# Implementation of a Learning Space Navigator for WBI

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## ABSTRACT

WBI provides new opportunities to realize the flexible learning environment based on hypermedia and to support distance learning with a diverse interaction. The instructors or learners in WBI claim to be able to resolve reluctant fluctuations such as disorientation and cognitive overload. To overcome these phenomena, a supplementary tool able to manage a learning space organized by the instructor's or learner's own way and offer effective navigation techniques is presented in this paper. A learning space management and navigation tool called HyperMap dynamically represents the learning space in the form of a two-dimensional labeled graph. This HyperMap also can be used for an instruction design tool, learners portfolio for the exchange of learning experiences, and the assessment of WBI.


# WBI를 위한 학습공간 네비게이터 구현

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## 요 약

WBI(Web-Based Instruction)는 하이퍼미디어를 토대로 유연한 학습환경을 실현하고, 다양한 상호작용으로 원격교육을 지원하는 새로운 교육 패러다임이다. 그러나, WBI 에서 교수자와 학습자는 하이퍼텍스트와 인터넷을 기반으로 한 하이퍼미디어의 가상공간에 방치되므로 방향상실과 인지적 부하등과 같은 문제에 직면해 있다. 본 논문에서는, 이러한 현상을 해결하기 위하여 교수자와 학습자 자신이 학습공간을 구축하여 관리하며, 효과적으로 학습공간을 탐색할 수 있는 교수/학습 지원시스템을 설계/구현하였다. 본 논문에서 설계/구현한 하이퍼맵은 학습공간을 2 차원 그래프 형식으로 정적 또는 동적인 방식으로 표현한다. 또한, 학습공간의 탐색은 기존의 브라우저가 제공하는 1 차원 선형방식이 아닌 2 차원 탐색방식을 기반으로 하므로써 방향상실과 인지적 부하 문제를 해결하고 있다. 본 논문의 하이퍼맵은 교육설계 도구와 학습경험의 상호교환을 위한 학습자의 포트폴리오로 사용할 수 있으며 WBI 의 평가도 적용할 수 있어, WBI를 교육현장에 정착시키는데 유용하다.


## 1. Knowledge-Driven Society

Information technology and the Internet will radically alter the way in which interacts with knowledge. The ubiquity of the World Wide Web (WWW) and the information infrastructure based on the high-speed global


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network presignifies the advent of the knowledge-driven society. In the knowledge-driven society of the 21th century, education will be a central theme and will lead the paradigm shift. The realization of a cyber community beyond the barriers of time and space, however, also requires education to precede the societal reformation by cultivating creative knowledge of workers[6]. Information technology as a catalyst for education reform affects instructional design and strategy, assessment, educational infrastructure, distance learning, and so on[7,12].

## 2. Growing Discipline: WBI

Web-Based Instruction (WBI) is a fast-emerging field in education according to the rapid growth of the Internet. WBI takes advantage of the interaction of hypermedia and a convenient medium to deliver the instructional materials from the Internet. WBI can realize the instructional strategies within a constructivist and the collaborative learning environment with its interactive characteristics[9]. WBI also supports learner-centered individual instruction and distance learning with asynchronous or synchronous interactions[2].

Though WBI offers a very rich and flexible environment and some amount of adaptivity and intelligence for education systems, there still remain some inherent problems that hinder the development of such systems. Since WBI leaves a novice unfamiliar with the instruction topics self-controlled, it causes the learner's distress such as fluctuation, bringing anxiety and confusion[3,8]. Such side effects due to hypermedia properties give rise to a spatial disorientation and a heavy cognitive overload to the learners. While some researches on WBI have focused on the development of instructional materials with authoring tools and instructional strategies on web space, navigators or browsers that can support the diverse navigation functions appropriate for WBI are necessary to resolve the known problems of learning from hypermedia[10]. Some commonly used web browsers such as Netscape, Internet Explorer or Opera that have a linear dimensional navigation, moving back and forth among web pages and recording the navigation history in a list, are not adequate for WBI navigators.

Visualization by analyzing the navigation actions leads to a significant improvement of usability, and a two-dimensional graphical navigation map such as WebMap helps learners to prevent the risk of disorientation[1,5,13]. In this paper, HyperMap, as a helper interacting with web browsers, is implemented to enhance the WBI environment. HyperMap's labeled graph offers two modes of operation: run-time dynamic mode and off-line static mode. In the dynamic mode, which is usually used in Internet access, HyperMap creates and updates a transition map, immediately reflecting the learner's traversal situation. In static mode, an instructor or a learner can design the courseware outline according to the instruction scenario. To overcome disorientation and added cognitive overload, HyperMap manages a two-dimensional graph with labels that symbolize the semantics of nodes and links. HyperMap is able to arbitrate the inconsistent learning spaces between instructor and learner. The organized learning space can be packaged into a single learning unit so that the instructor and the learner share the learning experiences.

## 3. WBI and Learning Space

The Internet is fast-emerging as one of an instructor's most important platforms, with the WWW emerging as the easiest and most popular way to access learning sources. The WWW is an efficient and useful instructional medium to represent, store and access multimedia instructional contents. The technology, coupled with the Internet and the WWW, has the potential to transform how we teach and learn. WBI

takes advantage of the Internet and the WWW to achieve a new education paradigm[7].

With WBI as a hypermedia-based instructional environment over the Internet or LAN, the instruction designer concentrates on content development and the realization of instructional strategies using authoring tools. The goal of the creation of instructional materials is to organize knowledge to promote specific learning goals from the constructivist's point of view[4,9]. It is also concerned with the knowledge access mechanism of hypermedia. The instruction designer sets up the ultimate goal of the task and usually divides it into subgoals in order to design in a top-down, goal-driven manner.

On the other hand, the learner as an explorer is an illustration of constructivist model of learning. The learner wants to explore the well-designed learning space in terms of the learner's interest, intellectual level or needs. The learner is also concerned with realization of a self-directed, self-paced instruction that can organize the learner's own learning space from the given instruction space[10].

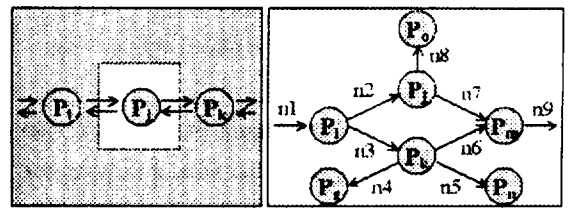
These two distinctive perspectives in WBI can be summarized as <Table 1>.

<Table 1> Two Perspectives in WBI

| | Instructor's perspective | Learner's perspective |
|---|---|---|
| Attention | Contents design Instruction strategy | Usability Intimacy Tool |
| Tool | Authoring tools | Navigation tools |
| Approach | Top-down, Goal-driven | Bottom-up, Knowledge-driven |
| Space organization | Static | Dynamic |
| Learning space | Instructor space | Learner space |

The instructor space is a knowledge network designed by instructor to achieve the goal. The learner space, however, is an individual space acquired through the instructor space.

The inconsistency between learning spaces invokes disagreement on reaching the instructional goal. In general, the learner is unfamiliar with the topics given in the instructor space and it is hard to select the right way to organize the individual learning space without disorientation[3,11]. To narrow this gap, first of all, the learner will see a learning space that is two-dimensional space with labels rather than the back and forth links within a single node window as shown (Fig. 1).



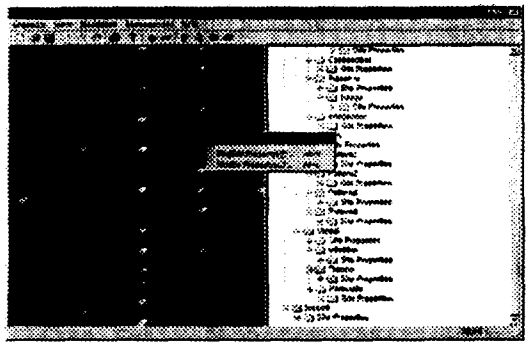

(a) A conventional space (b) A labeled graph space

(Fig. 1) Comparison of Learning Space

Although most navigation tools provide the learner with the ability to move in a nonlinear manner, the functions for constructing learner space are not supported. It is necessary to build up the learner space in accordance with the learner's traversal of the instructor space, and visualize graphically the navigation map. The learner space represented in a two-dimensional graph as in (Fig. 2), called HyperMap, with the labeled links, implies several merits as follows:

- Sense of the current location and direction without disorientation
- Access to arbitrary node in a nonlinear manner
- Information acquisition of a specific node or link
- Learner feedback for the instructor to grasp learner's attitude
- A learner's portfolio
- Assessment of the learner's achievement

- Package of instructional materials for the specific project
- Design layout for the instruction designer



(Fig. 2) Learning space representation in HyperMap

The navigation tools supporting a local or global map neither retain the management functions of the map nor offer the dynamic construction of the learner space[10]. This implies that neither instructor nor learner can manage the instruction process. Navigation through linear successive forward or backward operations without the manageable map is not adaptive for the requirements of WBI.

HyperMap can be organized statically by the instruction designer at the time of instruction development, and offered to the learner as an instruction guideline. The package feature of HyperMap may be used to share the learning experience between learners.

# 4. HyperMap and Learning Space Management

The learning space whether it is for instructor or learner, is noticeable in view of the fact that it can become an independent learning unit. HyperMap representing the learning space may supply a vital source information for instruction design and learning through navigation. Most of the authoring tools for the instruction designer include functions for the static learning space to display the outline of the instruction contents. Most navigators for the learner, on the other hand, neglect the management of the learner's learning space. Navigation assistance, such as bookmark, index, and history, may be insufficient for the management of the learner's learning space. As the learning space is only revealed during authoring and evaporates in navigation, the learner cannot understand the instructional objective, nor capture the instructor's intention.

## 4.1 Functions of HyperMap

For learner-centered WBI, learning space management should be supported in the navigation tool. In particular, the dynamic learning space of the learner can be managed to be compatible with the static instructor space. The functions to be included in a navigator to manage the learning space are as follows:

**4.1.1 Organization:**

- Dynamic construction of learner space according to navigation through hypermedia instruction space
- Static construction of instructor space to assist the outline of instructional materials

**4.1.2 Display:**

- Hierarchical tree with conceptual name nodes
- Two-dimensional graph with labeled links and named nodes
- Zoom-in/zoom-out for the specific area

**4.1.3 Navigation:**

- Jump to the arbitrary node
- Automatic replay between the specific nodes, for example, from the beginning to the end of traversal

**4.1.4 Management:**

- Save and load as a packed single instruction unit
- Edit nodes such as pruning and merging
- Set bookmark to restore the learning progress
- Transferral of learning space to others
- Conversion to HTML

- Show and update the property list of nodes and links

As the learning space can now be treated as a manageable learning unit, it is more efficient for creation and control of the learning process. It is possible, moreover, to contrive new applications using the packaged learning space.

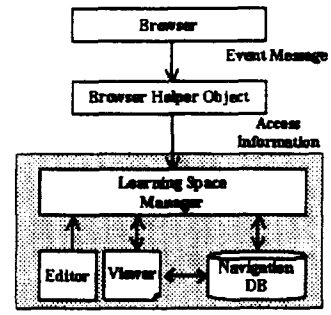
## 5. Implementation of HyperMap

In client/server systems, HyperMap can be implemented on either the client side or the server side. In case of server side implementation of HyperMap, the instructor can distribute the pre-defined learning space in a bundle. The server side implementation, however, has some problems in system overload and user interaction[14]. The client side implementation is presented in this paper.

### 5.1 System Architecture

Though a new navigator with HyperMap functions may be designed, an add-on approach that considers HyperMap as a helper for commonly used navigators such as Netscape or Internet Explorer is more practical. For the dynamic processing, the implemented HyperMap monitors browser actions continuously and updates the navigation database that stores the learning space, whereas HyperMap uses the editor to organize the static learning space for the instructor. The system architecture is shown in (Fig. 3).

In HyperMap, there are three key objects: Browser Helper Object (BHO), Learning Space Manager (LSM), and Navigation Database (NDB). The ordinary browsers have some facilities to communicate with other objects such as BHO[14]. The BHO captures the event messages occurring at the browser during navigation. The LSM analyzes the received event messages from BHO, updates NDB to accumulate a navigation history and performs the diverse functions described in the above.




(Fig. 3) System Architecture of HyperMap

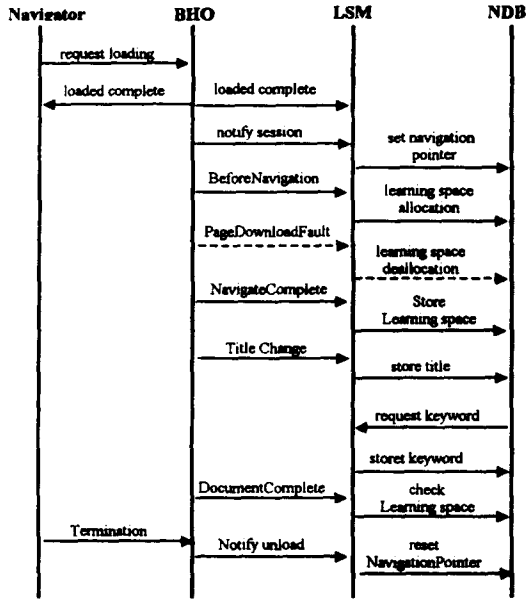
### 5.2 System Event Flow

The interface between a browser and HyperMap, BHO, sends the various types of event messages to LSM as shown in (Fig. 4). The viewer object controlled by LSM updates the display according to the information on NDB. In (Fig. 4), the main system events flow is shown for the case of Internet Explorer. The functionality of HyperMap can be easily implemented with object-oriented technology.

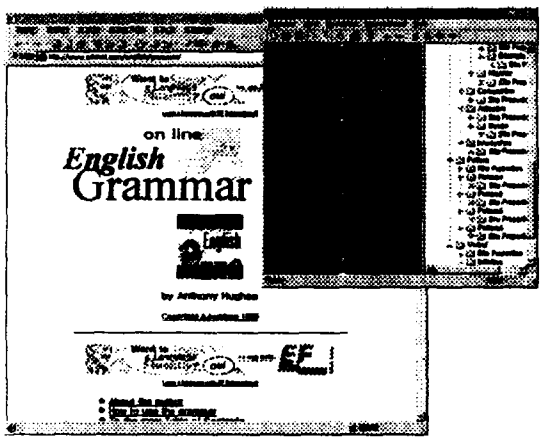
### 5.3 Application Example

The strength of HyperMap is that it provides a dynamic, manageable learning space and offers diverse navigational functions. A learning space organized by learner of English in a grammar class is shown in (Fig. 5). During the class session, learner constructed his or her own learning space for himself or herself, or in cooperation with other learners. A learner could exchange learning experiences acquired through navigation, and an instructor could observe the achievement of individual learners. The learning spaces of each learner were packaged as a database for the learner's portfolio. It was also found that HyperMap

could support collaboration between instructors and learners.




(Fig. 4) System Event Flow Diagram




(Fig. 5) Example of dynamic learning space

## 6. Conclusion

The Internet and the WWW are natural resources for education. WBI can realize the pedagogical instruction strategies for using the Internet and the WWW. Although WBI induces a more considerable synergy effect than traditional education, some argue the shortcomings of current hypermedia like learner disorientation, cognitive overload and manual construction of learning space. These problems, however, can be resolved with a supplementary tool that can organize the learning space to meet the instructor's or learner's own needs and offer effective navigation techniques. In this paper, a learning space management tool called HyperMap that can construct a static or dynamic learning space from the point of view of either the instructor or the learner and represent the learning space as a two-dimensional labeled graph with named nodes and links has been presented. The implemented HyperMap has a manifold management functionality for learning space in connection with ordinary Internet browsers, and the function packing learning space may be used for the exchange of learning experiences between learners and for the assessment of WBI instruction.

The user-friendly interface to enhance the usability and the intelligent agent to analyze the learner's activities in the learning space is very important for further research.

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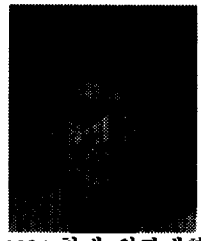

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