Aspects of a Modern WBT System

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Abstract - The paper offers a general view of Web-Based Training as a number of knowledge transfer processes utilizing advanced Internet technology to facilitate and speed the flow of knowledge to learners in a highly personalized, on-demand fashion. The key here is the use of both conventional and innovative tools compatible with current internet standards. The paper introduces an innovative application of internet technology to acquire, store, structure and transfer different types of human knowledge in a working environment. It starts with a number of typical training scenarios and shows that traditional WBT systems support only most rudimentary ones. We will demonstrate a number of concepts and tools necessary in the real training situations. Those tools are bringing together a number of disparate areas, encompassing more than what was traditionally considered simply "Web-based training". The following knowledge transfer processes are discussed: Web-based training, Web-based tutoring, Web-based mentoring, knowledge mining and knowledge profiling.

I. INTRODUCTION

It is our experience that many Web-based Training [1,4,7] systems do not take into account the latest advances in teaching paradigms – they simply reflect Internet technology. We have developed an application called WBT-Master. It is a set of tools that facilitates the flow of knowledge from experts/mentors to learners in a highly personalized, on-demand fashion. The key here is the use of both conventional and innovative tools compatible with the current Internet standards, to facilitate the flow of knowledge. As we shall see, WBT-Master brings together a number of disparate areas, certainly encompassing more than what was traditionally considered simply "training".

We believe that WBT-Master is not simply yet another Web-based Training system for delivery of online training materials [6]. It rather applies well-tested teaching paradigms to Internet situations enabling the acquisition, storing, structuring and transferring of human knowledge in working environments.
Generally speaking, WBT-Master tools work with so-called Corporate Memory. The Corporate Memory is made up of the knowledge that is found within the company. It includes huge collections of documents residing on the WBT-Master server, portals (i.e. references to information resources available from the Internet), on-the-fly material (i.e. annotations to documents, contributions to discussions, question-answer dialogues, etc.) as well as the personal knowledge of organizational members.

Since we consider training as a primary application area, all such knowledge elements are called Basic Training Resources. Basic Training Resources may be organized into composite structures, combining resources needed to accomplish a particular training task. These training resources when combined into a composite structure may be seen as a new training resource. In other words, training resources may be reused by inclusion into other collections. In this way training resources can be collected, managed, organized and made easily accessible to all members of the organization.

Corporate Memory may be seen as a combination of training resources and operations that are applicable to such training resources. The operations allow users to access and create new training resources, or to add an additional value to existing training resources.

To illustrate the concepts introduced above, a simple example might be helpful. A typical Web-Based Training (WBT) system utilizes HTML documents as learning resources [5]. Ordinary Internet hyperlinks (references) are used to create navigable data structures such as courses, chapters, books, etc [2,3]. Different WBT tools such as annotation, email, discussion forums, personal bookmarks

are used, as normal, to add additional value to the basic documents [4,7,8,11] However, WBT-Master can improve knowledge flow by introducing composite training resources such as reusable Learning Units, Learning Goals, Knowledge Cards, Mentoring Sessions, and Knowledge Domains.

In addition to specially prepared training materials, anything that is part of the enterprise knowledge, such as technical documents, presentations, or the personal experiences of employees can be used as learning resources via the Internet or Intranet. Note that the system essentially supports addressing human subject matter experts as learning resources. Since all information services operate with unified data structures, the result of any collaboration (discussion sessions, brainstorming sessions, annotations, question-answer dialogs, etc) can be seen as new training material and can be reused by others.

In addition to this WBT-Master also enables synchronous and asynchronous communication among distributed teams and team members. This includes discussion forums, brainstorming sessions, chats, annotation facilities etc. Communication tools such as these will, of course, support collaboration between different users.

In the following sections, several knowledge transfer processes are presented since they cover a part of the core elements of the WBT-Master methodology. The WBT-Master methodology represents a fundamental paradigm shift from the conventional "online course" model, in that it tries to capture the best elements of what works so well in classroom learning. It uses Internet technologies to transfer human knowledge in a much more general sense by incorporating Web-based tutoring, Web-based mentoring, knowledge mining and knowledge profiling. Thus, the methodology bridges the gap between the initial possessors of the knowledge (which often does not exist in an electronic form) to the ultimate ability of a learner to apply that knowledge in a practical situation. In this way it encompasses the entire Knowledge Life Cycle from authoring or capturing, through to integration and delivery, and finally to application of that knowledge.

II. WEB-BASED TRAINING

This process utilizes the classical “online course model” [4] and may be presented with the following typical situation: an experienced employee (i.e. tutor) is supposed to conduct training sessions on a regular basis. The tutor in collaboration with a courseware author develops a special Internet course and makes a special announcement on the WBT-Master server. Potential learners may access the announcement board and subscribe themselves for a particular training session. Before starting the training session the tutor defines a user group and user accounts for all members of the group. During the timeslot allocated for the training session, the learners work through the courseware material and communicate with the tutor and with other group members. Here we do not investigate this process in detail because it is a standard process in WBT systems. WBT-Master supports the process in a way similar to other modern WBT systems.

III. WEB-BASED TUTORING

Basically, Web-based tutoring repeats the situation of Web-based training. The principal difference is that after having analyzed the problem, the tutor cannot develop the courseware, but he has a number of heterogeneous documents (Textual files, WinWord files, PowerPoint Presentations, Simulations, etc.) that can be used for training sessions. The tutor uploads the documents to the WBT-Master server and defines a special training schedule prescribing which document should be accessed at each particular stage and what actions are expected from a learner working with the document. For example, learners may be requested to read a document, work through test questions, work with a simulation package, etc. During the time slot allocated for the training session, the learners work through the training schedule and communicate with the tutor and with other group members.

WBT-Master supports such training schedules through the concept of so-called Learning Goals. The Learning Goal may be seen as an alternative to a Leaning Course. The concept of Learning Courses in WBT has a very serious default precondition: learners are basically supposed to get knowledge from courseware that is available anytime and everywhere. Tutors simply monitor and assist the process of knowledge acquisition that is carried out via “mouse-clicking”, i.e. via browsing the courseware material. In the case where the tutor does not want to develop a learning course, but has a number of training resources that can be used to define a training schedule, WBT-Master provides a convenient tool to *prescribe* a set of so-called Learning Actions leading eventually to a designated Learning Goal without just pointing to a Learning Course.

This approach has a number of advantages in comparison with Learning Courses. First, a Learning Action is a much more interactive concept than just reading information chunks. A particular Learning Action may be: a reading session, communication with a tutor or another expert, passing a test, publishing a learner’s own material, solving a training problem, etc.

Another important aspect is that tutors can assess the Learning Actions carried out by learners during on-line sessions and, thus, communicate with the learners, track their activity and certify their results. Technically speaking, Learning Goals are defined by tutors in the form of structured collections of *Learning Actions*. Actions may be simple or complex. A complex Learning Action is a collection of other Learning Actions. A simple Learning Action is a request to carry out a particular action to move a user one step closer to the Learning Goal. A simple Learning Action is accompanied with a number of so-called

Learning Resources. A Learning Resource is a WBT-Master object, i.e. a course, document, learning unit, discussion forum, brainstorming session, etc.

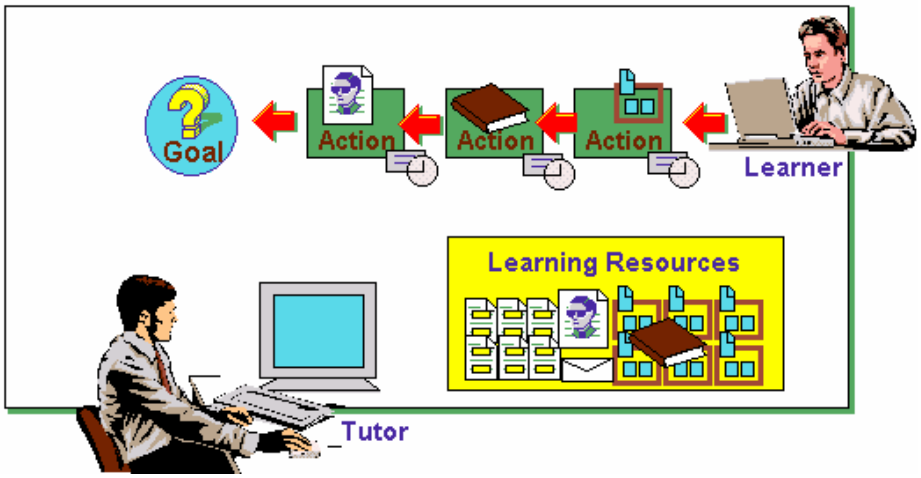

Figure 1: Authoring a Learning Goal

There may be the following simple Learning Actions (see Figure 2):

- ***Reading*** - a request to read (i.e. to access) one or more Learning Resources
- ***Questionnaire*** - a request to fill out one or more Test Questionnaires.
- ***Publication*** - a request to publish a document presenting the result of some work carried out by the student.
- ***Practical Work*** - a request to work with a real application.

Figure 2: Defining Learning Actions

Each Learning Action may have a particular time slot allocated to it that indicates when the action at issue has to be carried out. In other words, a Learning Goal may be described by a sequence of Learning Actions.

Each Learning Goal is defined by a *short name* (just one word without blank spaces) and by a *descriptive name* (a text defining the Learning Goal itself). A Learning Goal is created by the designated tutor for the users working with that particular goal. The tutor gets additional rights, for example, the tutor may see user statistics, comment on a particular user actions, subscribe users for the Learning Goal, etc. Each Learning Goal has one or more user groups associated with it. All members of such associated user groups are considered to be *subscribed* to the Learning Goal.

Learning Goals may be public, restricted or private. Any user may access a *public* Learning Goal and any registered user may subscribe to a public Learning Goal. *Restricted* and *private* Learning Goals are available only for *subscribed* users.

IV. Web-based Mentoring

Web Based Mentoring may be explained with the following typical situation. A learner (or learning group) needs to solve a particular problem and he/she has an ongoing partnership with a mentor. The mentor is supposed to help the less experienced students acquire new knowledge in a topic area. The mentor accesses the server to initiate a special one-to-many synchronous communicational session with the learners. In the rest of this paper, this kind of communication will be called a "mentoring session".

The mentor explains the problem solution by guiding the mentoring session. Thus, the mentor may:

- select a document which is automatically visualized on the learner's screen (share a document)
- provide an explanation (text, voice and/or drawings) attached to the document
- request the learner to perform an action which may be monitored from the mentor's screen.

Similarly, the learner may:

- provide comments (text, voice) to the shared document
- ask questions (text, voice) in the context of the shared document.

WBT-Master provide tools that support conducting of mentoring sessions online. Additionally, the mentor may record an online mentoring session in order to reuse it later as a learning resource. Thus, Mentoring Sessions may be seen as:

- a special form of synchronous communication (online mentoring sessions)
- a special method of structuring and presenting to users existing learning resources (recorded mentoring sessions).

An online mentoring session is carried out as a data exchange between a mentor's client (so-called, leading client) and a number of learners' clients (so-called, led clients). A recorded mentoring session is prepared by means of a mentor's client and can be viewed anytime by means of a learner's client. The main idea is that the leading client is provided with a number of special tools to control the data displayed by the led clients to learners. Thus, a mentor initiates a mentoring session and defines restrictions for learners to join the session. Selected learners are automatically notified about the session and can join it (i.e. can activate their led clients). The mentor is informed about learners joining the session. The mentor selects and browses learning resources by means of the leading client. The leading client may be seen as a monitor controlling other WBT-Master tools and sharing the resource with led clients. The leading client simply passes the selected resource to the led screens.

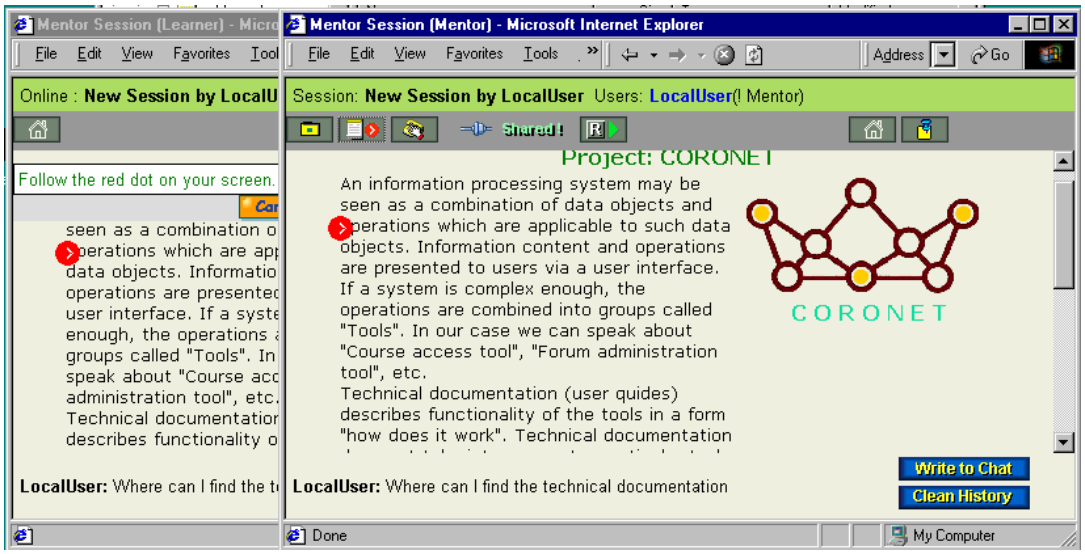

Figure 3: Running a mentoring session

Additionally, the mentor can attach an explanation (text, voice and/or live pointer) to such a shared resource. The explanations can take form of a chat session or a special transparent layer on the leading screen where pointer and texts may be put on top of a current picture. The explanatory layer is also automatically displayed on the led screens.

The leading client also can accept data from led clients. Thus, the mentor can request learners to perform an action (say, to write a short article), and they can then monitor the process from the leading client.

Learners are allowed to provide comments to a shared resource by means of special chat facilities. The same mechanism can be used to ask questions in the context of a shared resource.

V. KNOWLEDGE MINING

A typical situation involving the process of the knowledge mining may be as follows. A Learner needs training in a particular subject to acquire additional knowledge, and is aware that the WBT-Master server contains relevant information. The learner accesses the server to find most relevant material. They work through the material and communicate with subject experts as well as other learners working on similar materials.

Finding relevant learning resources in a WBT environment containing very many objects of different types (i.e. many courses, learning units, forums, learning goals, etc.) may constitute a serious problem. A search function often does not help because it analyses the document content as opposed to the knowledge that can be acquired from the

learning resource. Moreover, accessing learning materials should also take into consideration a preferable learning style, preferable tutor, available certification facilities, etc.

WBT-Master provides an alternative way of accessing preferred learning resources based on so-called Knowledge Cards (see Figure 4). The idea behind this concept is rather simple: Knowledge Cards allow the definition of a conceptual view of the server in the form of a collection of knowledge cards. A *Knowledge Card* is a description of particular concept (i.e. *semantic entity*). For example, a semantic entity "Database technology" may be seen as a knowledge card. In WBT-Master, knowledge cards may be combined into a *semantic network* [9,10] using just one type of relationship: "is a part of". Inverse relationships may be called "consists of". For example, the knowledge card "Relational Data Model" may be related as "is a part of" to the knowledge card "Database Technology".

Thus, a knowledge card associated with some particular concept (e.g. "Database Technology") contains information on learning resources for this concept and can be related to other knowledge cards using the semantic relationship "is-a-part-of". The semantic relationships essentially define a graph structure (as opposed to just a hierarchical one). For example, the same knowledge card "Relational Data Model" may be defined as a part of "Introduction to Oracle", "Information Systems", etc. Moreover, there may be Knowledge Cards defining areas of personal interest: say "Personal Knowledge of H. Maurer" which may also refer to the previously mentioned card "Relational Data Model", etc. To be more concrete, each Knowledge Card may provide access to a number of associated Learning Resources. For example, a Learning Course "Relational Data Model" may be associated with the Knowledge Card "Relational Data Model". In addition, some other Learning Units, Learning Goals, Discussion Forums, Documents, etc. may be associated with the same Knowledge Card. Moreover, WBT-Master consider users to be Learning Resources (so called "Peer Helpers") as well. Thus, Peer Helpers may also be associated with a Knowledge Card.

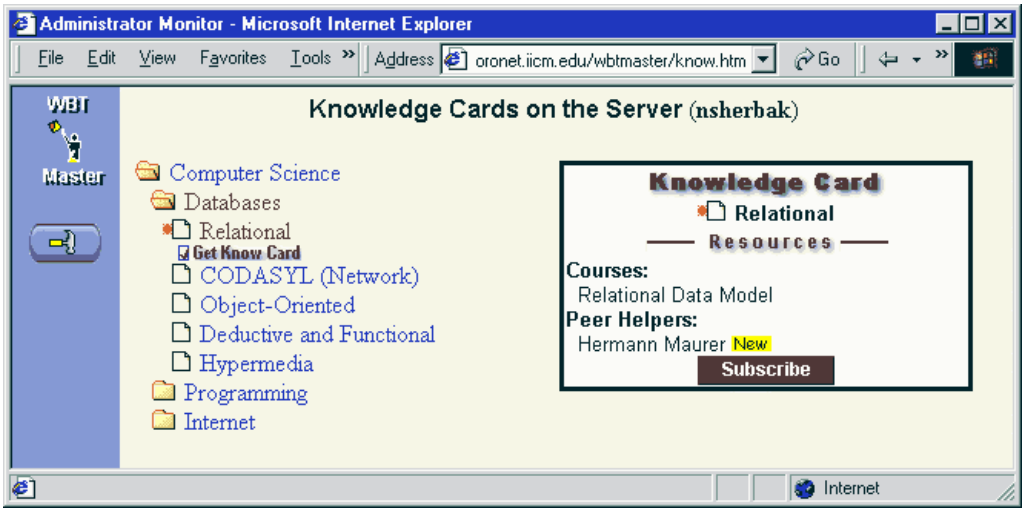

Figure 4: Resources attached to a Knowledge Card

Whenever a content provider contributes to the server with new material, he/she is supposed to associate it with one or more Knowledge Cards or create a new Knowledge card and place it into a proper position within the semantic network. Of course, a specially designated member of the server administration team (Knowledge engineer) may also do it.

Instead of browsing through countless learning resources new users are supposed, in the simplest case, to browse the semantic net consisting of previously defined Knowledge Cards (see Figure 4).

We should especially mention the most important property of the semantic network - the possibility of inferring Learning Resources using semantic relationships. Whenever a user accesses a knowledge card, the system infers all Learning Resources that are associated with this particular Knowledge Card and with the Knowledge Cards related to this one. Thus, for example, suppose that there were no resources associated with the knowledge card "Computer Science", but a number of other cards (say, Databases, Programming, etc.) were defined as "is a part of" Computer Science. Accessing the "Computer Science" knowledge card will result in the resources inferred from other related cards.

The situation discussed above, leads us to a number of very important conclusions:

- Content providers do not need to search for a precise "knowledge card" to associate their resources with. They can simply define their own field of interest (say, "Personal Knowledge of H. Maurer" and associate all their resources with this card automatically). Other users may decide that "Personal Knowledge of H. Maurer" is an important contribution to the "Hypermedia" concept, and create a relationship between these two knowledge cards. Of course,

"Personal Knowledge of H. Maurer" may be further structured as a number of knowledge cards (say, "Maurer & Theory", "Maurer & Hypermedia", etc.) that are related "as a part of" to "Personal Knowledge of H. Maurer".

- Learners do not need to browse the whole semantic net. They might be interested in defining a personal knowledge card related to the most important previously defined concepts of interest. In this case, whenever a user accesses such a personal knowledge card all relevant resources will be inferred automatically.

A personal knowledge card may serve as a "customized" entry point to the server resources. The server may also automatically notify the learner about new resources that might be of interest.

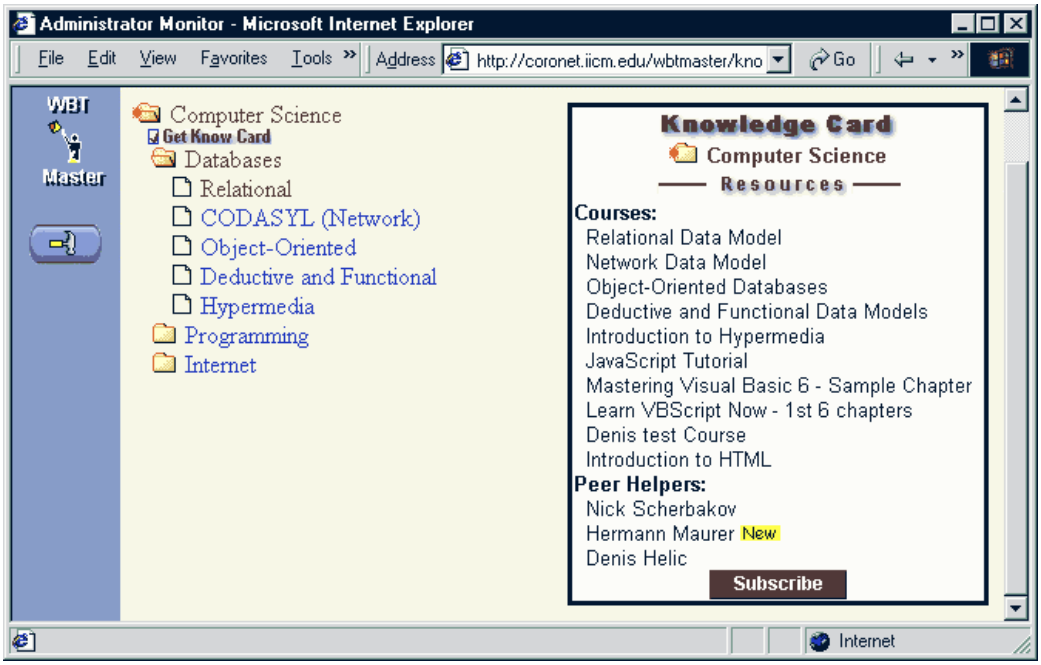

Figure 5: Resources automatically inferred for a Knowledge Card

VI. KNOWLEDGE PROFILING

The process of knowledge profiling may be explained through the following typical situation. Suppose a company needs to install knowledge profiles for each of its employment positions. The process may be seen as defining a position and providing descriptions of the knowledge components required for this position. Moreover, the knowledge components may be further associated with training resources which provide such knowledge. On joining the company an employee will need to be initiated into the practices and procedures of the organization. This will probably be achieved by them taking part in Web-based training sessions. So, they must be able see what knowledge is needed (i.e. they should be able to browse the position profile) and automatically access the training resources.

WBT-Master supports such knowledge profiling of learning resources in the form of Knowledge Domains. Each Knowledge Domain is a set of documents belonging to a number of predefined semantic categories. For the previously discussed example, we could speak about three semantic categories: Position, Resource and Know Component. For instance, we can also say that a document "Project Manager" (describing this position within the company) is an instance of the category "Position", a training course "Sub-contract management process" is an instance of the category "Resource" and a document "Sub-contracting" is an instance of the category "Know Component". Speaking in general terms, we can say that each semantic category is linked to a set of Learning Resources that are called instances of the category.

A *knowledge domain schema* may be seen as a definition of all categories and all possible semantic relationships between them.

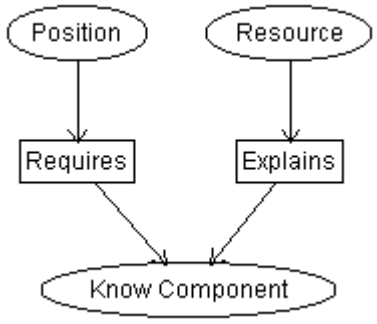

Figure 6: Schema of a Knowledge Domain

The definition of a Semantic Category includes the definition of a number of attributes, which are properties of instances of the Semantic Category. An attribute is a standard key-value pair. The value of an attribute is defined to be of a specified type, i.e., a value may be a string, a number or a selection from a list of possible values. For example, the category "Position" may have two associated attributes: name (string) and department (string). Similarly, the category "Know Component" may have just one associated attribute – name of the component.

The knowledge domain schema defines common properties of all the category instances. Any resource may be inserted (stored) into a particular knowledge domain as an instance of a predefined category. Thus, a responsible author simply selects an existing Knowledge Domain and a predefined category for a new resource and the system guides the author through the process of defining attributes and necessary relationships. For example, if a new instance of the category "Know Component" is created, the system automatically requests the selection of a name (an attribute predefined for the category). It also provides references to the resource where that "Know Component" is described and a certain position within the company (relationships predefined for the category). This, of course, facilitates the creation of well-structured repositories.

The concept of well-structured Knowledge Domains facilitates also browsing and searching the resources reused as instances of semantic categories. Thus, for example, whenever a user access the document "Sub-contract", the system automatically provides information on attributes attached to this document, references to instances of other knowledge categories which are related to this one, next/prior navigational tools, etc.

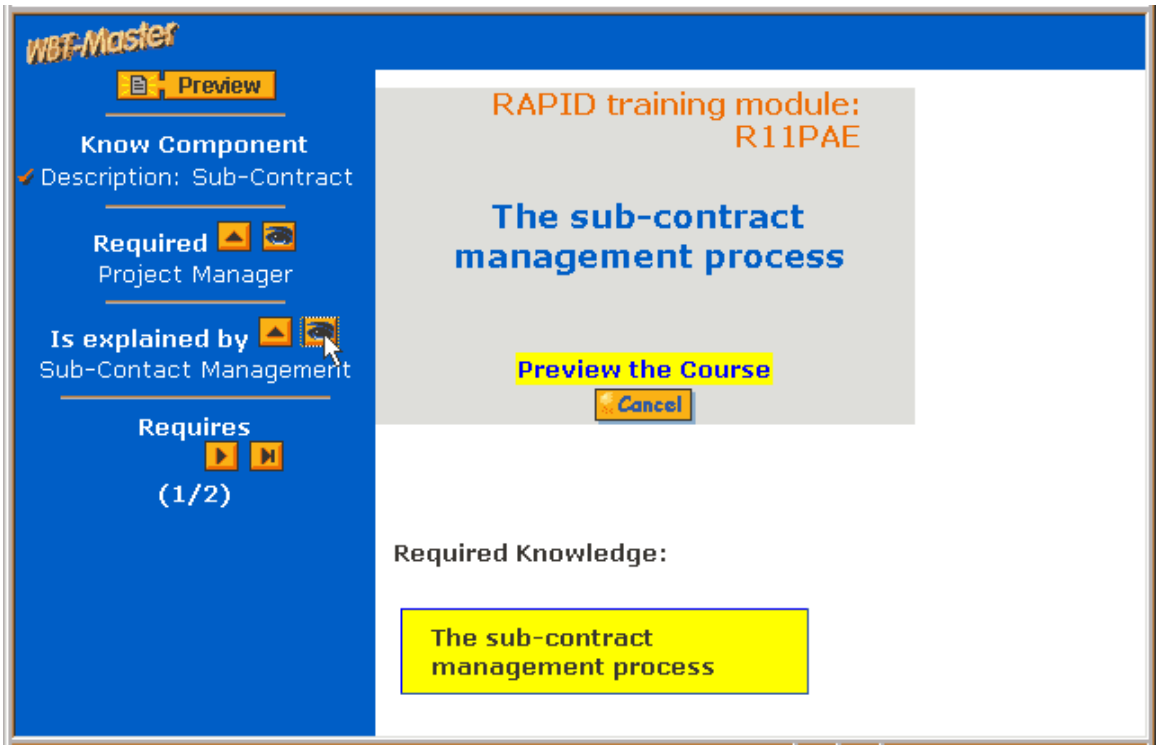

Figure 7: Browsing a Knowledge Domain

VII. Conclusion

In summary, the following features of the WBT-Master distinguish it from other existing WBT systems:

- In addition to existing data structures based on hypermedia links, it introduces such new innovative composite training resources as reusable Learning Units, Learning Goals, Knowledge Cards, Mentoring Sessions, Knowledge Domains and more.
- WBT-Master enables synchronous and asynchronous communication among distributed teams and team members. This includes discussion forums, brain storming sessions, chats, annotation facilities etc. The variety of communicational tools supports collaboration between different users working together.
- In addition to especially prepared training materials, anything that is part of the stored enterprise knowledge, such as e.g. technical documents, presentations, or the personal experiences of employees can be used as learning resources via the Internet or Intranet. Note that the system essentially supports addressing human subject matter experts as learning resources.
- Since all information services operate with unified data structures, results of any collaboration (discussion sessions, brainstorming sessions, annotations, question-answer dialogs, etc) can be seen as new training material and can be reused by others
- The WBT-Master methodology represents a fundamental shift from a classical "online course" model of a standard WBT system. Usually, the

standard WBT system reflects Internet technology providing access to courseware "anytime anywhere". On the contrary, WBT-Master tries to use Internet technologies to capture the best elements of what works so well in a classic classroom training. This methodology provides possibilities to transfer human knowledge in a much more general sense by incorporating the knowledge transfer processes such as Web-based tutoring, Web-based mentoring, knowledge mining and knowledge profiling.

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