Supporting Integrated Learning Processes

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Abstract

The paper describes the learning process and ways to support it. The support goes beyond supporting specific functions but considers the learning process as composed of a number of integrated activities. It uses Nonaka's knowledge creation process as underlying theory for defining the learning process. A number of learning activities are identified using this theory. The paper then identifies differences in support needed for each activity distinguishing between learning to understand concepts and learning to design systems. To do this requires different interfaces working from the same knowledge repository. The paper considers both social and technical issues and suggests knowledge portals that can be used to maintain a body of knowledge and provide services both to owners to continually update the knowledge base and learners to use it. The paper describes one example of a knowledge portal and its application in teaching.

Introduction

Learning communities are now beginning to take many forms. There are the conventional classroom situations, but increasingly we are beginning to see new forms such as work based learning, distance learning, and just-in-time learning in business processes. Increasingly web based technologies are being used to support these learning environments. The question is how to use web based technologies in ways that deliver higher quality outcomes at lower cost. 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. Most of such earlier research concentrates on particular activities in selected domains and does not integrate them into a learning process.

This paper looks beyond simply automating existing individual process activities, such as distributing materials, collecting submissions, or using some specialized learning tool in a particular problem domain. On the other hand the paper defines the learning process itself and then looks at the services needed to support the activities in this process (Shank, 1998) in an integrated way. Its goal is to define the services that can be combined in flexible ways to support different learning environments in ways that improve learning with some economic advantage. To do this requires both a definition of the learning process and integration of its activities.

The paper defines the learning process using Nonaka's (1994) model as underlying theory. It then outlines the activities needed to support this process and the technologies needed to support the activities. It concentrates on asynchronous learning networks (Hiltz and Turoff, 2002) and the technologies needed to make them effective. Technologies proposed here are workspaces and knowledge portals. Portals should go beyond supporting selected activities but be more broadbased and support a body of knowledge that can evolve and provide services that can be used in flexible ways by learners. These services should allow experts to construct the knowledge map using subject ontologies (Maedche and Staab, 2001) for a subject domain and services for learners to use that body of knowledge.

Flexibility requires changes in social practices to use the knowledge portals, especially in

forming moderated communities and sharing in the development of a knowledge base. A prototype system, called LiveNet, is used as an example of such a portal. The services provided by this portal for teaching are given.

Underlying Theory

Our approach is to develop a framework for describing the learning process uses the work of Nonaka (1994) as underlying theory. Nonaka sees knowledge sharing and creation follows the process shown in Figure 1.

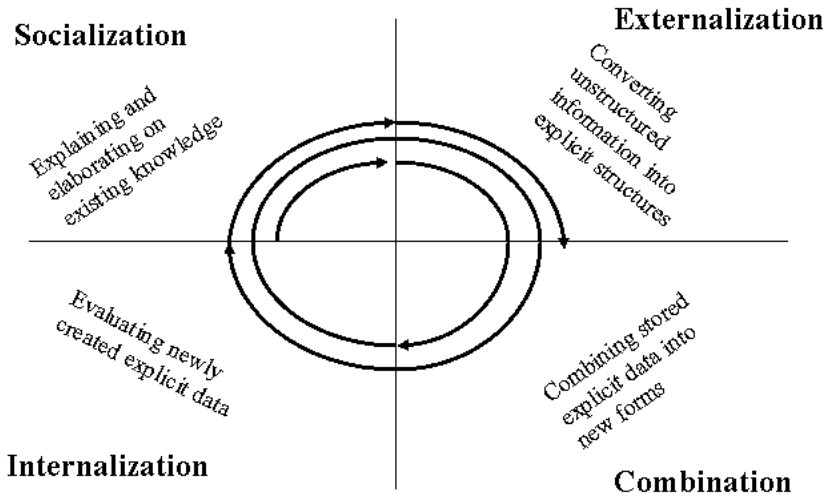

Figure 1 – Nonaka's knowledge creation process

Nonaka's process includes four phases. The first phase is socialization where people bring together their experiences and share insights in an area. This can result in new relationships or introduction to new concepts and ideas that can be followed through in later steps. The next step, externalization, is where some of this captured expertise is interpreted within given contexts to develop a better understanding of concepts and their application. The discussions now become more focused with specific issues being addressed and new ideas generated. The ideas are then combined where necessary with existing information to make use of previous experience. During internalization the knowledge developed is then used to carry out actions such as creating new artifacts. Any outcomes of any actions evaluated in further socialization and the cycle is repeated. Nonaka goes further and defines the environments under which knowledge sharing can effectively take place. He suggests that knowledge is only meaningful within a context and its environment. The context defines the relevance of what is discussed and provides the basis for any interpretations. Nonaka defines four different kinds of environments to match his process. These are:

Socializing - requires easy ways to exchange experiences, develop trust, share values
Dialoging - sharing of mental models, articulation of concepts, development of common terms. Usually consciously constructed.
Systemising – requires ways to visualize interactions, constructing artifacts, combine explicit knowledge.
Exercising - communicate artifacts and embody in working context. Reflect on outcomes.

Learning activities defined in terms of Nonaka's process

The learning process in this paper uses Nonaka's process as underlying theory. This learning process is shown in Figure 2. The process is made up of four learning activities, which are described in detail in Table 1. Table 1 also describes the relationship of learning activities to Nonaka's process and implications on agent activities. The agent in these activities is usually the teacher, but there are other possibilities such as tutors or electronic feedback, especially where learning about concepts. They can also be software agents. The goal is to improve processes by reducing agent costs or support them with better tools.

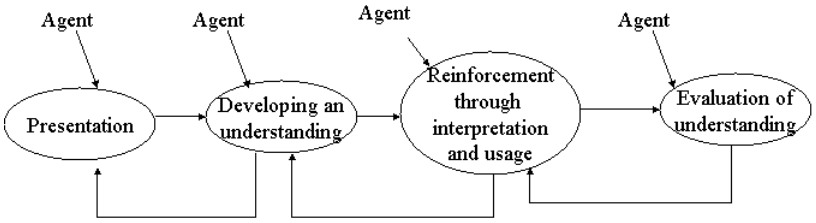

Figure 2 - Activities in the Learning Process

Learning Activity	Relationship to Nonaka's model	Environmental Requirements	Implications for Computer Support
Presentation	Socialization and presentation of important concepts	Easy ways to exchange experiences, which can be readily implemented with potential cost reductions. Distribution of materials.	Access to presentations or explanations. Can be done using the WWW. Requires ways of presentation that clearly identify important issues. Use of discussion databases for socialization.
Developing an Understanding of Concepts	Externalization through looking at examples and trying things out.	Sharing of mental models, articulation of concepts, development of common terms.	Requires interaction through feedback from experts and reinforcement through discussion or other feedback from agents.
Reinforcement	Continued interpretation with experimentation. Trying things out.	Reinforcement though interpretation and usage visualizing interactions,	Extension of the above with easy access to previous examples and

	Seeing how things work. Comparing with explicit forms and previous work.	constructing artifacts, combine explicit knowledge. Interact for evaluation	their interpretation in the current situation.
Exercising	Internalization by getting evaluations of experiments	Get feedback on outcomes	Better ways to eval;uate outcomes

Table 1 - Learning in Nonaka's terms

Combining medium and process

The way learning proceeds through this process requires different interaction and media at different learning activities. These are often determined by two other dimensions, shown in Figure 3. One is whether support is to be based on codification or personalization. In codification the emphasis is on storing knowledge in explicit form and providing the tools for learners to learn primarily through interaction with the codified knowledge base. In personalization there is more emphasis on personal interaction. The simplest example is that of delivery of materials. With codification there is emphasis on overheads, animation and on-line experimentation. In personalization the emphasis is on face-to-face lectures. Usually codification uses asynchronous and less costly methods, whereas personalization requires synchronous communication.

The other dimension is the teaching method used. The simplest difference is between a learner studying concepts and learning how to carry out design such as for example constructing artifacts. The difference between these two methods is illustrated in Figure 3. The emphasis on the former is on getting explanations and testing their own understanding the concepts. The emphasis on the latter is often through continuous trial and error and learning often takes through group interaction. Thus here students learn design guidelines, how to use them to respond to different situations.

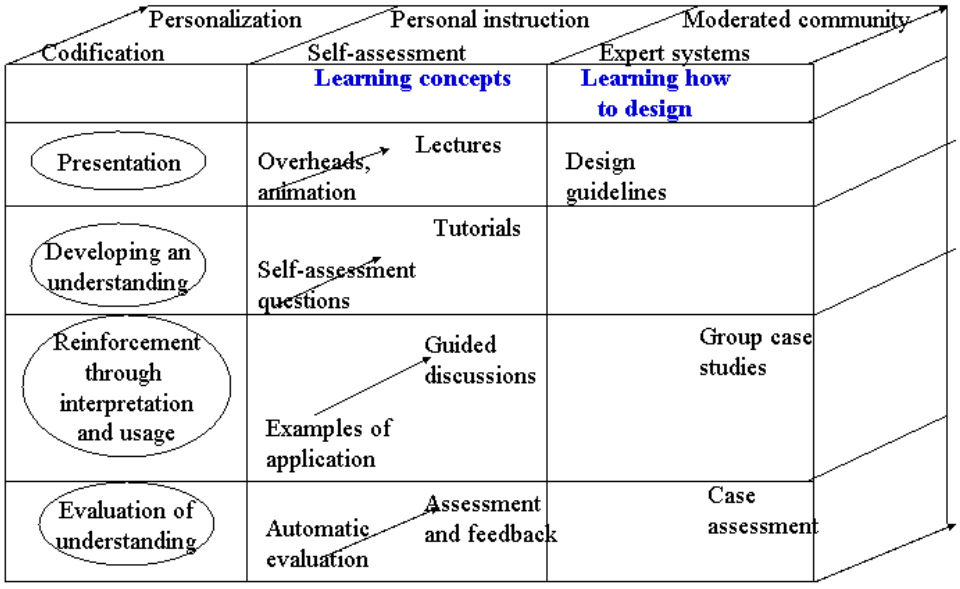

Figure 3 – Media Selection

Implication for computer support

Our goal is to provide portals to support a variety of interaction styles and cover the entire space of Figure 3, providing the necessary process support as well as the media to use at each activity while integrating them in a seamless way through the same portal interface. Thus learners should be able, for example, to move from a design process to reinforce their understanding of a concept and then move back to design through the same interface. There are a number of implications of such computer support. The most fundamental is the ability for learners to select the activities and use interfaces that present the right medium given the activity goal but working off the same knowledge base. Thus individual learning of concepts requires interfaces that usually evaluate responses to stimulate learning. Learning ways to carry out designs is usually group based allowing the learner to develop frames of reference often in consultation with teachers in moderated communities.

Learning about technology in electronic business

An example of a subject that uses both approaches is the introduction of technology in its application to electronic business. The way that the subject is taught is illustrated in Figure 4. First there is the learning of process and design concepts and ways to describe what business processes. Then various technologies are described. The concept learning takes place as individuals whereas in the design process students are organized into groups to discuss design alternatives and make design choices. Technology use evolves to support this approach. Initially access concentrates on getting information and socializing. Then a project space is created for each group where alternatives can be considered and design documents maintained. Finally there is the prototype development where students choose technology to implement the design.

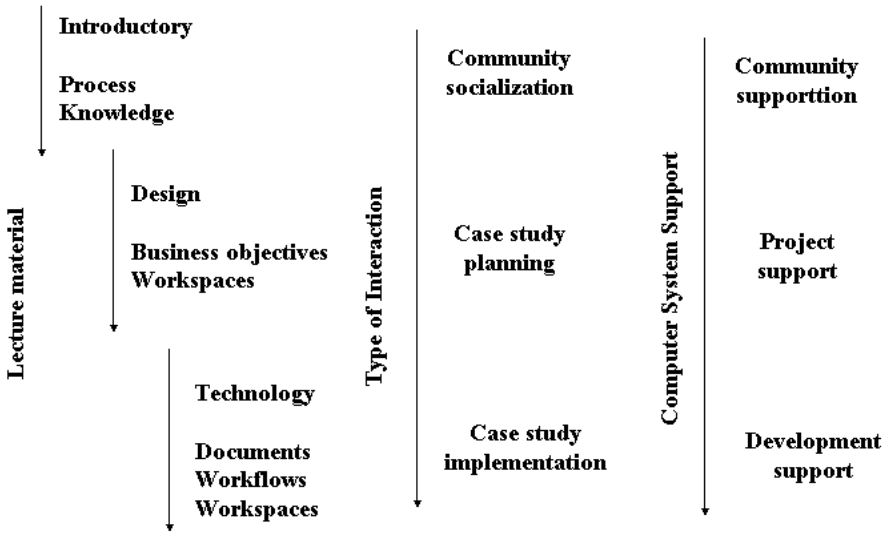

Figure 4 – The learning Process

Portals for Learning

The goal of a portal is to provide the services needed to support all the activities shown in Figure 3 and integrate them in a seamless way. The paper proposes that this be done through a knowledge portal. The portal structure proposed here is illustrated in Figure 5. It is described in three parts. These are the community of practice, the body of knowledge and the services provided to the community of practice. As shown in Figure 5 these bodies of knowledge are maintained collaboratively by a number of teachers. Services are provided

to learners. This gets away from the traditional way where individuals create material independently and present it as needed. What we are now looking is a collaborative group of knowledge workers, who may be a group of consultants or groups of academics, developing a body of knowledge often known as a knowledge center.

The community of practice

The community of practice can include a variety of roles. In most learning environments there are simply teachers and learners. 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. We also propose that there can be some advantage in teachers forming centers that develop bodies of knowledge that may be packaged in different ways for different courses. These can also include external experts for evaluating adding to the body of knowledge.

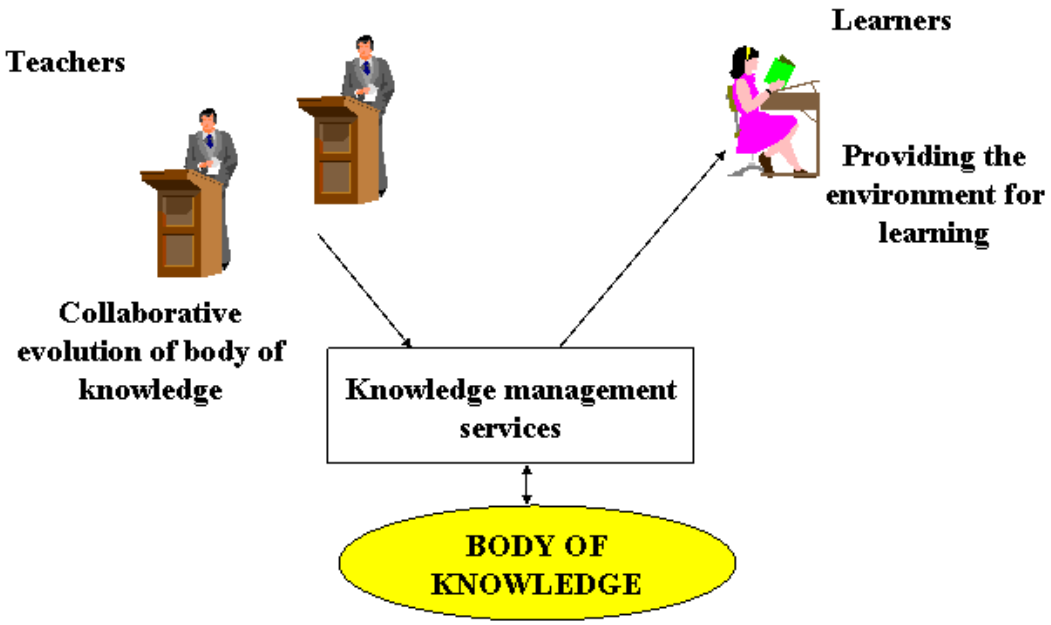

Figure 5 - The knowledge portal

Body of Knowledge

The body of knowledge depends on a subject domain. It is usually implemented as a metamodel of concepts and associated road maps that describe design processes. An example ontology is shown in Figure 6 for e-business. The ontology groups concepts by technology, commerce, organizational structure and business practice and provides links between them. There are road maps that describe design processes and these are linked to design concepts, grouped by analysis, design and service selection. Apart from the ontology of concepts the body of knowledge also includes exercises and solutions, exams, case studies and other study material.

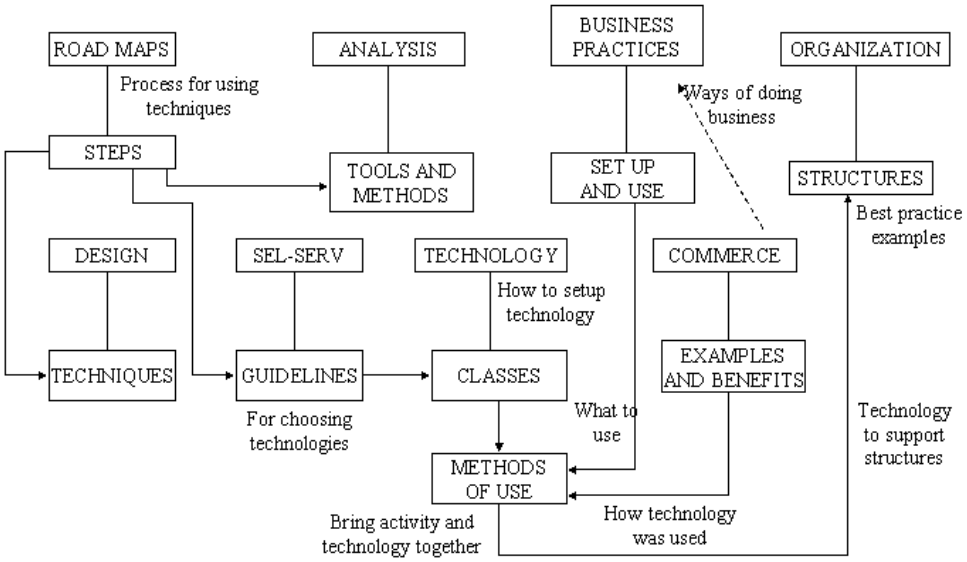

Figure 6 – Structuring the Knowledge

The concepts are usually entered into a knowledge map that serves as an initial entry point for learners. The relationships between the concepts can then guide students through a study pattern (Fischer, 2001). Thus some students can start with a commerce application or business practices, see what it does and then follow through to technologies useful for the application. Others may start with the technology and follow it through to potential applications.

One interesting question here is whether such bodies of knowledge should be developed by the individual teachers as happens in most tertiary institutions. Teaching method and even material change when the teacher changes. Currently most subjects change once a teacher changes with knowledge often lost in the changeover. Knowledge management requires more structured processes for knowledge development as those now found in a number of industrial organizations (Hansen, et.al. 1999). Experience in industry has shown more effective ways through management of knowledge centers with precise roles established for carrying out the variety of activities connected with knowledge sharing. The goal then is to have a group developing the knowledge while individuals or learning groups access the knowledge in a moderated way.

The services

Figure 7 shows a more detailed structure of the services to be provided by the portal. It includes services to maintain a knowledge map that is the prime point of access to the body of knowledge. The knowledge map itself can include terms to support learning concepts as well as guidelines for design processes when learning about design. The body of knowledge includes facts as well as processes and suggestions how to carry them out. It includes ways for owners to refine the body of knowledge.

Figure 7 also includes feedback from learners to refine the body of knowledge. Such feedback can be either codified as for example through discussion databases or personalized through face to face interaction. During such feedback messages are received about experiences in self-learning. These can be analyzed and sorted and used to refine the

body of knowledge. Such refinements can include adding experiences, refining processes or adding to explanations and suggestions made to users. At the same time feedback on processes can include experiences and suggestions at each process steps and ways of improving activities at each step. These can be either ways to solve some problem, or steps in the business process.

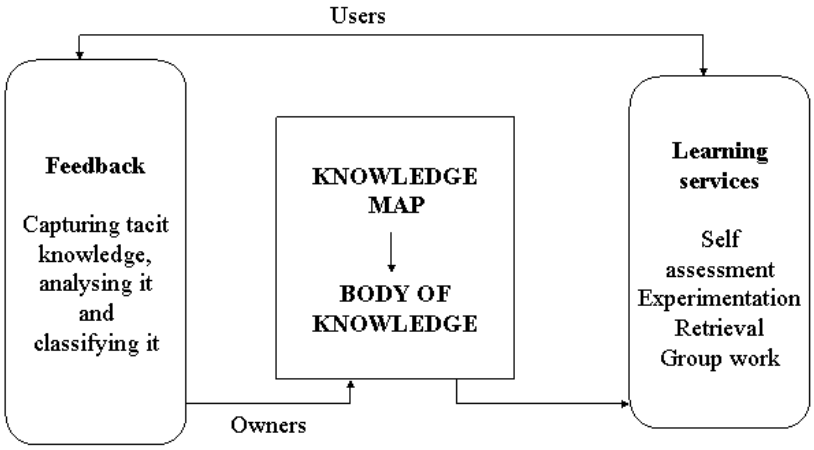

Figure 7– Managing the Body of Knowledge

The portal structure shown in Figure 7 includes support for evolving the body of knowledge. The feedback is provided by users and constantly analyzed to improve the structure of the body of knowledge. The feedback currently is through discussion databases that need to be analyzed to identify significant issues.

An Example Portal

Wade and Power (1998) identified interfaces as one of the important criteria for adoption of computer supported learning. Our approach has been to emphasize the idea of place that provides a community view and supports a selection of services. Currently we have been using a system, LiveNet, for this purpose. This provides an architecture that supports the development of a variety of interfaces each to match the different learning activity.

The community interface

The community interface, which is shown in Figure 8, is the first interface encountered by a user. It is customized to learning within the context of a subject and provides the learner with information of current activities, important issues, deadlines as well as the ability to communicate through messages or discussion databases. It also provides:

? the community governance structures through its roles. This allows community members with different roles to have different interfaces and permissions,
? supports interaction through discussions,
? provides access to the body of knowledge through overheads as well as an ontology,
? contain any number of explicit documents,
? provides a flexible folder structure to focus on specific learning goals, and
? allows students to form their own private groups for work on case studies that encourage

learning in groups.

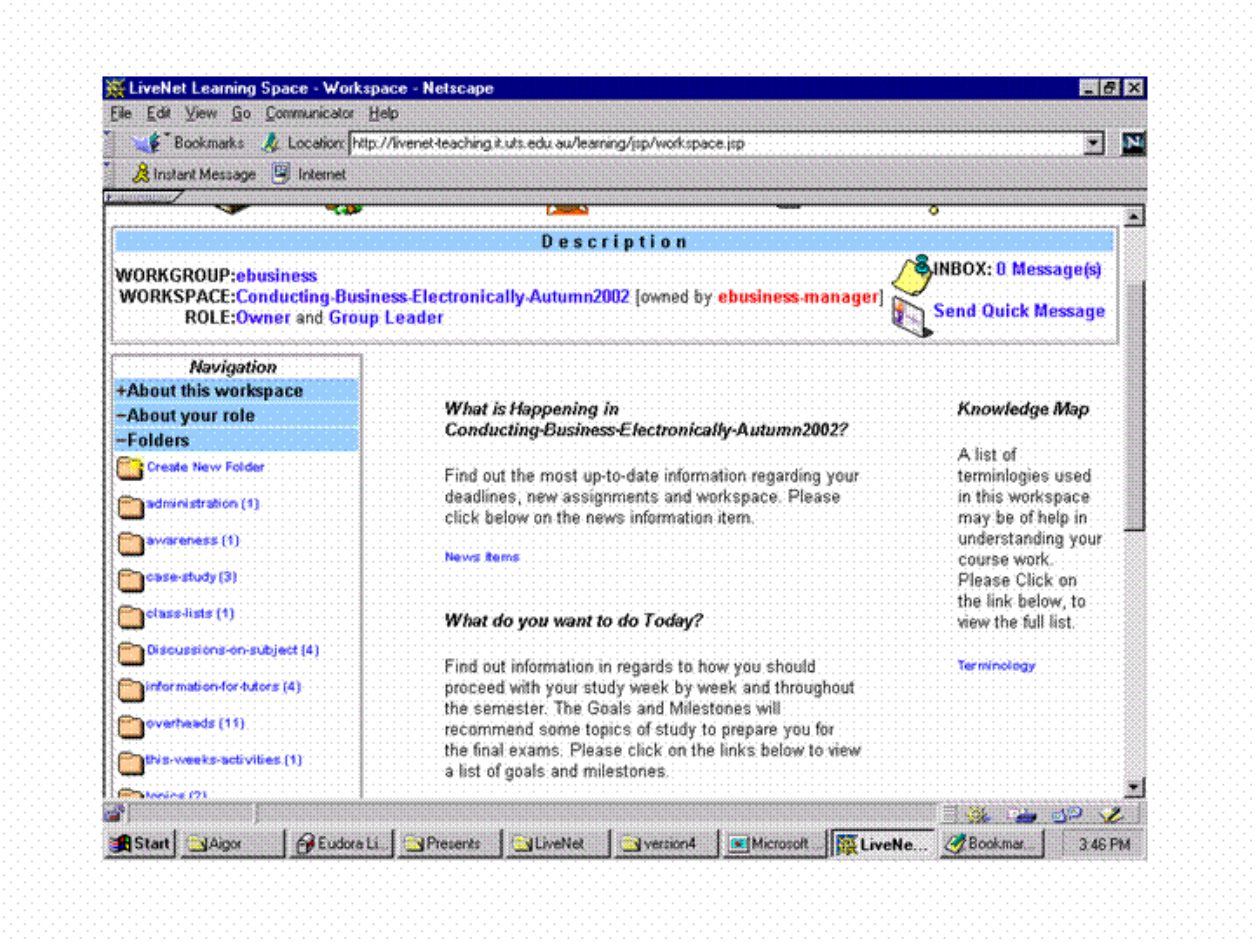

Figure 8 - Community Interface

The group interface

This particularly concerns learning through group interaction and supports case study work through generalized interfaces like that shown in Figure 9. The students form groups electronically using the LiveNet system and then create a project repository and use it for their case study. They can engage in private discussions and interact with tutors should they desire to do so. The case study is to define requirements for a collaborative system and implement it using LiveNet. The groups develop solutions to a case study that is submitted to tutors or lecturers in their project workspace. LiveNet provides the ability to customize places for case study support. Students can enhance this workspace by copying references from the community workspace to create a personalized interface for themselves.

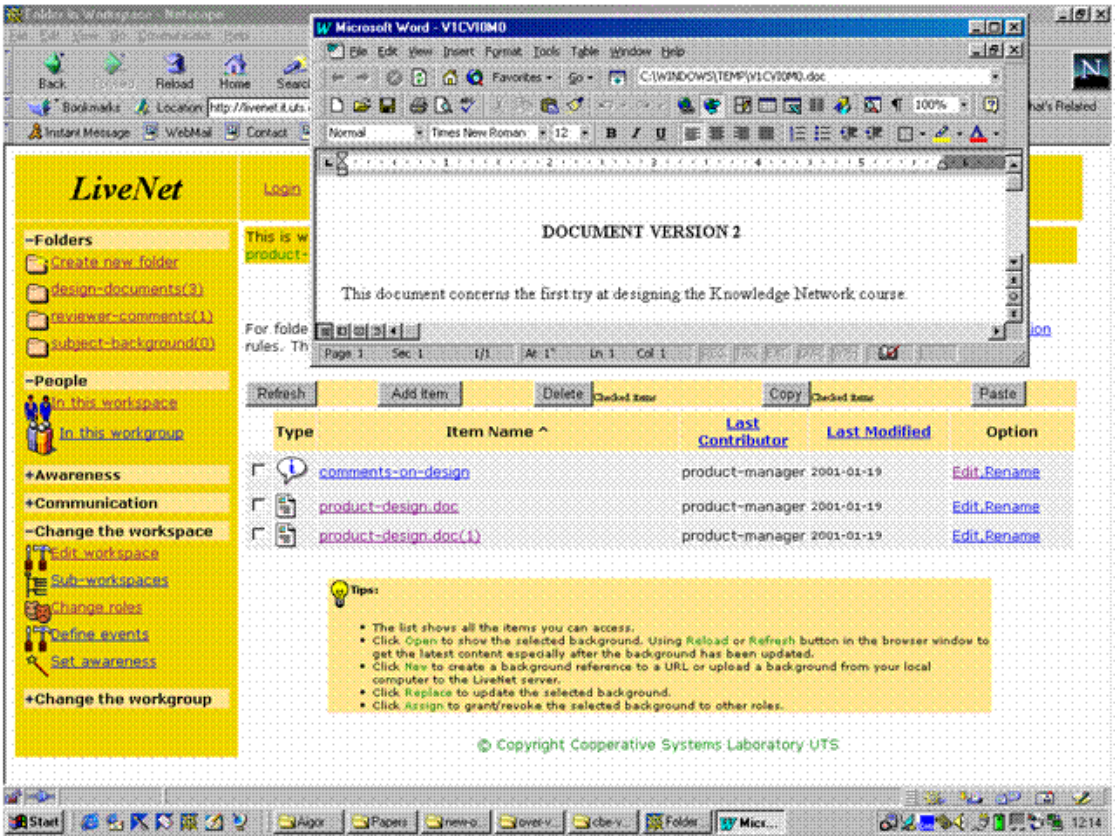

Figure 9 – A LiveNet collaborative services workspace

The Knowledge Map

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 8 or specific items can be linked to specific business process steps. Figure 10 is a simple knowledge map used in this system. It is a linear list of terms, each of which leads to a concept screen that describes the concept and a self-assessment screen. Concept screens provide links to related concepts thus allowing the learner to navigate the map.

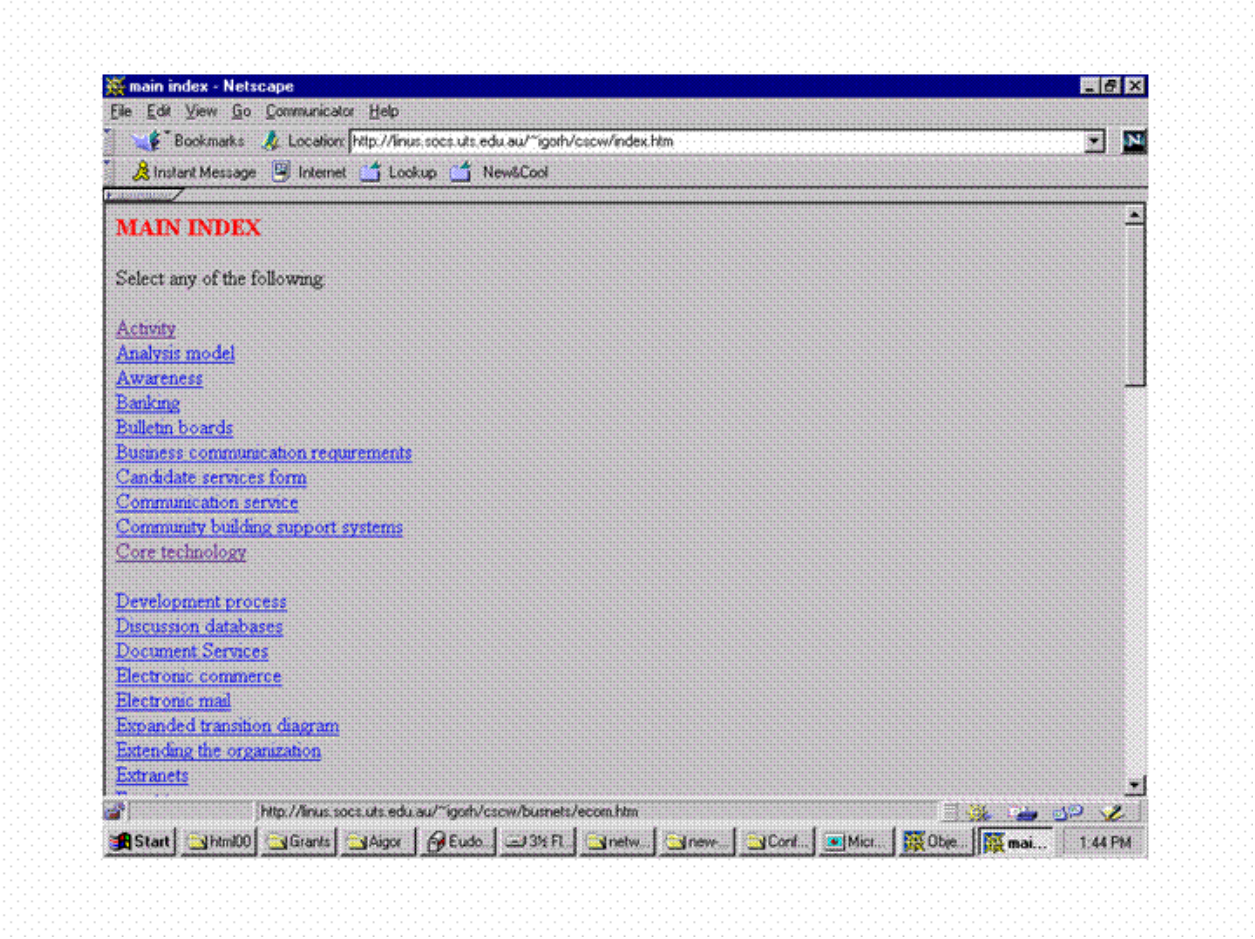

Figure 10 - A simple knowledge map

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.

Self-learning

This service allows learners to gain access to explanations of the concepts and examples of their use. Results provide feedback to owners of which concepts are best explained and which need additional support.

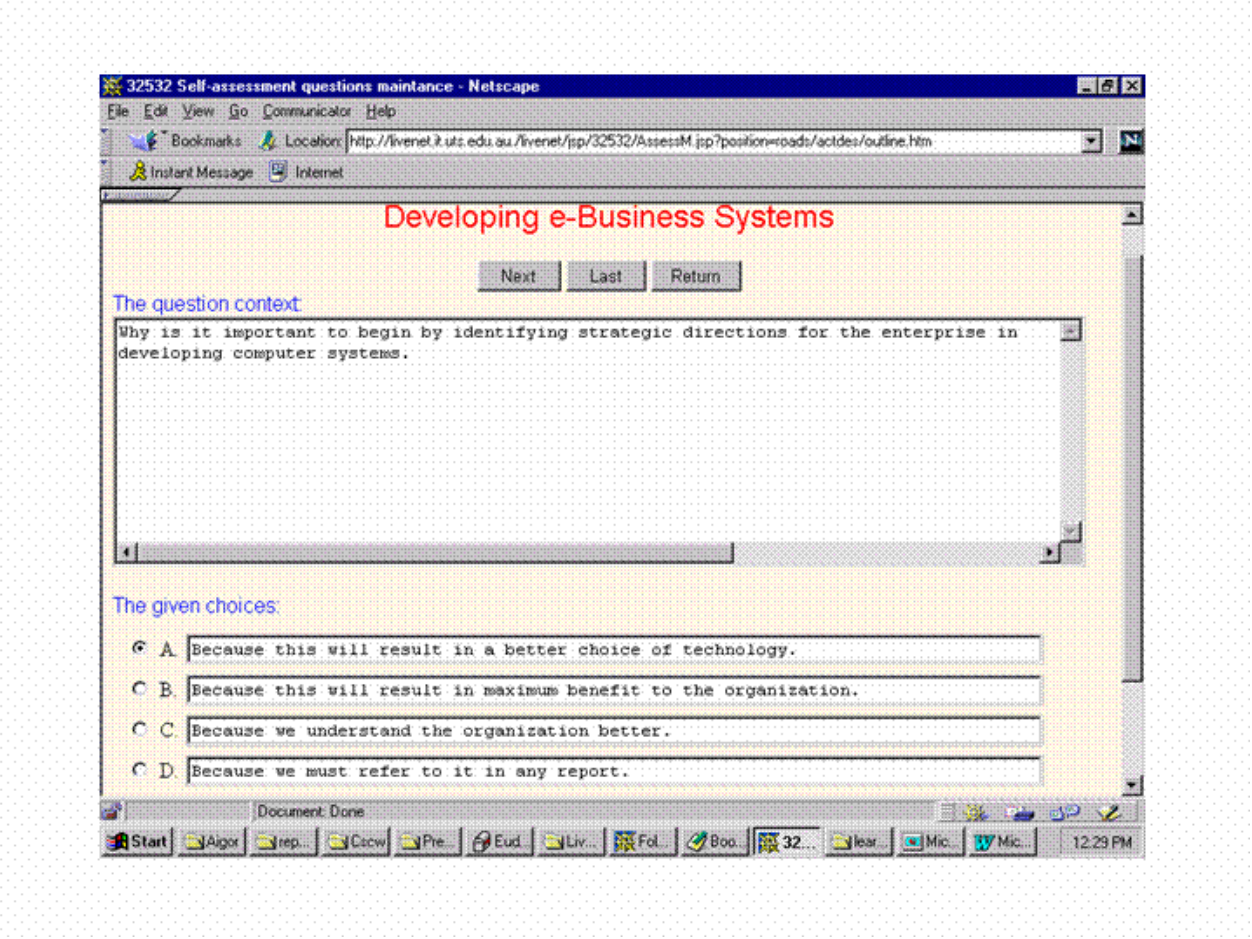

Figure 11 – A self-examination frame

It is of course possible at any time to post a question for further explanation by experts within the community. These feedback questions can be followed up with questions and discussions for further interpretation.

Social Issues - Diffusion into the Teaching Process

Introducing technology to support an integrated system also requires a careful strategy. Lessons learned included design of workspaces to provide focused effort without the need of excessive navigation. Our earlier workspaces provided separate spaces for tutor assistance, case studies and overhead and administrative matters. Over time we have developed the strategy that matches the subject structure shown in Figure 4 and very similar to that described by Salmon (2000). Experience with teaching in distant environments has led to some further observations.

One important issue is how technology is adopted and how it will diffuse through the learning process. An important here is how to manage the knowledge base and ways of introducing technologies for use by learners. These begin with familiarization using the community interface in Figure 8, going on to the private group workspaces for developing project goals shown in Figure 9 and finally through students using the software to develop the prototype for a case study. 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 initially understood the basic LiveNet collaboration model and workspace description initially through socialization. They then used this initial knowledge as a foundation to set up prototypes. 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 some students perceive it as a nuisance in that it requires them to

follow a process.

Summary

The paper outlined the way teaching can be supported using knowledge portals. It outlined the structure of such portals stressing the need to support flexible governance structures and a variety of services. It then described a system that supports a combination of collaborative services and knowledge services.

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