

TECHNOLOGY DIFFUSION INTO THE LEARNING PROCESS

I.T. Hawryszkiewicz
Faculty of Information Technology
University of Technology, Sydney
PO Box 123 BROADWAY NSW 2007
(e-mail: igorh@socs.uts.edu.au)

ABSTRACT

Support for learning processes requires ways to manage the diffusion of technology into the learning process in non-obtrusive ways. To do this the learning process must be clearly defined in terms of learning activities and the technologies needed for each activity. The paper defines the learning process as a set of activities using Nonaka's knowledge creation process as grounded theory. It then defines the kind of support needed for the different learning activities suggesting that the support needed changes as learning proceeds and that such change should occur in a gradual manner. The paper then illustrates the approach with an example identifying ways of diffusing the technology as learning proceeds through different activities.

KEY WORDS: collaborative systems, e-learning, groupware

1 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 learning, distance learning, and virtual universities. Increasingly web based technologies are being used to provide services that support these learning environments. Considerable work has taken place in using a variety of such services. Wade and Power [10] for example outlined a number of requirements for computer supported learning systems and described alternate technologies for supporting learning activities. Neal [7] 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.

A complete learning process will require changing technologies as learning proceeds. This paper describes ways to diffuse technology through the learning process. It first uses Nonaka's [3] model as grounded theory to define

the *learning process* as a set of activities. The paper then examines alternate support needed by these activities and describes ways of integrating technologies to support the activities

Diffusion of technologies throughout the entire learning process must combine ways to support different learning activities and allow the learner to follow different paths. It suggests that technology diffusion is often seen as a disruptive process and defines ways of gradually introducing technology to make diffusion less obtrusive. Support will depend on factors such as whether learning is objectivist or constructivist [4]. The simplest difference is that in objectivist learning the learner studies concepts and needs to find ways to understand them. In constructivist learning the emphasis is on process or best ways to do things. Examples are ways to construct artifacts. The emphasis in construction is often on groups and learning often takes place through group interaction. Thus here students learn design guidelines, how to respond to different situations.

Introduction of technology often requires changes in work practices for both learners and teachers. Such changes are often best introduced gradually to reduce disruptive effects. These new ways often require ways to customize computer systems to support the learning process and to evolve as learning proceeds. The paper uses the notion of a place that can provide different services as learning needs change. A system, called LiveNet, which can be used to customize such learning models, is also described

2 DEFINING THE LEARNING PROCESS

To apply the business approach requires a clearer definition of the learning process. Our approach is to develop a framework for describing the learning process uses the work of Nonaka [3] as grounded theory. Nonaka sees knowledge sharing and creation following the process shown in Figure 1.

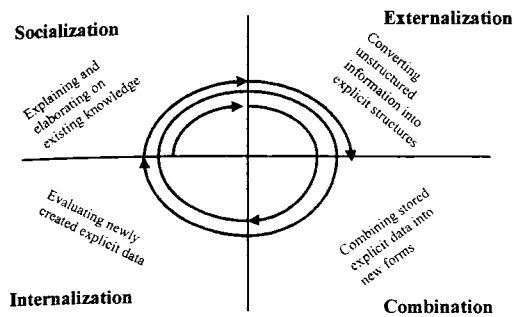


Figure 1 – Nonaka's knowledge creation process

Nonaka's process includes four phases. The first phase is socialization where people bring together their experiences and re insights in an area. The next step, externalization, is where some of this captured expertise is interpreted into a form that can lead to some actions. The discussions now become more focused with specific issues being addressed and new ideas generated. The ideas are combined where necessary with existing information and then the outcomes of any actions evaluated. The process then continues by further socialization evaluating experiences and so on. Different tools are needed at each stage. Knowledge sharing is only meaningful within a context. The context defines the relevance of what is discussed and provides the basis for any interpretations and supports the process itself. Nonaka defines four different kinds of contexts 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, construct artifacts, combine explicit knowledge.
- Exercising - communicate artifacts and embody in working context. Reflect on outcomes.

As environmental requirements lead to the issue of medium to be used in the learning process with different media often needed in the different contexts. Shoen has found the importance of proper media to enhance learning. The media must include both ways of productive interaction as well as reflexion, mainly in the context of sign. This again is transferable to learning as it focuses effective interaction as well as ways to reflect on current status. Such reflexion does not only include analysis of their own activities but extends to examination of similar work and experience of others.

The way media are provided can also differ for objectivist and constructivist teaching.

Objectivist learning principally concerns transferring existing knowledge from one source to another.

The knowledge here is structured and can be passed as facts requiring minimal trial. Learning in the use of computer system commands is an example here. A standard office procedure is another. Often such learning can take place individually requiring presentation and perhaps some experimentation or self-assessment.

Constructivist learning concerns transmitting knowledge by learners interacting with each other. It concerns transfer of knowledge about ways of doing things like design. This often requires synchronous interaction within group environments.

2.1 Learning activities defined in terms of Nonaka's process

The learning process in this paper is defined using Nonaka's process as grounded theory. The way Nonaka's process is interpreted as a 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 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 other assistants. They can also be software agents. The goal is to improve processes by reducing agent costs or support them with better tools.

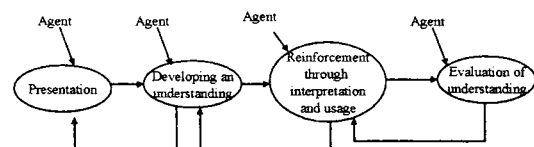


Figure 2 – Learning Process

Learning Activity	Relationship to Nonaka's model	Environmental requirements	Implications for agents
Presentation	Socialization and presentation of important concepts.	Easy ways to exchange experiences, which can be readily implemented with potential cost reductions. Distribution of materials.	Primarily lectures or presentations. 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 the 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 and reinforcement through discussion or other feedback from agents.
Reinforcement	Continued interpretation with experimentation. Trying things out. Seeing how things work. Comparing with explicit forms.	Reinforcement through interpretation and usage visualizing interactions, constructing artifacts, combine explicit knowledge. Interact for evaluation	Extension of the above with easy access to previous examples and their interpretation in the current situation.
Exercising	Internalization by getting evaluations of experiments.	Get feedback on outcomes.	Better ways to evaluate outcomes.

Table 1 – Learning in Nonaka's terms

2.2 Combining medium and process

The way learning proceeds through this process requires different interaction and media at different learning activities shown in Figure 2. 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, self-assessment 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.

2.2 Providing a learning place

The ideas of reflexion and working in groups lead to the concept of creating a place where the learner can get access to knowledge, interact with others and reflect on their situation. It is also a place where they can experiment with ideas. A generic place structure is shown in Figure 3. It illustrates some of the main concepts in forming places.

A more detailed description of these concepts can be found in [2]. The central concept is the role, which has defined responsibilities in the workspace. These can be to access materials or carry out assigned actions. People are assigned to the roles. Roles or at least people assigned to the roles can also interact in a variety of ways. There are other concepts concerned with workgroup creation and a variety of awareness parameters. The system, LiveNet, which is described here, includes ways to support these requirements and evolve in the way shown in Figure 7.

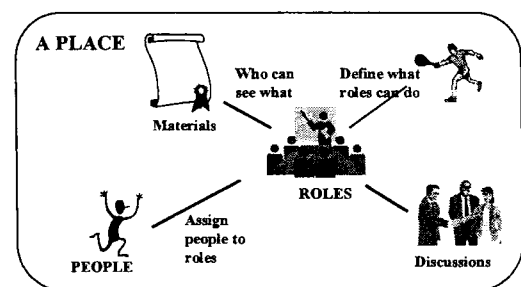


Figure 3 –Describing Places

Places should evolve as learning goes through the various activities. The places should also be adapted to different roles. Thus what a teacher does may be different from what a learner does or what an assistant or tutor does.

3 Achieving benefits

The goal of most systems is to reduce agent costs either by:

- Enabling the agent to become more productive by managing an increasing number of students,
- Provide tools for self based learning reducing agent costs,
- Providing access to a wider set of knowledge sources, or
- A combination of the two.

perhaps the following assumption can now be made. Benefits can only be achieved if the process diffuses naturally with minimal agent interaction.

DL USION INTO THE LEARNING PROCESS

work so far has concentrated on the early learning steps described in Table 1. In the classroom situation the obvious business benefit is the ability to manage more students through the reduction of workload in distribution of explicit documents and responding to standard questions. When it comes to distance education the question becomes what business model to use to realize the benefits. Providing this through technologies such as video chatroom interaction does not necessarily imply more effective teaching than face to face and can place pressures on instructors with consequent cost increases.

The goal is to use technology to support face to face learning. Figure 4 illustrates the main activity using the model shape with the roles of teacher and student and the four artifacts shown as rectangles in Figure 4. It includes teachers, students and tutors.

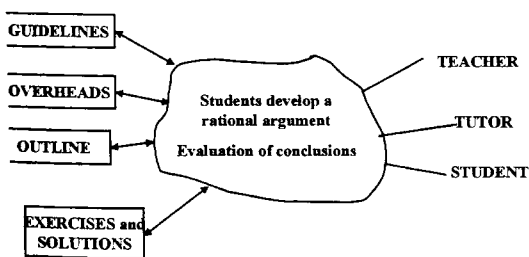


Figure 4 - Describing a learning environment

goal is to bring participants, who in most cases are parents and teachers, into a commonly shared workspace (Wyrzykiewicz, 1999) and provide the flexibility and dynamic structures to set up a variety of collaborative environments. Our workspace for this initial stage is illustrated in Figure 5. It provides:

the community governance structures through its roles,

- supports interaction through discussions,
- contain any number of explicit documents, and
- supports group formation for constructivist learning.

It also provides awareness and notification features to alert community members to events important to them. The notifications can be customized to community needs. The interface shows all the information in the subject. It also provides different roles with different views. Thus for example the folder names 'information-to-tutors' can only be seen by tutors thus reducing the need for meetings and saving peoples time. The interface can then be used to enter the body of knowledge and use its associated knowledge services.

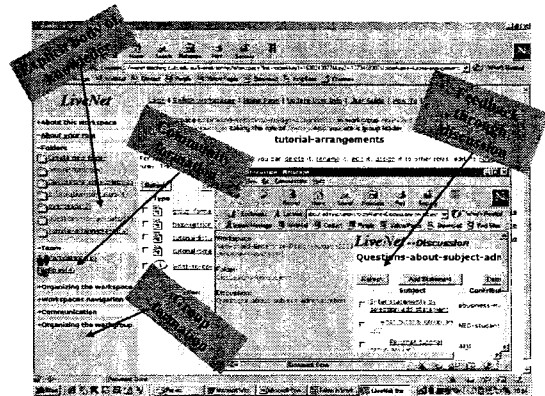


Figure 5 – A LiveNet collaborative services workspace

The interface shows all the information in the subject. It also provides different roles with different views. Thus for example the folder names 'information-to-tutors' can only be seen by tutors thus reducing the need for meetings and saving peoples time. We now continue to show how places can be customized to support constructivist learning,

To go beyond presentation and support constructivist learning requires a new process. The goal is to teach students how to design collaborative systems. The diffusion process is illustrated in Figure 6. It introduces technology and learning in a gradual way. First there is some objectivist learning to describe what business processes using community workspaces. The next step is when the actual design process is introduced and students organized into groups to discuss design alternatives and make design choices. Correspondingly a project space is created in which such alternatives can be considered. Finally there is the prototype development where students choose technology to implement the design. In this case the group is provided with development guidelines.

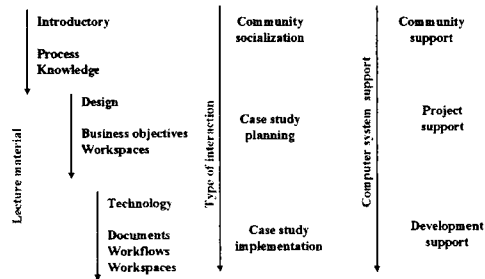


Figure 6 – The learning Process

The students form groups electronically using the LiveNet system and then create a project repository and use it for their case study. The case study is to define requirements for a collaborative system and implement it using LiveNet [5]. 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. The place is shown in Figure 7. It provides the same generalized interface but its roles and abilities are different. It also concentrates on document management as designs evolve.

3.1 Other models and places

We have also used this approach for teaching across distance. Here material is initially presented to students in an intensive course and followed through experience sessions moderated by a distant tutor with electronic assistance from the teacher. Thus the relationships established during the follow up phase are for direct interaction between tutor and student with monitoring and advice provided by the teacher.

4 EXTENSION

Our work with workspaces so far has concentrated on the strategy shown in Figure 6 described earlier in this paper and involve an average of 1000 students per semester. 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. The subsequent navigation led to some dissatisfaction and the creation of the workspace shown in Figure 5 proved much more acceptable. This provides access to all these services but governance features and folders allow us to focus information for particular roles.

One difference that we have found is the necessity to “push” the process in a number of environments. This requires closer monitoring and driving by teachers.

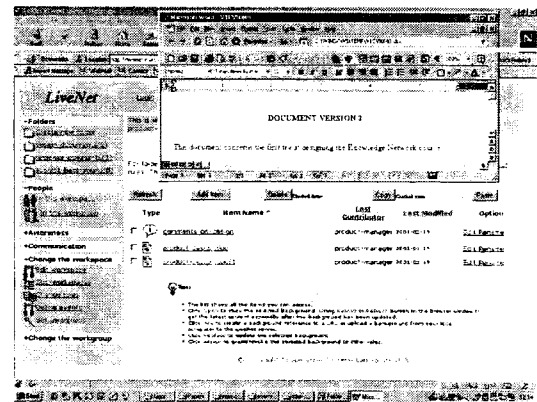


Figure 7 – A presentation interface for group case study

The strategy shown in Figure 6 also proved successful. The introduction of technology in gradual stages has proven to be less disruptive. These begin with familiarization using the community interface in Figure 6, going on to the private group workspaces for developing project goals shown in Figure 7 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 understood the basic LiveNet modeling method 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.

The question is how to push the benefits into the later stages of the learning process. There are macro and micro issues in achieving benefits. The macro issue is the way to support knowledge management including defining roles and structures and a strategy for introduction.

4.1 Macro issues

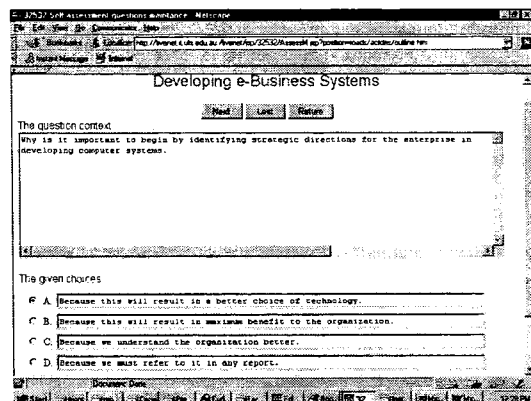
The main issues here are how to manage the knowledge and ways of introducing technologies. The question here is whether the individual teachers are sustainable. Knowledge management requires more structured processes for knowledge development. Currently in most tertiary institutions knowledge is embedded in individuals. Teaching method and even material change when the teacher changes.

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

[illegible]

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.

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.



It is of course possible at any time to post a question for further explanation by experts within the community.

6 SUMMARY

7 ACKNOWLEDGEMENTS

8 REFERENCES

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