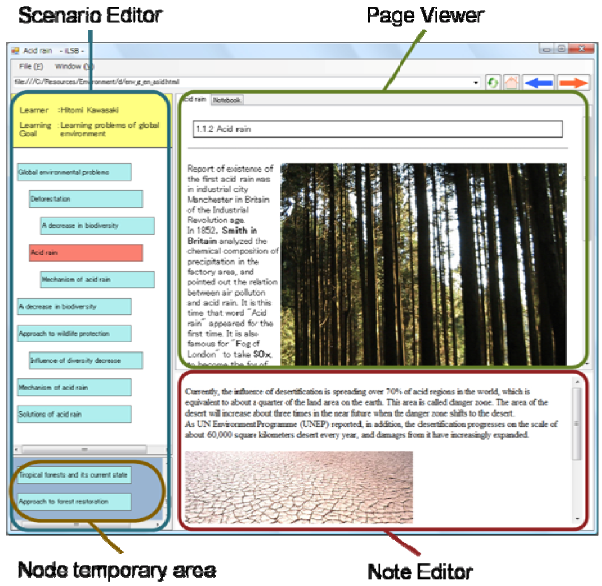


Figure 3. User Interface of iLSB

In the learning scenario reconstruction phase, the learners are expected to reconstruct the learning scenario by themselves. However, it is not so easy for them to execute the scenario reconstruction from scratch. In this phase, iLSB first automatically generates a sequence of the nodes included in the knowledge map as shown in the scenario editor in Figure 3, which represents a learning scenario. Referring to and reconfirming the contents of any node in the scenario with the page viewer and the note they have taken with IH by means of the note editor, the learners can alter the sequence of the nodes and change the titles to edit the scenario. Moreover the learners can remove the node from scenario editor as needed. Such removed nodes are stored in the node temporary area below the scenario editor, which can be restored. They can also edit the notes corresponding to the nodes. Such edit operations would activate their reflection particularly on the relationships among the nodes that are viewed as the components of their knowledge. Reconstructing the learning scenario, in this way, the learners can reflect on their navigational learning process and constructed knowledge.

The notes corresponding to the nodes are automatically sequenced according to the learning scenario as a notebook, which can be viewed in the page viewer. The notebook contains the titles and contents of the nodes. Each title in the notebook is given a caption number according to the hierarchical level of the corresponding node. Reconstructing the learning scenario with such notebook, the learners can recall their knowledge construction process and knowledge itself more easily.

Following these phases, learners would be able to recall/reconstruct the order of their self-directed navigational learning process and the relationships among pieces of knowledge learned, and resolve the issue of knowledge unstableness. They could be accordingly expected not only to stabilize their understanding of their knowledge constructed, but also to refine their knowledge, which is indicated by the knowledge map in IH, in accordance with refinement of the learning scenario. Such knowledge refinement would result in reinforcing relationships among their knowledge components.

2.4 Automatic Generation

Let us here demonstrate iLSB with an example.The learning scenario is first automatically generated from the knowledge map as follows. The sequence of the nodes is created according to each KI included in the knowledge map. Each primary navigation process in the KI is also sequenced according to the navigation goal as shown in Figure 4.

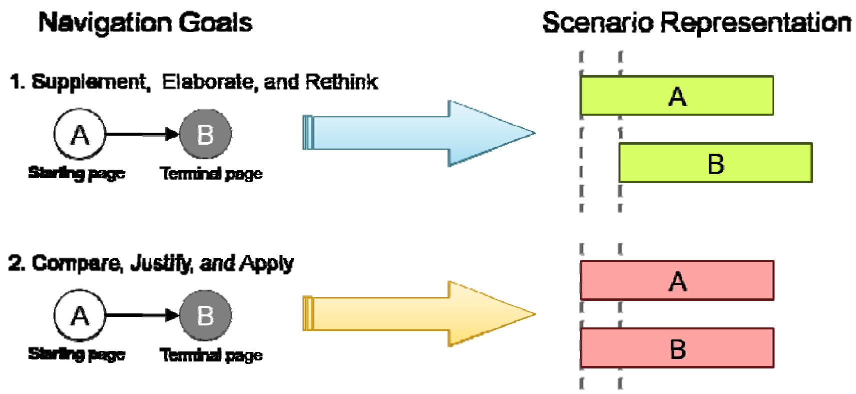


Figure 4. Scenario Representation for Primary Navigation Processes

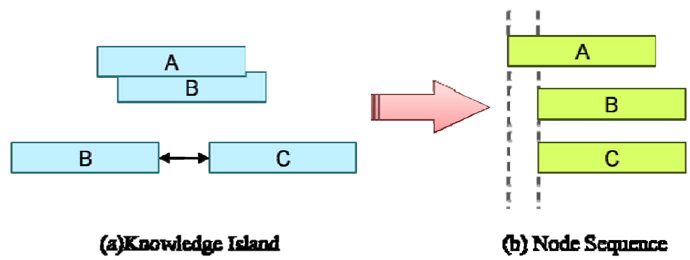


Figure 5. Automatic Sequencing of Nodes

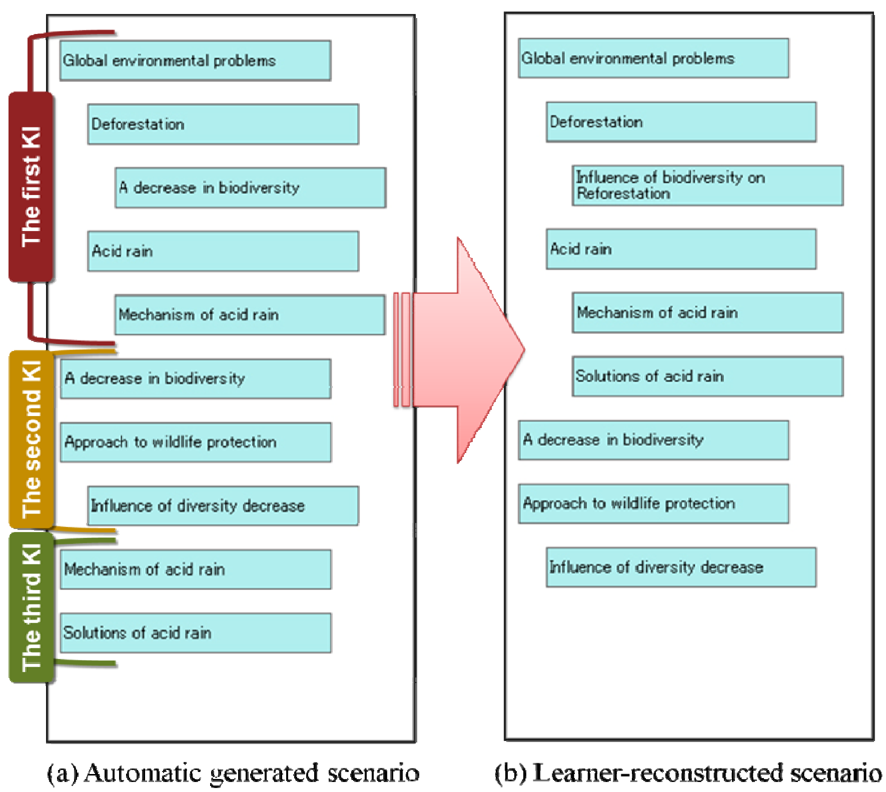


Figure 6. Learning Scenario Reconstruction

For example, the KI shown in Figure 5(a) consists of two primary navigation processes whose navigation goals are Rethink and Compare. In this case, iLSB generates the sequence of nodes as shown in Figure 5 (b).

Figure 6(a) shows the learning scenario automatically generated from the knowledge map shown in Figure 2(b), which is represented as the sequential and hierarchical relationships between nodes. The sequence of the nodes is created from three KIs in the knowledge map. The sequence of the first five nodes from the node of Global environmental problems to the node of Mechanism of acid rain is created from the first KI in the map. The sequence of the second three nodes from the node of A decrease in biodiversity to the node of Influence of diversity is also created from the second KI in the map. The sequence of the last two nodes is created from the third KI.

Each node in the scenario has a link to the corresponding page, which can be viewed in the page viewer. It also has a link to the corresponding note taken in the knowledge construction phase since the note is important for the learner to recall the contents learned.

2.5 Scenario Reconstruction

The automatic generated scenario is next reconstructed by learners. iLSB allows the learners to alter the sequence of the nodes, to change the titles and to remove the nodes. Dragging any node in the sequence, the learners can move and drop it at any place and any hierarchical level (four levels at the maximum) in the sequence. The hierarchical level allows the learners to represent their scenario contexts in a simple way. As explained in 2.3, the learner can also edit the notes/notebook with reconstructing.

Figure 6(b) shows the learning scenario reconstructed from Figure 6(a). In this case, the learner places the final node of Solution of acid rain next to the node of Mechanism of acid rain that is below the node of Acid rain. Following this operation, he/she also deletes the second to the last node, which is Mechanism of acid rain. In addition, he/she changes the title of the third node A decrease in biodiversity into Influence of biodiversity on Deforestation. The node of A decrease in biodiversity appears twice in the automatic generated scenario. This means it has been learned in the two different contexts. In this example, the third node has been learned as the influence of biodiversity on deforestation.

The scenario reconstruction, in this way, allows the learner to make the sequence of the nodes much better than the one before editing. Such edit operations would activate their reflection particularly on the relationships among the nodes that are viewed as the components of their knowledge. iLSB also allow them to save and reproduce the reconstructed learning scenario for afterward recalling the knowledge construction process.

2.6 Future Direction

Let us here discuss the future direction of iLSB. We will particularly focus on improving the functionality of iLSB. We have already conducted a case study with iLSB. The results suggest that learner-reconstructed learning scenario is so effective for reflection on knowledge constructed in hyperspace. But, we found that the learner-reconstructed learning scenario iniLSB was not sufficient for representing the sequence of the knowledge construction process.In particular, the learning scenario could not currently represent the semantic relationships among the nodes and the contents learned in each node.

In order for learners to understand the learning scenario generated with iLSB to reproduce their knowledge, it needs to represent the following four elements at least: (1) the sequence of nodes, (2) node segments, (3) contents learned in the nodes, and (4) semantic relationships among the nodes. As described in 2.3 the learning scenario generated with iLSB has a sequence of nodes, each of which has its own title. The node sequence is also segmented with hierarchical relationships between nodes, which is indicated by means of indent. The learners could understand the sequence and segments of knowledge construction process from the node sequence. As for the contents learned in the nodes, on the other hand, the learners could use the node titles as cues to reflect on the contents learned. However, they would often have difficulties in the reflection process. Furthermore, the hierarchical relationships between nodes do not indicate the semantics. The learners would accordingly need to reflect on how they combined the contents learned among the nodes.

In order to resolve these problems, we plan to refine the functionality of iLSB. We will first attach some keywords, which are included in the Web pages corresponding to the contents learned, to the nodes. These keywords could help them reflect on the contents learned. Second, we will use navigational goals generated with IH to represent the semantic relationships among the nodes in the learning scenario. Such semantic relationships could allow them to reflect on their knowledge construction process. These two functions would contribute to the knowledge stabilization.

3. Conclusion

This paper has proposed self-directed reconstruction of learning scenario as a promising solution to the issue of the knowledge unstableness in self-directed navigational learning. The scenario reconstruction involves sequencing the knowledge construction process in hyperspace, which could activate learners' reflection on their constructed knowledge. Such reflection contributes to stabilizing the constructed knowledge.

This paper has also demonstrated an interactive learning scenario builder, iLSB for short, which enables learners to reconstruct a learning scenario with automatic scenario generation. iLSB accordingly allows them to stabilize their knowledge with less cognitive efforts. In future, we will ascertain whether the learning scenario generated with iLSB contributes to reproducing knowledge constructed, and will refine iLSB according to the results.

Acknowledgements

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