DESIGNING LEARNING ACTIVITIES FROM LEARNING OBJECTS

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Abstract

Learning objects have been proposed as an approach to creating and sharing learning resources. There are further advantages to be gained if the objects can be reused. This paper emphasizes the creation of learning environments from reusable learning objects. It suggests that reuse can be simplified by a learning object classification, which can be used to semantically construct learning activities. The paper suggests three major object classes for this purpose. These are environment, subject and learning method objects. The paper then describes how web-based learning spaces can be composed from these object classes. An illustration is given using teaching about technology as an example.

Keywords

Portals, Knowledge Management, Learning Objects, Customization

Introduction

Learning communities are now beginning to take many forms. There are the conventional classroom situations that still predominate, but increasingly we are beginning to see new forms such as work based and just-in-time learning, distance learning, and virtual universities. Web based technologies are increasingly used to support learning in such environments. Early work in this area has illustrated the potential advantages of web-based support. Wade and Power (1998) for example outlined a number of requirements for computer supported learning systems and described alternate technologies for supporting learning activities. Neal (1997) has carried out work on their use in distance teaching emphasizing the delivery of materials. It is however fair to say that much of this early research has been in specific settings and supported limited activities. The field is now beginning to recognize the need to develop reusable materials that can be used in different learning contexts. Three questions appear important in solving this problem. These are:

- How to package materials so that it can be used in different contexts and learning strategies?
- What granularity of packaged material is needed to allow material to adapt to different contexts and learning strategies? and
- What technology or implementation environment is needed to deliver the materials?

Learning objects have been proposed in answer to the first question. The goal here is to share learning objects across the InterNet. Standards are now being developed for learning objects. Perhaps the two most quoted standards are the Dublin core metadata initiative (http://www.dublincore.org) and the IEEE Learning Technology Standards (http://ltsc.ieee.org). These emphasize the definition of a metadata structure that can be used to describe any learning objects. These standards are very general and describe objects in terms of the standard elements that can be shared across the WWW. They do not suggest any classification schemes to make design easier. Other proposed standards are the Netherlands Open University and the Canadian Cancore Learning Resource Metadata Application Profile (http://www.cancore.org).

Some writers have found the need to classify learning objects to simplify design. Fisher (2001) suggests the need to define object classes and metadata to describe their combination. This includes separation of subject metadata and learning metadata as well as metadata to describe the construction of questions from subject metadata. Douglas (2001) suggests object oriented approaches to design also suggesting the need for a classification scheme to improve reuse. Two kinds of reuse are also possible. One is the reuse of learning objects as a whole, which is suggested by most standards. The other is to have finer objects that can be used to construct new learning activities. As an example, should a learning object be a book or a chapter. If the latter we can customize a book for a course. Similarly should an object be a whole subject or individual groups of lectures, so that we can customize subjects.

This paper emphasizes the second class of reuse and defines an object classification to provide a meaningful way to construct learning activities. It proposes that learning activities be constructed from three object classes – subject metadata, learning method and environment. The paper proposes Nonaka's knowledge creation process (1994) as the underlying theory for defining learning methods. Nonaka's activities include socialization, developing an understanding of concepts, articulation of ideas, followed by artifact construction and evaluation. The paper then describes a system, called LiveNet, which can be used to customize such learning models, is also described.

This paper proposes a way to classify learning objects to provide a semantic basis for combining them into learning activities. It concentrates on logical definition of learning activities followed by mappings to an implementation given a technical environment. Different implementations are possible for the same learning activity.

Developing a Classification Scheme

In this paper we categorize learning objects into a number of classes. One class learning objects is explicit information as illustrated in Figure 1. Here information is gradually focused through appropriate subject classification schemes on a particular learning objective and then used to create the learning object. The learning object is often a collection of artifacts that satisfy a particular keyword set but is presented in a way suitable for learning. There is however more to learning than accessing selected explicit knowledge. Learning must take place in an environment that enables learners to apply explicit knowledge to reach some goal.

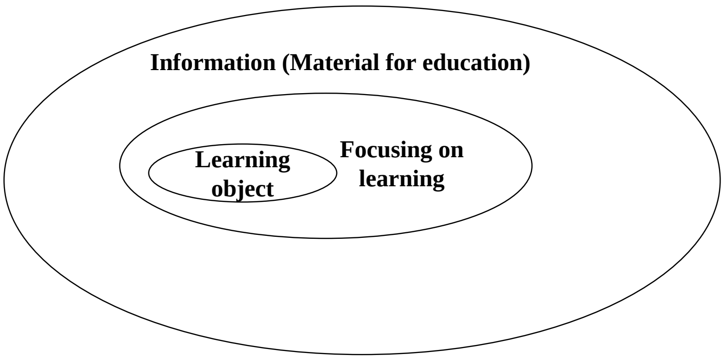

Figure 1 – From information to learning object

Our proposal is to construct learning environments from the object classes shown in Figure 2. Figure 1 is one of these classes – the subject class. Here the subject metadata describes the material that is to be taught. This sets a framework for discovery and is usually implemented as links within the subject metadata structure. Thus teaching for example about databases may place it within the context of businesses or applications. The second class of object class is the environment, which is made up of the learning goal and support services. The learning goal defines what is to be achieved. Thus in a University the goal may define assessment procedures whereas in a project environment the emphasis is on project goals. The learning method is another object class that defines what learners actually do. The learning activity defines the methods to be used to achieve the goal. The methods will use any support services provided by the environment. Hence the semantics of building systems follow the idea "Use the goal to select metadata of subject material and define the learning activities that define the methods to be followed in leaning about the subject to reach the context goal."

This classification differs from the structure proposed by Fisher (2001), who includes subject metadata and learning metadata but includes a metadata definition for generating test questions. Koper (2000) on the other hand defines units of study composed from subject and learning models. The context in both of these is thus limited to questions about subject matter. We thus differ in specifically requiring an environment, especially the learning goal, to be included in the system.

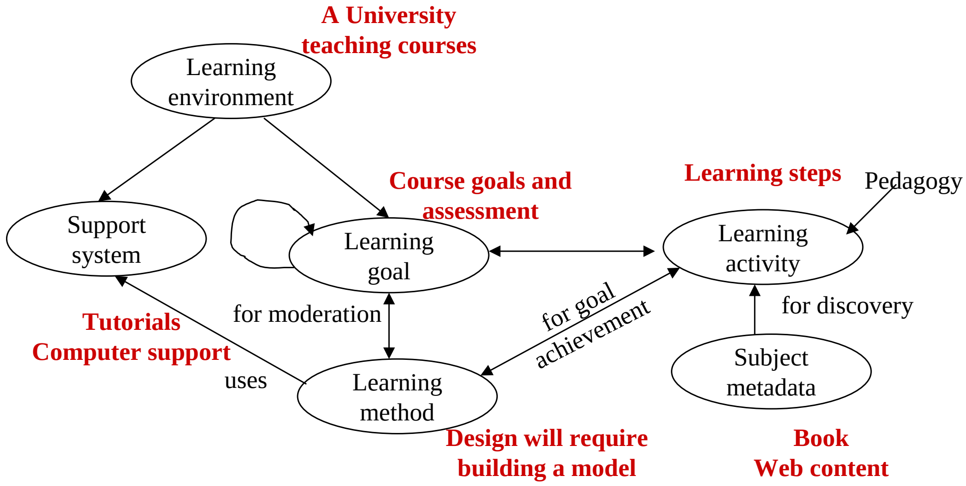

Figure 2 – Objects classes

It should be noted here that a learning goal can require more that one learning activity. Thus a University subject assessment scheme can require many activities as can a project task. Learning activities can themselves be composed of smaller activities. Similarly contexts can be gradually narrowed into smaller contexts. The paper now explains the three classes of object in more detail.

An example of a subject metadata structure

As an example the paper describes the metadata used as an example here – teaching information technology to business students. It emphasizes what is commonly known as e-business (Kalakota, 2000) and also includes a design methodology.

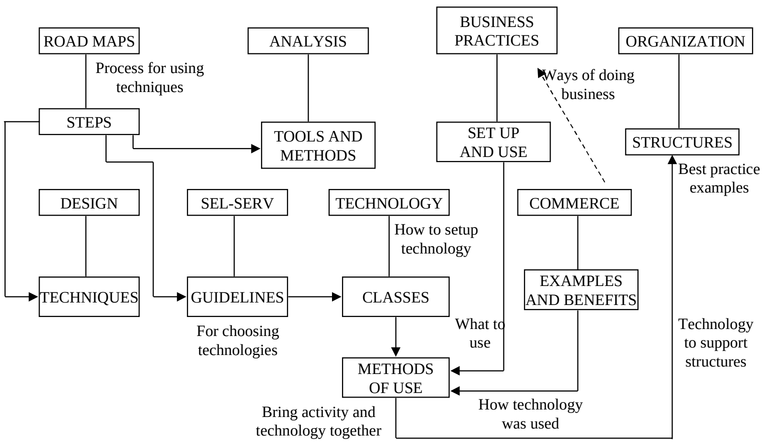

Figure 3 – Structuring the Knowledge

The metadata structure is illustrated in Figure 3. It divides knowledge into seven categories:

- Business practices used in electronic commerce including customer relationship management, supply chains and so on,
- Analysis to describe ways to analyze new systems and define requirements,
- Design approaches that define the steps needed to design new systems,
- Commercial applications,

- Technologies used in electronic commerce,
- Business services and how to select technologies to provide them, and
- Organizational relationships needed within electronic commerce.

The metadata also contains relationships between these categories to facilitate knowledge discovery. A learner can begin at one concept and then follow links to related concepts. Thus it is possible to start with a business practice and then follow links to technology to see what technology can be used to support the practice. The same objects can be used in different learning activities and contexts.

Apart from the ontology of concepts the body of knowledge also includes exercises and solutions, exams, case studies and other study material. It can include previous experiences and suggested actions in a business process step. It can also include guidelines for filling in forms and check-lists for deciding on actions.

Defining the environment

The environment itself is composed of objects and there is the possibility of generilizing contexts for different kinds of enterprises. The objects may be different depending on the enterprise. In a University they may be subjects, whereas in a business enterprise they may be project tasks.

Defining the learning method

The third class of object are learning method objects. To indicate what is meant by learning method object in this paper, we identify number of generic learning goals here called Type A, Type B and Type C for convenience. Each of these may require different learning methods. These are:

- Type A - Understanding technologies and their application, which is primarily the teaching about the capabilities of different technologies. This primarily requires application of socialization for explanations and elaborations about subject material through discussion and exercises,
- Type B – Articulation on the use of technologies in business contexts by developing topic reports that make hypothesis about how technologies can be used to realize business goals. It primarily involves interpretation of the way technologies can be used and framing them (Boland and Tenkasi, 1995) in ways that facilitate interpretation in terms of business objectives and submitting them as topic reports, and
- Type C Learning to use groupware technology, which primarily requires a case study that leads to the construction and evaluation of a small system.

Our goal is to ensure that we include a complete set of learning methods to support learning activities that realize these goals. To do this we use Nonaka as the underlying theory to provide guidelines for learning objects.

Some Underlying Theories For Learning

Learning stresses the importance of interaction within a community. This in turn requires ways to describe communities and governance structures within them. It also requires ways to describe the learning process itself. To do this we draw on the ideas of communities of practice and from the work of Nonaka (1994).

Learning Communities

It is now general for most e-learning standards to define roles and their responsibilities in teaching activities For example, the IEEE Learning Standards Committee defines a variety of roles for this purpose, especially learners and coaches with different interaction styles for different learning environments. These can be expanded to include tutors or assistants that work together with the teacher. In more elaborate environments, there can be owners, experts, novices or apprentices as well as a variety of users. Communities of practice can also include a variety of experts such as subject specialists to discover, classify and distribute knowledge. In business environments, they can also be people responsible for specific business process steps. These roles can be allocated responsibilities and provided with appropriate services to carry out these responsibilities. Thus the responsibility of the owners may be to create and update the body of knowledge. They can also give permissions to users to access the portals. Our description of communities is based in a collaborative metamodel (Hawryszkiewycz, 2002), which predominantly specifies activities in terms of roles with workspaces with given responsibilities for actions and artifacts.

Nonaka’s Knowledge Creation Process

Our approach is to develop a framework for learning process objects using the work of Nonaka (1994) as underlying theory. Nonaka sees knowledge sharing and creation following the process shown in Figure 4. These identify the kind of activities that are fundamental to knowledge management.

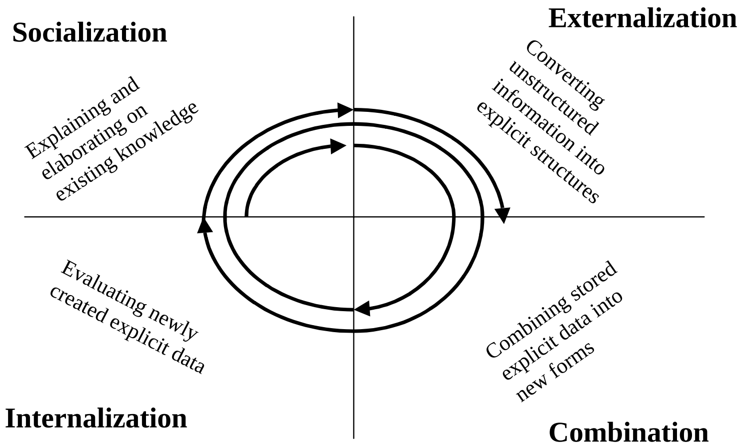

Figure 4 – Nonaka’s knowledge creation process

Nonaka’s process includes four phases together with their associated environments. These are:

- socialization to bring people together and share their experiences and insights in an area. For example, this may be a description of subject material in lectures and in informal ways to exchange experiences, develop trust, share values, particularly applicable in Type A activities,
- externalization, is where some of this captured expertise is framed and interpreted into a form that can lead to further actions. For example, tacit knowledge about subject material is externalized through examples and experiments. This requires articulation on ideas using agreed upon terminologies to externalize them to familiar contexts, usually assignments. The emphasis is on dialoguing, sharing of mental models, articulation of concepts, development of common terms and requires ways to visualize interactions, construct artifacts, particularly applicable in Type B and C activities,
- Combination is where ideas generated in externalization are compared to earlier outcomes, as for example previous assignment solutions, to relate newly created artefacts to previous stored ones,
- The ideas are then combined where necessary with existing information and then applied in practice during internalization in completing assignments followed by reflection on the outcomes after assessment.

Any outcomes of any actions evaluated in further socialization and the cycle is repeated. Our goal is to provide such generic services as reusable objects and provide ways to customise them to particular application needs.

Creating Learning Activities

We now describe how learning activities can be created using the various classes of objects. The ideas of Nonaka give a guideline on what is needed in a learning space. The most important paradigm here is that learning takes place in a space that allow a variety of interactions as well as the ability to reflect on outcomes. For our example, we need to define a different space for each of the three goals described earlier and yet integrate these spaces within the same context.

Objects needed to create the learning space

The spaces for learning activities are created from a combination of learning objects Figure 5 illustrates this combination. It also shows the two main requirements of customization, namely:

- Providing ways to combine the standard subject and the environment and thus relate learning to the context goal, and choosing the activities suitable for the subject and pedagogy.

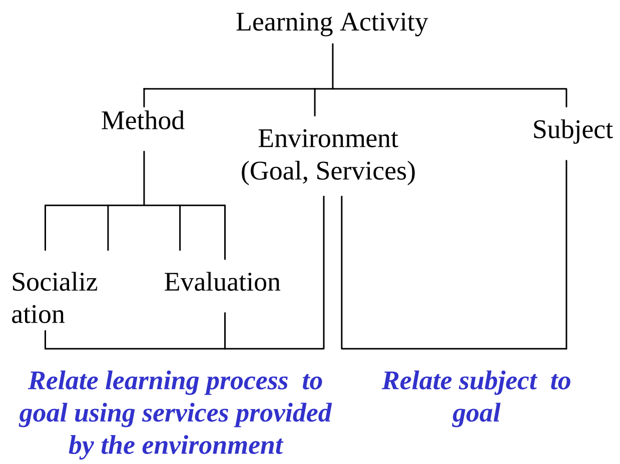

Figure 5 – Object Classification

Components in the learning space

The next question is what should be available in a space. The abstract object structure proposed for learning is illustrated in Figure 6. It combines Nonaka's framework and contains components that support the aspects of Nonaka's process. These for example, are stories, discussions for socialization, and experiments and assessments for learning within the environment context. The explicit knowledge is predominantly derived from standard learning objects.

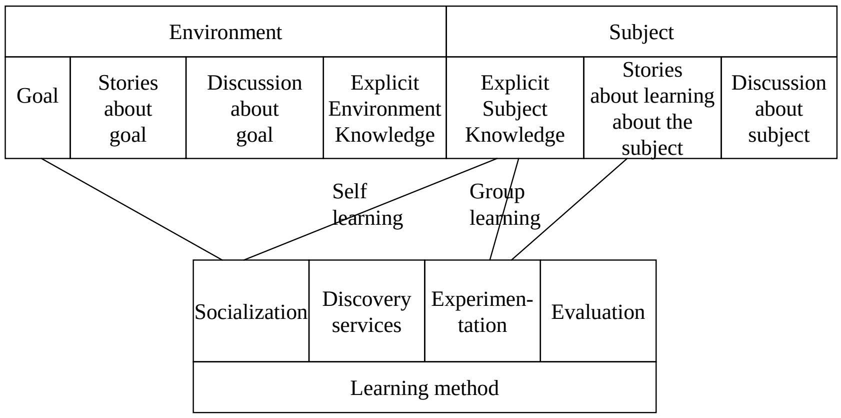

Figure 6 – Generic Structure

There is of course the explicit knowledge to describe the environment goal and the subject matter. Stories in the diagram predominantly result from the capture of tacit knowledge. A variety of services are then provided to support learning. Hiltz and Turoff (2002) describe the importance of providing services that match the learning environment.

Creating the Learning Space

Given the object classification, the following steps needed to build the learning space:

- Identify the environment goal,
- Select the subject matter from the subject metadata,
- Select the context and develop links to the subject matter,
- Specify the pedagogy in terms of learning activities to be followed.

- Specify the method to be used in each learning activity,
- Select the environment services t support the method.

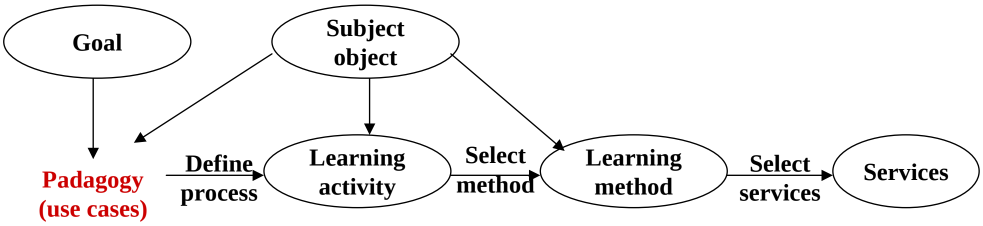

Figure 7 – The Design Process

The paper now illustrates these steps using a technical implementation.

Technology

Figure 6 indicates the kind of services that must be provided in learning spaces. The environment includes technologies that provide a variety of generic services to support the construction of learning objects and support a chosen pedagogy. Some choices here are described by Benbunan-Fich (2002), who discusses the general options of supporting synchronous or asynchronous work. These technical choices include discussion, chatboxes, terminology builders and so on. The technical infrastructure must contain generic functions that can be easily combined to provide these services. Such generic structures include:

- the community governance structures through its roles,
- supports interaction through discussions,
- provides ways to manage explicit documents, and
- supports group formation for joint study.

Combining the services

The basic components are now used to create a variety of learning services. Many contemporary technologies often simply automate existing processes but do not provide frameworks for defining learning activities that support the discovery and contextual services implied by learning objects. Technology in this case should provide a way to select object structures and place them in context. A number of reference models have been proposed for technical implementations. We use the model shown in Figure 8, which is closely related to Koper’s model. Here there are three classes of service namely:

- Creation of subject metadata that is often left to subject matter experts,
- Creation of learning spaces, or what is termed publishing, and
- Delivery, which can include the evolution of the workspaces as learning evolves.

Each set of services supports different roles. Here the subject metadata is developed by experts, and is published as learning activities by teachers who are free to choose their own pedagogy. It is then delivered to students who can in change the learning activity. The amount of change permitted can depend on the activity. Thus considerably more change will be allowed for case study groups than to activities that concentrate on presentation of material.

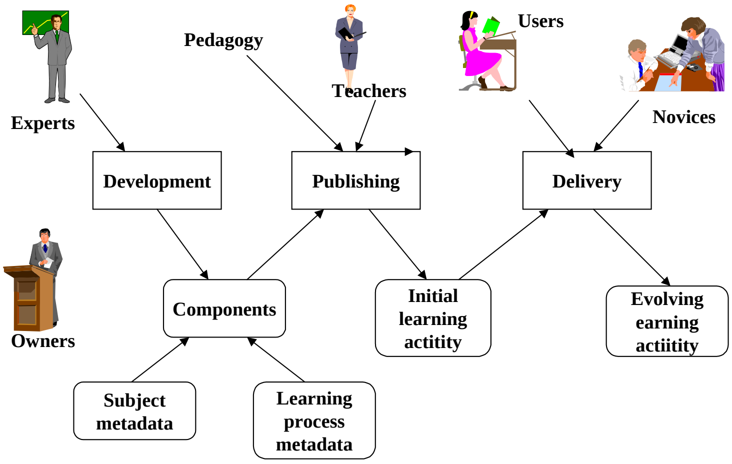

Figure 8 – The portal approach

An Example System

Currently we have been using a system, LiveNet, for this purpose. The approach is to emphasize collaboration through an entry interface that emphasizes collaboration while providing access to the body of knowledge. Figure 9 illustrates the basic structure of this interface.

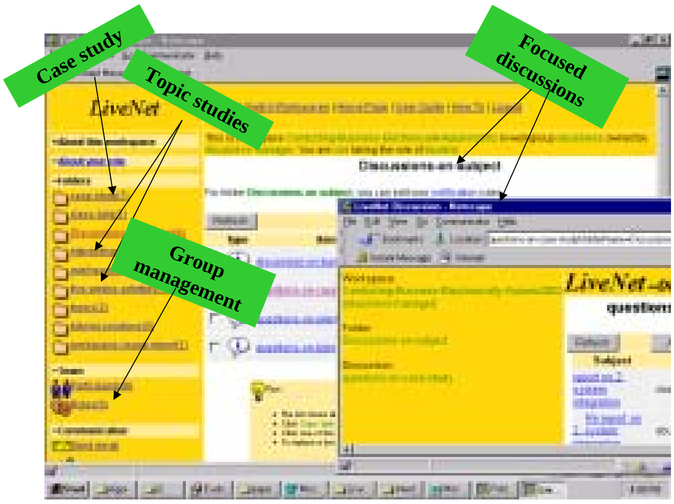

Figure 9 - A LiveNet collaborative services interface

Our mapping here is for a workspace like that shown in Figure 9 to present a learning environment with individual activities defined by folders that contain both subject matter as well as interaction support. Roles can be given responsibilities to both change the workspace and the folder. Other folders lead to different topics for in-depth topic studies. Discussion is also focused on individual learning activities. Students can also create their own spaces for the case study activities in Figure 4. The workspace also provides awareness and notification features to alert members to events important to them as needed in emergent processes. Some details can be found in Hawryszkiewycz (2000).

The interface shows all the information in the subject. It also provides different roles with different views. Thus for example there is a folder named 'information-to-tutors' can only be seen by tutors thus reducing the need for meetings and saving peoples time.

Accessing Subject Metadata

The body of knowledge is accessed through a knowledge map. Knowledge maps show the concepts and relationships between them and can be accessed from any system. Thus they can be accessed from a community space like that in Figure 9. Figure 10 is a simple knowledge map used in this system and useful for Type A situations. It is a linear list of terms, each of which leads to a concept screen that describes the concept and a self-assessment screen.

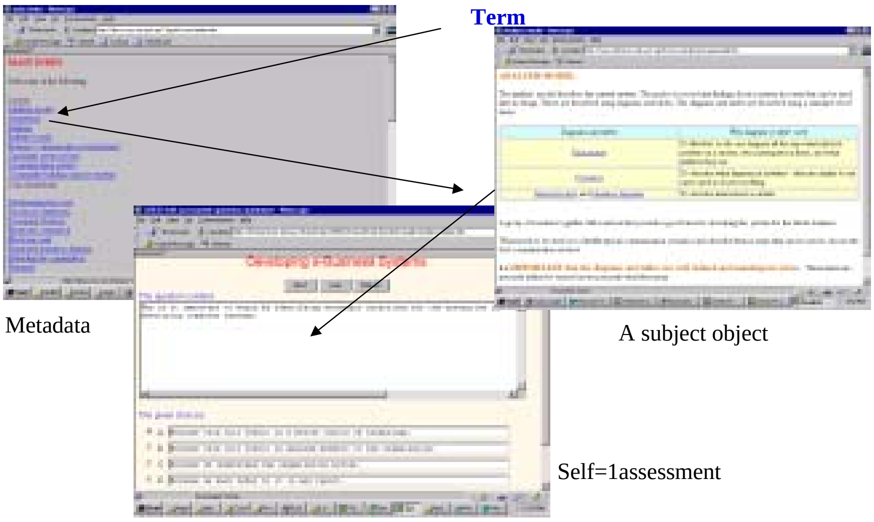

Figure 10 – Using the subject metadata

On selecting a concept or process step the user is presented with a description and can then follow up with some self-learning services. With concepts that refer to process steps, they can add to the concept by recording their experiences and interpretation of step guidelines. It is of course possible at any time to post a question for further explanation by experts within the community. These can be followed up with questions and discussions for further interpretation.

Introduction Into Teaching

One of our goals has been to use the technology in ways where it easily diffuses into the process and ensure that use of technology does not become dominant and detract from the learning process. For this reason the computer technology was introduced in a gradual way to improve diffusion for the different learning activities. Following the ideas of Salmon (2000) we first set up community pages where students accessed information needed in Type A activities to familiarize students with the technology. The next step was to introduce the design process. Students are organized into groups to discuss design alternatives and make design choices that dominate Type C activities. Correspondingly students create a project space where such alternatives can be considered and final decisions posted. Finally there is the prototype development where students choose technology to implement the design. In the case study students were given a number of milestones to aim for, starting with analysis, through design specification to setting up a prototype LiveNet system. Generally, these were successful in the sense that students understood the basic LiveNet interface and functionality and workspace description and set up prototypes with little effort. The social effect of this is to require students to pace their work according to the process rather, as is often the case, leaving it to the last minute. This has an obvious learning benefit although it is perceived as a nuisance by some students in that it requires them to follow a process.

Summary

The paper described ways of using the ideas of learning objects to create learning activities. These centered on creating spaces where learning takes place through the gradual construction of a body of knowledge. Three classes of objects were identified to provide a semantic basis for creating learning activities. The paper described the structure of such portals and illustrated this with an example.

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