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A COMMUNITY OF PRACTICES FOR ACCELERATING THE ADOPTION OF INFORMATION TECHNOLOGY IN ENGINEERING EDUCATION

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Abstract *— There are serious problems in the adoption of information technology (IT) for teaching in engineering. Professors hesitate to use IT for teaching: they are not familiar with the technologies, and know little about the theories and practices around their use. The research is part of an initiative undertaken by a group of early IT adopters to build and share new knowledge related with the use of technology for teaching. The paper presents an innovative approach to accelerate the adoption of IT for teaching and improve its value for transferring knowledge. Three types of technologies are analyzed: intelligent boards, audience response systems and community-based tools for learning. Practices from superusers are captured using ethnographic methods. Members of the community validate these practices through experimentation in a learning laboratory. Then a framework of practices is developed and shared within the community's knowledge base.*

Index Terms — IT in teaching, community of practice, best practices, knowledge portal.

INTRODUCTION

New information technologies (IT) transform every aspect of modern life, including the way we teach and learn. Some technologies have transformed classroom dynamics. Furthermore, computer networks that facilitate the distribution and exchange of information mean that learning does not take place only in the classroom anymore. This transformation of the traditional context in which knowledge is acquired questions the traditional paradigm according to which learning is an individual process of knowledge transfer. Learning can take in groups, around technologies such as virtual learning environments (VLE) that act as mediating objects.

However, introducing these new IT in traditional teaching settings raises a number of challenges. Foremost among these are the choice of appropriate technologies and the adjusting of current teaching practices to encourage learning in a participatory setting.

As for University teachers (i.e. all university personnel involved in teaching such as professors, readers, sessional lecturers, etc.), they face two major changes. The first is the shifting of the teaching paradigm toward practices that encourage participation and group learning. The second is the introduction of new technologies to support these new practices.

These changes raise two important problems. The first is the additional efforts and risks associated to changing teaching practices. Teachers have to deal with an increase workload in terms of tasks to be performed and of new knowledge to be acquired. New technologies mean not only having to learn how to use it, but also having to adjust one's teaching practices. All those that have taken the plunge have been confronted with the following questions: which technology is appropriate for this particular course? What is the expected benefit/effort ratio? Is the technology supported by the institution's IT services? Is this technology likely to become rapidly obsolete? Isolated and ad hoc efforts to introduce these technologies can become dead ends as early adopters become exhausted rather than champions in the larger adoption of technology in their institutions.

Not surprisingly, studies show [1, 2] that teachers hesitate to get involved with new technologies, especially if there is no support structure or special incentives to adopt and use it. Some even perceived these transformations as a threat. Osborne and Hennessy [2] indicate that concentrating on knowledge content rather than on pedagogy is another factor that limits the use of these technologies.

In this paper, we present a new social learning approach to accelerate the adoption of IT in teaching, based on activity and situated action theories. A second expected contribution of the ongoing research to knowledge will be an ontology and a conceptual framework regarding the integration of IT in teaching that will take into account its two core paradigms: positivism and socio-constructivism.

THE INSTITUTIONAL SETTING

The École de technologie supérieure (ETS) is an engineering school based in Montreal, Canada. Routine IT currently available at ETS for teaching purposes at his institution includes standard websites, e-mail and classroom equipment such as computers and projectors. State-of-the-art a few years ago, this suite of resources now pales in comparison

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with what is available in many comparable institutions in Quebec and Canada.

In the past 5 years, a number of individual (and sometimes duplicate) efforts have been made by members of the teaching staff to experiment with various new IT, including VLE, audience response systems (ARS), interactive screens and Tablets PCs. These efforts have met so far with limited success in terms of the diffusion and wider adoption of these technologies in the institution. Institutional support structures (particularly in the form of user training and support) has also failed to materialize.

It is in this context that a core group of early adopters (including the authors) gathered in order to bring these bottoms up, user lead initiatives to the next step by developing resources for the wider adoption and use of these technologies in the institutions through the community of practice approach.

THE CAPTURE OF MERGING KNOWLEDGE AND THE CREATION OF NEW KNOWLEDGE

The review of the literature on the targeted technologies has revealed that there is in fact very little research being done on their use in education. A vast majority of the literature consists of case studies documenting various attempts at introducing the technologies in the classroom. While these are helpful in identifying potential problems and errors and in illustrating the variety of roles these technologies can play, there is an obvious lack of research addressing specifically the benefits and drawbacks of using these technologies in various classroom settings, according to different learning paradigms (the positivist vs. the socio-constructivist approach, for example). There is also a lack of research on the various approaches that can be used to encourage the wider diffusion and adoption of these technologies in academic institutions.

THE DESIGN OF THE RESEARCH

The research adopts a socio-constructivist approach to knowledge generation based on recent empirical research on how to accelerate the generation, mediation and formalization of new knowledge within organizations. According to Blackler's theory on knowledge and innovation [3], organizations are networks of knowledge and sense-making activities systems, grouped around communities of practices. New knowledge is mainly generated during knotworking – unique activities involving multiple disciplines [4]. A proper context has to be established to first stimulate the production of this new knowledge (perspective shaping). Then each community, through consensus, has to review, mediate and incorporate this new knowledge within their own body of knowledge (perspective taking).

According to the connectivist theories of social learning (activity theory, situated action), context plays a pivotal role in the ability of a group to create and share knowledge. The community of practice [5] is an approach that formalizes this process that has recently emerged in industry in the wake of the concept of the learning organization [6]. Based on situated action theory, communities of practice rely on a social learning process based on the collaboration between individuals that share a common interest [5].

The initial stage of this project was to invite professors who had shown a marked interest in these technologies to group together within a community of practice. Named C-UTILE, this community of practice on the use of IT in teaching at ETS is comprised of fifteen members of the teaching personnel, all early adopters of at least one of the technologies mentioned above (C-UTILE is a french acronym that means « **C**ommunauté de pratique sur l'**U**tilisation des **T**echnologies de l'**I**nformation dans **L**'**E**nseignement »). Every department of the school is represented. The primary objective of this community is to share knowledge concerning the pedagogical practices associated to the new information technologies.

The strength of communities of practice is the exchange of knowledge between the members of the community. It however has limitations for generating new knowledge or to build the theoretical and empirical foundations on which ontology could be built. First, the effective use of new technologies requires a change in teaching practices. The classroom is not the best place to experiment with these new technologies. Second, communities of practice tend to perform rather poorly when it comes to the creation of knowledge (as opposed to simply sharing it). Third, a community of practice has to create a context to help create that knowledge, capture it and make it available for use in practical settings.

To overcome these limitations in the community of practice, a research project based on a multipronged strategy was devised. The research methodology is based on grounded theory [7]. The first element of this strategy is an investigation to capture state-of-the-art knowledge and practices through a literature review and interviews of superusers in various academic institutions. The literature review allowed us to identify a set of core concepts and categories. The interviews with nine superusers (three by technology) added practice-based concepts and categories for each technology. These interviews were analyzed with Nvivo8. Currently, small groups of users from different disciplines and teaching approaches (formal or participative) are invited to map and add to these concepts and categories using conceptual mapping software (knotworking). The data concerning the use of the technologies was divided according to the positivist and socio-constructivist paradigm. From fusion and iterations around these maps, the community will incrementally build the ontology and nurture the content of the knowledge base. The second element is the creation of a design laboratory to allow exchanges between the teachers and experimentation with various techniques and approaches. The third element of the

strategy is the creation of a knowledge portal along with individual digital notebooks to support learning and allow the capture of knowledge emerging in the field, through the use of the various technologies. The last element is a survey of the teaching personnel and students to measure their interest and maturity in the use of the technologies.

THE TECHNOLOGIES

This work focuses on and is organized around three types of technologies: community-based tools for learning, audience response systems and interactive screens. These were selected on the basis of existing, limited, use at ETS. The market currently provides a wide variety of solutions for each of these technologies. This section briefly presents each of these technologies and tries to identify the difficulties that may prevent its adoption.

Community-based tools for learning

The use of Virtual learning environments (VLE) has grown rapidly over the past 15 years, fuelled mainly by the impressive expansion of the Internet [9]. More recently, community-based tools begin to appear as an alternative to commercial products. One of these is the Moodle platform, which has been the object of rapid development and exponential growth in use in the past few years. It is a free software package (distributed under the GNU Public License) that is used to create effective online learning web sites. Many universities have already adopted this platform. However, the transition from a traditional static course website to a VLE is not as simple as it sounds. Teaching staff as well as IT staff must agree to make this transition and accept to spend some time to set up and learn how to use the new environment. Teachers, in particular, are reticent to make the transition to VLE without a proper "Quick start guide" or "How-to manual" to help them start efficiently.

Audience response systems

An audience response system (ARS) combines wireless response keypad (often called clickers), a receiver, and presentation software to create interactive presentations. ETS has recently adopted (on a trial basis) the TurningPoint system from Turning Technologies. The polling software is an add-on the Microsoft® PowerPoint and the response clickers are small 10 digits keypad. This system is mainly used in the classroom to get some feedback from students during lectures. It creates more interaction between the teacher and the students, contributing to their motivation and active participation [10].

Despite all the benefits that ARS can bring to a classroom, several issues can prevent its widespread adoption by the teaching staff. These are technical, organizational or even pedagogical (how formulate good questions?). Many technical problems that can arise when the use of the ARS is mastered by a few users but this experience is not communicated to new users. Moreover, all the material created by ARS users is confined on individuals' computers instead of being shared across the community.

Interactive screens

This type of technology regroups tablet PCs and interactive whiteboards. Some teachers are using a tablet PC connected to a VGA projector as an alternative to traditional chalk boards or white boards. Tablet PC is easy to set up in a classroom that is already equipped with a projector. Interactive whiteboards, on the other end, is a large interactive display mounted to a wall or on a floor stand. It has to be connected to a computer and to a VGA projector. It is expected that one of every seven classrooms in the world will feature an interactive whiteboard by 2011, according to Decision Tree Consulting [8]. Teaching with these new technologies requires training and practice. Superusers are the best persons to exchange good practices with new users.

EXPERIMENTING WITH TECHNOLOGY: THE DESIGN LAB

The concept of design laboratory stems from research and experiment based on social learning theories (situated action and activity theory). The design laboratory at ÉTS was first conceived for research in construction on integrated design. Because most of the technologies used in the laboratory focus on facilitating team learning, it was a perfect setting for the activities of the community of practices.

Working sessions are held in the laboratory. They are aimed at (1) getting familiar with technologies for teaching outside of the classroom; (2) sharing experience and problems regarding the use of these technologies (3) generate content.

The content of the workshops is captured within conceptual maps that are used first to build the ontology for the knowledge base, second to organize the content within the ontology. The ontology and content are then transferred into a knowledge portal. This portal is a virtual space for the community to access, share or update information on these technologies or best practices in their use.

KNOWLEDGE PORTAL

The knowledge portal is a platform where all the information about the use of the different technologies is centralized. Figure. 1 shows the topology of the proposed platform. The central database is located on a remote computer running Microsoft® SharePoint server. On the other side, teachers can download numerical knowledge binders on their computer through C-UTILE's website. The knowledge binders have been created with Microsoft® OneNote. There is one binder for each technology. Each of these binders is

organized following the same structure for ease of use. The main sections in the binders are:

- Quick start guides
- How-to
- Known problems
- Frequently Ask Questions (FAQ)
- Document templates
- Good practices
- Literature links

When downloading a copy of a knowledge binder, the teacher has instant access to all the information related to the technology she/he wants to use. The binder is a guide for the teacher, but it is also a place to keep new data generated as the user gains experience and experiments with the technology. Then, the updated binder is sent back to the superuser responsible for that specific technology, so that the knowledge portal database can be updated. This cycle helps to gather important data for each technology and redistribute it to the community.

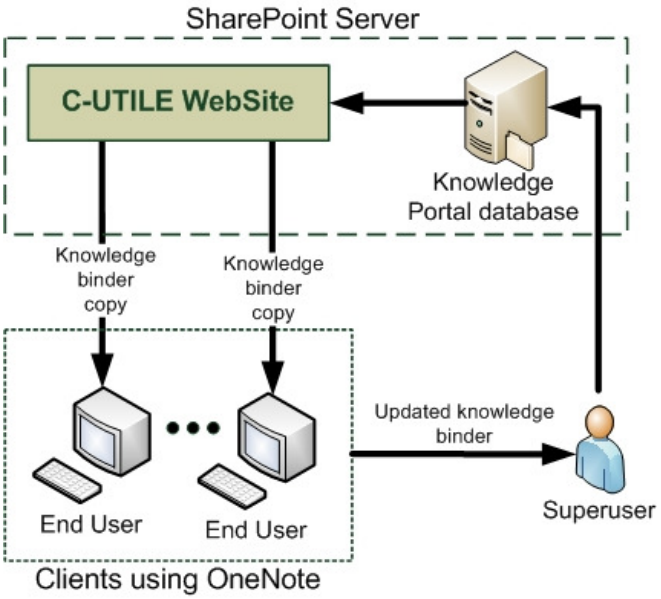

FIGURE. 1
KNOWLEDGE PORTAL TOPOLOGY

CONCLUSIONS

Experimentation with this model started in June 2009. The performance of this model can be measured by the speed at which state-of-art practices and knowledge will have been identified, captured and made available. The knowledge portal is almost complete, the interest groups within the community of practice are experimenting with the technologies according to the identified practices and the survey of the teaching personnel and the students will take place shortly. The community has already gained enough credibility to influence future institutional decisions concerning the acquisition and deployment of these new technologies and has established links with other academic institutions to share best practices.

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