From Knowledge Management to Technology-Enhanced Workplace Learning: Issues and Examples

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Abstract—Instead of developing E-learning from scratch, one can integrate it with existing information systems. We refer to this form of E-learning as Technology-Enhanced Workplace Learning (TEWL). The context for the paper is the analysis and design of TEWL in the European Knowledge Practices Laboratory (KP-Lab) project (www.kp-lab.org). KP-Lab focuses on developing an integrated learning environment aimed at facilitating innovative practices in sharing, creating and working with knowledge in education and workplaces. A major effort is focused on understanding boundary crossing between educational institutions and workplaces. To study these phenomena, we develop a conceptual framework based on a survey of trends in knowledge management and related areas. We distinguish between three perspectives on KM (technical, sociotechnical, and sociocultural). The perspectives, concepts and tools we highlight are used to discuss three cases of knowledge practices (software company, hospital institution, and school).

Index Terms—Case studies, knowledge management, sociocultural perspective, technology-enhanced workplace learning.

I. INTRODUCTION

Work in the knowledge-based society is characterized by open-ended problems and multi-professional teams with highly skilled individuals working together to solve complex tasks, often separated by distance [13]. We distinguish this form of practice from the prevailing institutional practices characteristic of most companies today, which identify the core skills and assets employees need to know about, and build e-learning modules to support these and integrate with the companies’ competence programs. Knowledge-based practice is to a larger extent dependent on working with technology at the outset, and is more supportive of experimentation and the adoption of new practices. It also has a stronger focus on collective knowledge advancement. These practices do not replace but more often broaden the knowledge-based practices that are grounded in well-established routines and embodied skills [13, 15]. We believe this also calls for new knowledge infrastructures, which integrate organizational, cultural, managerial and technological dimensions to support and secure the seamless operability, relevance and invisibility of the common knowledge infrastructure, and amplify the integration of work and learning [11, 19].

We use the term Technology-Enhanced Workplace Learning (TEWL) instead of E-learning for the following reasons. E-learning is loaded with many meanings, due to its early adoption by different stakeholders in the application of distance education technologies (from research to business to policy making). We have included the phrase workplace learning in the TEWL name to emphasize the application of E-learning in this arena, and we use the phrase Technology-Enhanced as synonymous with mediated action as used from a sociocultural perspective (i.e., the role of tools to mediate activity and learning) [24]. In addition, we aim to integrate E-learning and knowledge management, as the latter is the more commonly used technology to support workplace learning, i.e., to provide company-wide information and communication sharing support. Albeit not designed primarily for individual and group learning, knowledge management systems do contribute to organizational learning [23]. It is the convergence of e-learning and knowledge management in workplace settings that we refer to as TEWL.

In order to analyze knowledge-based practices in concrete workplaces, we look at how specific institutions handle change, and manage open-ended and complex problems through networking and collaborative teamwork. The case studies we report describe practices in a software company, a hospital institution, and a school in their efforts to understand current sub-optimal practices, how to transform these practices into new knowledge-based practices, and to support this with different forms of TEWL (methods and tools). We show how the move to technology-mediated practices has implications for prevailing routines and the knowledge management initiatives in place.

We address the following research questions (one for each case):

- How to expand the channel of communication between developers and customers in a software company as it goes through a process of improving customer relations while simultaneously expanding into new markets?
- How are the multi-level institutional processes of knowledge management and advancement affected when developing shared tools for analysis and reconfiguration of a social practice in an upper secondary school?
- What are the resources practitioners draw on when interacting with a repository of standardized work descriptions, aiming at facilitating TEWL, new social practice, and staff mobility in a hospital institution?
The remainder of the paper is organized as follows. We present a conceptual framework based on a set of issues developed from surveying three perspectives on knowledge management technologies and additional concepts associated with the sociocultural perceptive on workplace learning. This conceptual framework is then used to frame the analysis of findings of three cases that address the research questions listed above. Finally, we conclude by comparing the analyses and suggesting some directions for further work.

II. SOCIOCULTURAL EVOLUTION OF KNOWLEDGE MANAGEMENT SYSTEMS

We start with a brief overview and differentiation of three perspectives on knowledge management (KM). This differentiation draws on the distinction between the first and second generation of KM [2]. The first generation is characterized by a focus on systematizing and explicating the skills and knowledge assets already present among members of an organization; the second generation extends this to foster abilities for creating new knowledge and the tools and processes needed to support this. In the survey below, we develop a distinction between three perspectives on KM: 1) technical, 2) socio-technical and 3) socio-cultural.

A. Technical Perspective on KM

This perspective on knowledge management is rooted in the original work in information systems and computer science [e.g. 22]. It has to do with the management of information on a computer made possible by the personal computer and client/server architecture, as well as how to capture, store, distribute, and utilize this information for the purpose of improving performance related to well-defined skills [5]. The focus has been on representation of information, including the various formats for data storage and protocols for data interchange that are needed for networked information systems. From this perspective, approaches to knowledge management are adopted from three related disciplines: 1) databases (document management systems), 2) information systems (information management), and 3) artificial intelligence and expert systems (knowledge engineering).

The first generation of KM tools appeared in the mid to late 1980s with pioneering multi-user software running on personal computers such as Lotus Notes. However, Lotus Notes was not specifically designed to be a KM tool. Around 1990, so-called “online yellow pages” emerged in North American corporate settings. They were arguably the first generally accepted KM tools for helping employees in large organizations locate expertise. However, the initial technology was limited (akin to today’s personal homepages), listing names of people and their expertise as attributes. This soon came to a halt and had short-term success because the effort to create enough useful information required an upfront cost that was often higher than the benefits, thus creating a cost/benefit discrepancy.

KM technology expanded in the early to mid 1990s to incorporate features of collaboration technology (combining on-line discussion, online chatting, email, phone books, and document databases to name a few), and most importantly the first generation of web browsers (e.g. Mosaic). A technique that was developed on this technology is knowledge mapping [1]. This technique creates a map of the relationship of knowledge assets to core business processes. This is accomplished in a two-phase process: 1) discover what knowledge exists at the start of a knowledge intensive project and 2) build a map of the relationships between communities involved in knowledge creation and sharing. This brings us to the next perspective, the socio-technical.

B. Socio-Technical Perspective on KM

This perspective on knowledge management is a step beyond technical KM as seen from a user-centred point of view. It is oriented towards computer-supported cooperative work (CSCW); the focus is less on the technical aspects of representing information and more on how to utilize it for the purpose of sharing information with others and connecting people in an organization [1]. This perspective has in many ways converged with the trend in information systems towards more interactive systems, exemplified by dynamic web pages and on-line transactions in e-business and e-commerce. This originated with the rapid expansion of the WWW in the mid to late 1990s, a growth that has exploded in the past five years with the semantic web, improved online searching, and most recently Web 2.0 applications for social networking, collaborative creation and updating of personal information (e.g. Facebook, LinkedIn, blogs and wikis). These applications have created a fertile ground for a new generation of knowledge management tools, shifted the focus away from monolithic systems and reached far beyond the original application of KM and into the workplace, homes and many other public and private arenas of physical and virtual encounters and information exchange. The incentive to volunteer with information in these environments is much higher than it has been in the past due to the fact that there are so many potential users of the information. At least those who frequently interact in cyberspace perceive it in this way. Consequently, the cost/benefit discrepancy is no longer a major issue.

There are shortcomings with both technical and sociotechnical KM related to getting access to needed information in unforeseen situations. In other words, when the context of information use is substantially different from the context of information design, KM approaches will often fail to deliver expected results [9]. This is referred to as the “knowledge activation problem” or in short form “problem of enactment.” It is related to the fact that knowledge may be accessed at different stages: before, during, or after knowledge-related activities. Knowledge management practitioners offer systems, repositories, and corporate processes to encourage and formalize these activities, exhibiting varying degrees of success [20].

C. Socio-Cultural Perspective on KM

This perspective on knowledge management is concerned with how people access information in mediated action [24], and studies the social aspects of information and knowledge sharing with tools. Another dimension of this perspective is associated with the “pervasiveness of knowledge,” which is manifest when knowledge and work is tightly integrated and can best be described as “knowing in practice,” and supported with tools and processes for knowledge-creation practices [17].
On one hand, this highlights that knowledge creation and learning is a social and participative activity [10]. On the other, for TEWL, this raises the question of how KM tools and other tools can mediate this activity and how new knowledge can be constructed in the collective practices of organizations.

This flexibility of tools implies that other (non computational) tools can take on the role of (being part of or working with) a KM tool. However, this does not mean that developers are freed from developing innovative KM solutions. On the contrary, the challenges are greater and the stakes are raised. Reference [3, p.2] has defined the sociocultural perspective in the following way: “to attend less to the things people apparently know, the information they possess, than to what they actually do – to their work practices”. When one only takes into account “the things people apparently know”, one ends up with the problems of technical KM. On the other hand, when one also takes into account “the information they possess”, there are still socio-technical problems remaining, as argued above. The socio-cultural perspective on KM is about supporting what people actually do, and augmenting their knowing in practice.

By identifying key features in the development of knowledge management as seen from these three perspectives, we have contrasted the sociocultural perspective since it is less known in the E-learning community. This perspective is related to previous work in KM in North America. For example, Reference [21] introduces two socially motivated concepts grounded in empirical data from a workplace study: “social computing” and “knowledge socialization.” By social computing, the context of information (e.g., awareness, recommendations, subscription) is included to enhance the performance and activities of people, organizations and systems in a network of producers and users.

Knowledge socialization capitalizes on storytelling as a technique to facilitate knowledge creation, sharing and reuse. Stories are helpful when creating, capturing, disseminating and internalizing knowledge, and contribute to building a common vocabulary that again helps to coordinate multiple roles within different communities of practice. This approach is somewhat optimistic in that it portrays socio-cultural interaction as “unguarded discussion among people who know one another, who share professional interests, and who understand the contexts within which their remarks are being made” [21]. It does not pay sufficient attention to the complex dynamics of collaborative teamwork, social networking, and communities of interest [6, 8]. From this view, KM may prove to be problematic if tensions and conflicts are not taken into account at the outset, so that the situations can be tackled in a meaningful way for all the stakeholders. To accomplish this, we make use of a dialectical framework to identify divergent voices in an effort to stimulate mutual transcendence. When the sociocultural perspective adopts the dialectic stance, we have a range of analytic tools at our disposal for addressing tensions and for sustaining development based on contradictions [e.g., 7, 14]. When successfully applied, this will open up new arenas for learning and knowledge creation.

The socio-cultural perspective allows for the use of different artifacts and representations in order to understand the underlying dynamics of KM-practices when organizations undergo changes. Routines, procedures, and methods are artifacts that influence KM-practices. They form infrastructures for object-oriented activities [6]. Reference [15] suggests that studies of organizational routines provide insightful resources for analyzing how practices, or critical aspects of a practice, can be made into an object of inquiry in order to produce novel and alternative ways of acting. According to these authors, routines constitute an important part of the organization’s operative knowledge. Routines are maintained by the pre-reflective consent of individuals, as well as by traditions, control systems, and legitimized institutional practices. In reflective practices, on the other hand, routines may be carried out in different dynamic positions, as tools, objects or activities. In an activity-theoretical perspective [6], this “retooling” process is a key to changing practices [15]. In other words, studying dynamic interactions between tools and routines in KM-practices opens up a window to understanding knowledge creation and practice transformation.

In sum, we have outlined three perspectives on knowledge management. This is characterized by a move from KM as representation, to sharing, to knowing-in-practice. The ultimate goal of this as we see it is to make KM an integrated part of practice, a practice that integrates work and learning, doing and knowing. This is what we mean by knowledge creation practices. In the cases we describe below, we focus on the interplay (co-existence) of each of the three KM perspectives and identify strengths and weaknesses of the sociocultural perspective. Our goal is to contribute to research illuminating different types of knowledge-based abilities, understand the dynamics of boundary crossing, and identify the characteristics of sustainable knowledge-based organizations.

III. THREE CASES

Below, we present data from three cases to illustrate aspects of the three perspectives on KM. The cases represent three different workplaces, and three ways of working with knowledge. After the presentations we summarize and compare the findings:

- **Knowledge management for internal communication and customer relations** is a case study that aims to improve knowledge management practices in a small software house by focusing on enhancing developer-customer relations;

- **Mediating tools in teachers’ professional development and institutional change** is a case that describes the new institutional knowledge practices that emerge when a top-level pedagogical leadership team in an upper secondary school breaks away from existing routines for conventional practices;

- **Exploring negotiations when establishing a knowledge infrastructure** is a case that investigates the process of standardizing work descriptions on the basis of local in-house clinical procedures during a hospital’s transition to best practices and a patient centric approach.
A. Knowledge Management for Internal Communication and Customer Relations

This case investigates knowledge management and practice transformation in a small software house in Norway that employs 25-30 people. It is currently located in two regional offices, but it is rapidly adding employees, market share, and new offices abroad. The company develops and sells a family of project planning and management tools for the oil and gas industry, and provides consultancy services in using these tools. To expand to new market segments (in particular the building and construction industry and int’l markets) the company has started to improve its knowledge management routines regarding customer relations.

The company’s customer relations originally rested on oral and personal connections. These practices are time consuming and inefficient and not aligned with the goal of serving a growing market with diverse customers. The first attempt involved installing a Helpdesk function, but this did not work well (little used). The second attempt (ongoing) is an interactive web-based knowledge tool (web portal) integrated with a Customer Relations Management (CRM) system that the company hopes will be a two-way communication hub between the two national offices, a link between consultants in the field, and provide increased online customer support [18].

KM in the company is a combination of the three perspectives we presented above, including storing information, sharing information, and constructing new knowledge in order to support the needs of the employees and its growing customer base. Using findings from this case study, we can point to a blend of approaches to knowledge management, identify novel situations that require the integration of work and learning, and describe the evolutionary development brought about by the dynamic interaction of bottom-up user driven innovation (e.g. from error reports to end-user development) and top-down professional software development.

The case has focused data collection and empirical analysis in conjunction with knowledge creation in situations of boundary crossing, since these situations are likely to provide tensions and contradictions as a result of conflicting interests and multiple perspectives on shared issues [18]. For example, customers are concerned with getting project management tools that support managing large projects, whereas the company is in business to sell software to the customers who will pay for their services. By boundary crossing, we mean the interaction of two or more activity systems [6] or two or more communities of interest [8]. In particular, we study: 1) improving customer relations, 2) adaptive product development, and 3) researchers’ intervention in design workshops.

When the company entered into new marked segments (from oil and gas to building and construction) it also hired new staff. Critical to this transition has been to alleviate the additional burden for the staff, the company launched two initiatives: streamlined information exchange both internally and with customers; and a mentoring program for new employees, letting them work as super users at a customer site for the first 6 months in order to learn the tools and maintain good relations with a customer. We have identified the following tensions based on the three areas we identified above: 1) contradiction in the mentoring program between mentors’ time spent on learning a new business culture and responding to local requests versus time spent on learning the company software, 2) contradiction between developers and customer needs regarding new functionality to be added to the product, and 3) tension between developers and researchers in defining the user requirements for a new CRM system.

B. Mediating Tools in Teachers’ Professional Development

This school-university partnership project provides an arena for exploring how institutional knowledge practices change when new leadership structures and shared tools are introduced. The tools we provide support the discovery, analysis and redesign of teachers’ classroom practices. The aim of our intervention is to improve information flow and reflections across institutional levels and communities and to create productive support structures for teachers’ classroom work. This is a participatory intervention study based on Developmental Work Research [4, 7], which challenges the existing routines of leadership and tools for assessing and reconfiguring teamwork as well as classroom practices. Over time, the school we work with has implemented a set of high-quality evaluation and improvement routines integrated with a Learning Management System (LMS). These learning technologies are widespread in the organization and widely used by both teachers and students.

In collaboration with the school, we have identified the need for a technology for “shared spaces, tools and communities” (SSTC for short), targeted to stimulate cross-level (teacher-student) reflections on social and educational practices. We believe this can serve as requirements for improved systems of knowledge sharing and management at the school. Specifically, we have explored the principal’s and the pedagogical leadership group’s strategies and tools used in these changing work conditions.

The SSTC strategy includes the following components: 1) a wiki technology for storing and reusing resources for analysis and reconfiguration of tools and knowledge objects (Shared Space technology developed in KP-Lab project), 2) a set of conceptual and cultural tools for reflection on practices like external school review data, ideas/models of data interpretation, design models for collective assessment, 3) video technology to be used for description and reflection on teamwork and classroom practices, and 4) community meetings and workshops for school leaders and teachers. We have observed group interactions in meetings and workshops, analyzed management routines, tool usage and configurations of prioritized school development objects at different stages of development. The methodological approach is based on the experiences gained in a previous intervention project at the same school. In that project we developed a TEWL for teachers by use of video paper technology [12].

The SSTC-strategy can be looked upon as a collection of mediating tools for professional development and institutional change. They are interconnected through a common activity system [7], involving all members of the leadership group including the principal. We observed that the conceptual tools brought into the intervention process
by the researchers and the participants themselves play a major role in the knowledge transformation process of this activity system. As such, the conceptual framework of the wiki technology space becomes an important part of the tools being used, but without being used as a material artifact only. The videos of teamwork and classroom practices have a lower threshold for being used and integrated into the designed practices.

The knowledge transformation process described in this case study shows that the wiki technology in itself (interfaces, infrastructures) designed for facilitating the sharing, storing and analysis of knowledge practices plays a minor role in the team building and knowledge creation process. The underlying ideas of this tool design are the most important ones used by the participants in analyses and object development work. Videos used in interactive workshops play an important role for reflection and shared understanding of practices. We observe that the tools implemented for mirroring and analyzing knowledge practices is gradually adopted as an important means for supporting the leadership work.

The main conclusion, so far, supports the understanding of knowledge management and creation in this particular organization, as a part of social and contextualized process being supported by a range of resources. It is worth stressing that the application of advanced technology is very much dependent on the social practices at hand, the time line for implementation and how conceptual ideas of the technology fit into existing as well as potential future practices.

C. Standardized Work Descriptions

To further understand the evolving nature of KM, the Standardized Work Description (SWD) case study offers ample opportunities to explore the design and introduction of a comprehensive knowledge infrastructure in a health care institution. This infrastructure is seen as a resource to support a future, patient centric workflow, and to support the staff to work competently in different care settings. Specifically, we have explored nurses’ negotiation and consolidation of local procedures with a standardized repository of work descriptions, the PPS-procedures. Practical Procedures for the nursing Service (PPS) is a technological repository of nursing procedures the hospital bought forward as a measure to support and facilitate evidence based practice, as well as more uniform treatment of patients.

We observed several working groups that met regularly to review standardized and in-house versions of the work descriptions. These groups proposed, negotiated and decided upon local additions to consolidate the repository of work descriptions. Over time, practice has evolved; consequently, standardized descriptions as well as in-house procedures are more or less updated and accurate. However, the process is long and tension-laden, often leading to local amendments and, consequently, many versions of each procedure [16]. During the negotiations the groups suggested hospital specific changes and amendments to the work descriptions before acceptance and inclusion in the knowledge infrastructure. The main objective of the consolidation process was to reduce variation and suggest necessary hospital specific additions as well as changes to the standardized procedures. In the process, the groups also commented on the usability and the design of the tool; this has been reported to the developers for further development.

As part of the process to re-design and customize the electronic knowledge repository for the organization’s use, the participants draw on different resources. We found interactions and interplay of formalized, highly abstract knowledge and shared understanding of situations where the SWD would be used, but also systemic routines expressed as collective expertise and personal experiences. Negotiations in the working groups are examples of social practice and activities where knowledge in different representational modes is used and shared before being transformed into prescriptive text as working procedures. In the consolidation processes we find that accumulated expertise and interpretations of accepted knowledge are local and contextualized resources. These resources are activated to make the repository of work descriptions applicable to their work context [16]. The consolidated repository is a re-designed tool that they integrated in their larger knowledge infrastructure, the Electronic Quality System (EQS). This is now a shared, customized knowledge infrastructure for this particular organization, and our next step is to study how this tool will contribute to the workplace’s envisioned future practice.

The hospital’s systematic review can be seen as a knowledge creation process, and exemplifies a capacity to explicate and advance workplace knowledge, consolidate what is already known in the work practice, and contribute to supporting new, innovative approaches. Drawing from interviews, negotiations play a part to further develop and design the tool, and the opportunity to feed the changes into the development cycle is considered most valuable for supporting and implementing the re-designed, standardized work descriptions as a part of the knowledge infrastructure. The created knowledge also leads to global changes in the standardized work descriptions, in the content as well as the further design of the repository.

For this particular hospital, knowledge creation is seen as a continual process, necessary for sustainable changes in knowledge practice, and to secure the seamless operability, relevance and invisibility of the knowledge infrastructure [19]. In sum, the empirical findings from this case study support the shift in KM approaches towards a social understanding of knowledge management and knowledge creation in the organization.

IV. SUMMARY AND CONCLUSIONS

We have developed a conceptual framework for TEWL based on the capacity of knowledge management to support ‘knowing in practice’. To that end, we suggest that existing KM approaches should be complemented to provide support for TEWL and knowledge creation in workplaces. Particularly, this evolution represents shifts from individual to collective efforts, and from stable to dynamic and multi-representational advancement. It also calls for further exploration of what constitutes knowledge of infrastructure. The case studies illustrate processes and tensions stemming from the efforts to find a balance between general and specific development. On one hand, they deal with standardizing work or providing common information systems for a large group of users, and on the other, dealing with localized problem solving and adapting the tools and practices toward specific needs.
These two levels rarely coincide and mutually influence each other in a dialectical relationship.

To what extent does the sociocultural perspective on knowledge management address the problems associated with technical and sociotechnical KM? We refer to this as the “problem of enactment,” getting things out of knowledge management repositories. This is related to the fact that knowledge may be accessed at different stages: before, during, or after knowledge-related activities by different people with different background and in different work contexts. With the sociocultural perspective we study the pervasiveness of knowledge in organizations and the situations where knowledge and work intersect, i.e. the complex sociocultural settings in the interaction between developers and users of a project planning software, discovery, analysis and redesign of teachers’ classroom practice in an upper secondary school, and consolidation of localized work descriptions with standardized descriptions to be used at a hospital as part of a KM system and together with the knowledge infrastructure at that workplace.

We believe the cases we have presented provide examples of “knowing in practice,” which means actively attending to and including resources from a wide variety of technical, sociotechnical and sociocultural tools and knowledge infrastructures, beyond the purely codified and easy to explicate and represent, but not excluding it. Challenges we have encountered are that to a large extent the ICT systems we have studied are not up to date when it comes to the potential we wish to exploit with them. For example we have found that the tools have to provide broad channels of communication, go beyond technical infrastructures, and they have to be easy to update and modify. The methods associated with this have to be cost effective and flexible. In light of this we are currently exploring new methods and tools, such as the agile development method in software engineering, semantic web middleware, and web 2.0 applications as end-user tools.

ACKNOWLEDGEMENT

The authors thank the InterMedia staff and students who participated in the KP-Lab project: Renate Andersen, Kinga Horvati, Shazia Mushtaq, Damir Nedic, Sturle Nes, Svein Olav Norenes, Kathrine Nygård, and Espen Olsen.

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Manuscript received 15 April 2008. Developing knowledge-practices laboratory (KP-Lab) is an integrated project (IP) financially supported by the European Information Society Technologies (IST) Program, under contract no. 27490.

Published as submitted by the authors.