Integrating E-learning with Performance Support: Workplace Learning as Extension of Work

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Abstract—The paper is a case study of E-learning introduced in a chain of the gas stations in Norway. First we develop a conceptual framework for the analysis that distinguishes primary work and secondary work. Next we describe the design process of the E-learning system (web portal for short), as it is integrated with an existing work practice and performance support system. Then we conduct an empirical analysis of the adoption process of the integrated learning environment at selected gas stations. The analysis focus in particular on the multiple information-seeking strategies the employees make use of during work and which they rely on as they alternate between primary and secondary work. The findings are discussed in terms of “gap closing” primary and secondary work, and co-existence of old and new technologies.

Index Terms—Evolutionary prototyping, learning-on-demand, participatory design, technology-enhanced workplace learning.

I. INTRODUCTION

Since the introduction of the World Wide Web in the early/mid 1990s, online (web-based) learning has attracted a great deal of interest in the service sector in Norway and many companies are now pursuing web-based learning for all or part of their staff. Therefore, we refer to E-learning as web-based learning and we use the terms “web-based learning portal” and “web portal,” to refer to the educational technology. This form of learning can strengthen the integration of work and learning when part of the work is computer mediated, which is increasingly becoming the standard for most workplaces.

The paper presents and analyzes data from a three-year Norwegian project, Learning and Knowledge Building at Work carried out between 2001 and 2004. This project was organized as a consortium of two companies in the service sector, the Federation of Norwegian Commercial and Service Enterprises, and three research institutes (one being the University of Oslo). A goal of the project was to introduce web-based learning in the two companies. One of the companies is the gas station division of an oil company (hereafter called ServiceCompany). A primary emphasis has been on using participatory design techniques during the planning stages and evolutionary prototyping during software development [14].

From the ServiceCompany’s point of view, web-based learning is a way to organize work to help reduce the high turnover rate among its employees. The average worker at a gas station stays in the company for about 12 months. Although the work at the gas stations is, for the most part, manual labor, it is thought that the addition of online training could extend this time by giving employees more enjoyable conditions in which to work. It was estimated that this could be achieved in at least two different ways:

1. Improving the interaction between customers and attendants; and
2. Providing online access to product information in a uniform way.

Both of these goals are challenging. First, the work is not computerized. Computers are integrated in the cash register and through a single computer in the back office of the stations. Second, there are, to the best of our knowledge, no established theories of technology-enhanced workplace learning to guide our analytic efforts. We have developed a conceptual framework that integrates insights of a diverse (but compatible) set of existing theoretical frameworks that focus on different aspects of technology-enhanced workplace learning, namely situated action and apprenticeship learning [4, 17], learning on demand [7], computerized work [9], and gap-closing activity [6, 13]. This has helped us to identify secondary work characteristics, and to understand the similarity and complementarity of primary and secondary work.

This paper will address the following: We start by identifying issues for workplace learning in order to develop a conceptual framework for analysis of educational technology adoption in a workplace and its early use. Next we describe techniques for involving users in the design process, followed by an evolutionary prototyping technique to incrementally deliver a web-based learning portal. Then, we make use of the conceptual framework to analyze findings from a field trial of a new web portal integrated with an existing work practice. At the end, we discuss our findings and compare our results to related research.

II. ISSUES FOR E-LEARNING IN THE WORKPLACE

The need for learning at work in service work is evident as skills and abilities required for performance when serving customers is high. Previous studies have shown that customer interaction provides a rich setting for studying learning at work [12]. However, the combination of high demands on quality of customer interaction and the rise in number of products and services an employee needs to know about to successfully perform have given rise to new demands on workplace learning. Indeed, the gas stations we studied are also effectively small supermarkets, fast food snack bars, and outlets for automobile products. The employees in these multi-purpose service centers are faced with a large inventory that contains many different products and services they need to know about. In fact, there are few people who
know everything because knowledge has become increasingly specialized and fragmented and the staff is often young and inexperienced.

One basic characteristic of the work context is that the need for learning is grounded in a real concern, but this need may not always coincide with an opportunity to sit down and study the problem to resolve it optimally (i.e. conventional learning methods). The starting point is therefore real situations in context of work. A theoretical framework that addresses this type of learning is apprenticeship learning [4, 17]. Apprenticeship is about bridging the gap between conceptual (high-level) understanding and practical problem solving in day-to-day work, and this gap is evident in the ServiceCompany. On one hand there is a corporate training program institutionalized by the company, which defines generally useful information every employee should know. On the other, practical concerns and local problem solving occur in the gas stations on a daily basis, and cannot always be planned for in advance. Apprenticeship is the learning method preferred by many of the employees we studies and can be illustrated by the following hypothetical situation.

A customer is asking an attendant for help measuring the car’s antifreeze level on the liquid cooling system, but the attendant cannot respond the customer’s request. He or she then asks a more experienced colleague at the station to demonstrate the procedure for the attendant. Therefore learning can, in this context, be seen as a by-product or side effect of practical action, not as an end in and of itself. The training programs provided by the HR department of the company can identify these learning needs and provide programs to support it, at a general level [11].

A. Primary and Secondary Work

We understand workplace learning at the gas stations we studied as an extension of the daily work and the two basic processes we focus on are referred to as primary work and secondary work. Secondary work is our main focus. By secondary we do not mean work that is less important, but of a different and related kind. Furthermore, we understand the integration of primary work and secondary work as a “gap closing” activity [6, 13], which in inevitable in complex work. Primary work refers to the main tasks to be accomplished during a workday and these tasks are often written in a work description. Secondary work supports and augments primary work in more or less convenient ways and comes to the foreground when the work is analyzed in detail or is otherwise disrupted and becomes an object of reflection. The boundary between primary work and secondary work is not fixed, but floating: gradually changing as secondary work is absorbed into primary work and as old work routines dissolve.

Reference [9] was one of the first researchers to study computerized work as secondary work and defined it (without using the term) as composed of articulation work and adaptation work. Articulation work, a term borrowed from Reference [18], is the work involved in coordinating interactions between “social worlds” of people, technology and organization, and at a more detailed level, to “smooth out inconsistencies” in primary work tasks [9]. It applies to a wide range of application domains, ranging from interactive customer service [10] to air traffic control [20].

Gasser identified three types of adaptation work: Fitting, augmentation, and working around. Fitting is the strategy of modifying a computer system or changing the structure of work to accommodate a mismatch between employee and computerized work tool. Augmentation refers to undertaking additional work to make up for an inconsistency in primary work [9]. As such, it can be seen as an extension to primary work. Working around refers to using a computer system in ways it was not intended, or avoiding its use and relying instead on alternative, suboptimal means. One example is backup systems [9]. They are older technologies one relies on when the main work support fails or becomes temporarily unavailable. They can be manual or computerized and may even be redundant in functionality and duplicate data across systems. An example is the use of post-it notes around a computer display in order to remember difficult commands.

The distinction among types of work has helped us to conceptualize the gap between high-level understanding and practical problem solving that forms the backbone of the apprenticeship model. This can further be enhanced with computer-based tools in order to bridge the gaps between high-level understanding and practical problem solving, which is manifest in the activities of primary and secondary work, and more concretely in terms of practical problem solving and information sharing in the ServiceCompany. An approach to this is learning-on-demand [7]. Learning on demand is how scaffolding techniques can be embedded in information systems to find and present information to resolve a difficult situation associated with the task at hand. This could be by connecting the attendant in the above situation with a more experienced colleague, or automatically by the system itself, supporting the retrieval or autonomous delivery of relevant information from the company’s knowledge management system.

### III. The Design Process of the Integrated Learning Environment

One of the primary goals of the Learning and Knowledge Building at Work project was to involve the workers at the gas stations in the design of their new ICT supported learning environment and future workplace. By making the employees “owners of the problems” [8], and “champions of the project” [22] they helped us to:

1. Identify situations for which technology-enhanced learning could improve existing work practice;
2. Sustain the project after it was completed.

This was accomplished using Participatory Design (PD) techniques [1, 5]. We made extensive use of PD techniques, in particular mock-ups (Figure 1), exploration of design alternatives, role-playing, and learning scenarios. These techniques were used during the planning stages. This was followed by hardware and software prototyping during which we made use of evolutionary prototyping techniques. This was in order to create a gradual transition from informal (user readable) representations to software (computer readable) representations, and to extend local employee ownership.
A.  **Mock-Ups and Design Alternatives**

The use of low-fidelity mock-ups for rapid prototyping has been an integral part of the PD tradition since it was pioneered in the UTOPIA project [5]. It is widely recognized that communication with end users must be done through concrete representations of ideas, and that such representations nurture the creativity of both end users and researchers in cooperative design settings [21].

The mock-ups the employees created were not merely representations of their collective understanding of their workplace. The materials employed are inexpensive, concrete, and readily available, which meant that the participants could create different versions of their ideas in a brief period of time, thus empowering all those who wanted to take part, including those without the background for or interest in using computers (Figure 1). When the employees had envisioned and modeled their ideas, the mock-ups needed some polishing before they could be presented to the developers in the IT department (who later developed solutions, see section on Evolutionary Prototyping). The researchers made new mock-ups by varying the size and refining the interactive behavior of the user generated representations. Together they served the dual purpose of providing intermediate abstractions for talking about design and transforming the early design suggestions into hardware and software prototypes. As such they served as “boundary objects between the users and the researchers, and between the researchers and the IT department.

The mock-up that was chosen by the ServiceCompany was a large-sized information display. The deciding factors in the selection process were the envisioned location in the store of this mock-up and its size; it was thought that the smaller sizes would more easily be misplaced by attendants or stolen by customers. Nevertheless, the employees definitely contributed to the decision-making process through their constructive participation in the workshop and by their critical feedback afterwards. They generated ideas, made clear what they wanted, and understood the role of intermediate abstractions.

B.  **Role-Playing and Learning Scenarios**

We employed a technique we called “learning scenarios,” which are work interaction scenarios that depict potential learning situations at the gas stations. The employees created the learning scenarios in small work groups based on examples provided by the researchers. The scenarios described work situations that were either complex and would require assistance by a colleague or a tool and/or were current situations that could be improved upon. After the scenarios were created we executed (played) them, similar to how role-playing is done in dramaturgy.

We hired a professional theatre instructor to provide the participants with an introduction to dramaturgy for the purpose of creating convincing scenarios (to fuel interest and acceptance in the company at large). The participants consisted of station attendants, regional managers and researchers. In collaboration they created scripts that were later enacted in two situations.

The second situation was to simulate future work, which was dramatized in two acts. The second act (Figure 2) incorporated and resolved the breakdowns identified in the first act. This was accomplished by a technique called “freeze spots,” which are external interruptions by an interlocutor to stop the action and create a temporary delay in performance. The delay is meant to trigger reflection and stimulation for what to do next in the current situation. The actors are asked to continue with a recovery that takes the situation in a new direction than originally planned [3]. When we dramatized the future work situation with the aid of recovery props (mock ups and other available methods), the employees were able to...
see, in a semi-realistic way, the extent to which they were able to improve upon their current work situation and recover from a difficult situation by resorting to the available support.

C. Evolutionary Prototyping

The Service Company’s IT department created the first computer-based prototype based on one of the refined mock-ups. This prototype was a touch screen-mounted terminal facing the attendant and placed in a pilot station for a period of two months. The system contained product information about car batteries and windshield wipers. During the trial period, all employees at the gas station explored the prototype’s features at least once. They were eager to tell us what they thought of it and how it could be improved. The feedback we received gave us the impression that the employees had a real need for access to detailed information about automobile products due to the complexity of this type of information and the frequent request from customers. The employees were enthusiastic about having a web-based tool that could supply this information. This initiated an evolutionary design process [15].

Although initially intrigued by the system, the attendants only sporadically used it. Its design was criticized in for various reasons. For example, the information was organized from the perspective of the system’s builder (IT-department) and not from the perspective of the users’ problem situation (i.e. several menus had to be traversed to retrieve the necessary information). Furthermore, the attendants misunderstood the use of color-coding to differentiate the various models and types of automobile products and in some instances they found it difficult to understand the written explanation on the products displayed on the screen. Based on these findings (revealed during a usability test), we decided to improve the user interface by using a simpler navigation structure, more intuitive symbols and a uniform organization of information for all automobile products that matched to the established color-coding schemes to the extent possible.

In the next round, a third prototype was developed. The decision-makers of the company (the IT department in collaboration with HR department managers) saw the potential of the previous prototypes and opted for a web portal delivered on a laptop (Figure 3). In addition to automobile product information, hot food procedures, news, and product campaigns from the central administration were incorporated. The rationale for the new information added was to integrate the portal with the company’s existing communication and information sharing system. Furthermore, a bulletin board was added as an extra tool. The aim of the bulletin board was to support communication among employees at the three pilot stations with the option that the other stations would be able to use this feature at a later date.

However, there was no mandated use of the system. After another usability test, the system was improved and the database increased by additional information, eventually making it a pilot web portal, supporting realistic usage. The latest version (completed one year after the project ended) has been installed at 230 gas stations (Figure 4), mainly in Norway, but some in the other Nordic countries as well.

IV. ANALYSIS OF RESULTS

A. Data Collection

Data was collected by observation, interviews, and survey (online questionnaire). Triangulation was used to crosscheck data. The questionnaire was sent to 25 retail stations, representing the 230 stations where the portal has been installed [16]. The majority of the respondents were attendants in the age group 20-29. The average number of years working for the company was three. The items in the questionnaire concerned information-seeking strategies employed during daily work as this was judged to be an important method for integrating work and learning. Thirty-four respondents completed the survey and on average, one or two persons from each of the 25 retail stations took part in this.

B. Design Process

From an evolutionary prototyping point of view, we see a shift from a focus on performance support for small, localized groups toward new tools for communication and information sharing for the entire company. This is primarily a result of the company-wide initiative launched by ServiceCompany after the third prototype was installed to provide a shared portal for the organization. This merged with our grassroots user participation initiatives at selected stations. The end result could be seen in at least two different ways: 1) as a (partially completed) web-based learning environment supporting workplace learning according to the learning-on-demand strategy [7], and 2) as a centralized information-sharing system.

Figure 3. Third prototype (portal on laptop) created on initiative by the ServiceCompany. Left picture shows the location of the laptop at end of the counter. Right picture shows the user interface.
findings can be grouped into the following categories:

emerging as a new form of work [2].

From an organizational learning point of view, we see a shift from local engagement to an alignment with the company’s overall profile and shared values. The hands-on, work-oriented material of the mock-ups and dramaturgy sessions [21] created a close connection with the operations of the first prototype, thus resulting in a higher level of engagement than we have seen with the third and fourth prototypes. On the other hand, the third and fourth prototypes have more durability due to corporate backing. If the latest version is allowed to evolve over time it may eventually lead to a system that will meet with enthusiasm and engagement by the employees.

C. Early Adoption and Use

The data we report from below pertain to the use of the third and fourth prototype [16]. With the fourth prototype the adoption process in 230 stations lasted for about 14 months, and the data collected represents a three-month period during which the portal had been installed at 25 stations, 3 to 6 months after the first installation. Even though the use of the system was not mandated at the general management level, the station managers encouraged the attendants to use it and the attendants were informed about its introduction well in advance. The station manager and the colleague at home if he or she encountered problems that no one present could answer. The station manager and the assistant manager were the two people most likely to be contacted in this way.

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The findings can be grouped into the following categories:

- Integrating primary and secondary work;
- Information-seeking strategies;
- Co-existence of old and new technologies.

1) Integrating Primary and Secondary Work

We see a continual shift between primary work and secondary work in the following way. Primary work (e.g. serving customers) is periodically updated to reflect the demands of society in terms of customer needs and to provide a certain image of ServiceCompany to the outside world about its priorities. Secondary work is often the source for updates to primary work because it is more responsive to new innovations and less rigid than explicit work descriptions. Furthermore, access to information to answer everyday questions has increased a result of the ServiceCompany’s continual effort to expand into other market segments. To stay abreast employees must continually adopt the new methods and practices introduced with new business areas in case the older ones become unavailable for further use.

This can be seen as gap closing activity [6, 13], which for the employees means to gradually extend the scope of their repertoire of working methods while simultaneously evaluating the relevance of the existing methods. Gap closing is an important part of secondary work. This was accomplished when reflecting on what methods to choose for information seeking.

2) Information Seeking Strategies

Information seeking was identified to be the main secondary work method. It was used to find required information to carry out primary work tasks. We asked the employees at several stations how they would get access to the relevant information if none of the self-help strategies applied. A representative answer was: “We just pick up the telephone and call a nearby ServiceCompany station.”

The new web portal was implemented more or less in competition with already well-functioning technologies for communication with others. The employees had already established information-seeking strategies that supported a kind of “learning on demand.” These methods currently outperform computer-based information retrieval. Table 1 gives an overview these methods for supporting primary work, ranked according to frequency of use.

| TABLE I INFORMATION-SEEKING METHODS BEFORE THE PORTAL (N=34) |
|-------------------|------------------|
| Method            | %                |
| Ask a colleague   | 81               |
| Paper catalogs    | 58               |
| Staff meetings    | 50               |
| Call a colleague  | 38               |
| Post-it notes     | 19               |
| Call another station | 19            |
| Product sheets    | 19               |

Results from the survey show that 81 percent of the respondents said that to ask a colleague was the most useful approach to seeking information. In addition, 38 percent of the respondents said they would call a colleague at home if he or she encountered problems that no one present could answer. The station manager and the assistant manager were the two people most likely to be contacted in this way.

The other frequently used methods for information seeking were paper catalogs (58 percent) and staff meetings (50 percent). Paper catalogs refers to vendor specific product catalogs. The catalogs were consulted when an attendant needed specific information about automobile products. The staff meeting was a weekly forum for information exchange where questions could be asked. When new products were introduced, the attendants would be informed about them at the next staff meeting.
3) **Co-Existence of Old and New Technologies**

After the portal was introduced, 46 percent of the respondents said they stopped using one or more of the older methods. We have no data that indicate which specific method(s) was replaced by the portal, but we have anecdotal evidence the post-it notes and calling colleagues at home were seen to be redundant and no longer needed.

Regarding use of the portal, one of the respondents said: "It simplifies work to get rid of all the papers scattered around the cash register and to get all this information in one place." Paper-based methods that are costly to produce (e.g. fancy product sheets and automobile parts catalogs) or those that tend to mess up shared workplaces like post-it notes may eventually disappear when web-based methods take on a more dominant position. New innovations tend to make older technologies obsolete (for example the mobile phone has made coin-operated public phones obsolete in many parts of the world, and online phone books have replaced paper-based catalogs, etc). Critical mass, early adopters, peer pressure and mandated use are important social factors for successful adoption of the new technology at the gas stations we have studied.

On the other hand, if older technologies (such as the telephone or paper-based catalogs) continue to be sought after so that the market for periodic updates and service remain, these technologies will persist as well. The remaining 54 percent of the respondents said they continued to use the older methods despite the availability of the portal. In fact, several employees preferred to use the paper-based catalogs instead of the information display in order to find product information quickly. As the paper-based catalogs instead of the information of the portal. In fact, several employees preferred to use continued to use the older methods despite the availability of the new technology at the gas stations we have studied.

The management’s position on the issue is to make the work as efficient as possible, and to profile the company as a leader in the field. They plan to terminate the production of some of the older methods, which are costly (e.g. updating paper-based manuals). As we have shown, many employees at the gas stations believe it is important to have alternative means for accomplishing work, even if some of the alternatives are sub-optimal. Therefore, removing the sometimes sub-optimal alternatives may complicate recovery from a difficult situation and prevent work completion altogether. It seems that older methods have a well-defined role as backup system [9] in the ServiceCompany. There were plenty of backup systems at the gas stations we visited and they provided recovery when the recommended method failed.

Reference [19] calls a similar phenomenon “artful integration,” which she defines as a hybrid of technology and work practice where technology is comprised of multiple layers of heterogeneous devices, each associated with a specific generation of work support. In our case, this would mean the coexistence of multiple technologies and practices associated with helping employees to serve customers and find information: cooperative problem solving with customers, contacting senior colleagues, checking customers’ automobile parts, paper-based catalogs, and web-based portals.

V. **SUMMARY AND CONCLUSIONS**

We have over a 3-year period participated in the introduction of a web-based learning environment for a group of employees at a large Norwegian service company, the gas station division of an oil company. During the early phases of the project we made extensive use of participatory design techniques to involve future users (employees) in the process of designing their future workplace. They created mock-ups and learning scenarios that suggested new ways of working, simplifying some of the current work, and providing new opportunities for learning. Learning in this context is seen as an extension of work, implying direct access to relevant information that can help improve work performance. To distinguish these two forms of working we introduced the terms primary work and secondary work. To extract the “e-learning potential” from this, we asked the participants to reflect on the process from which we produced a first prototype. After the introduction of the first prototype the focus changed from user participation to company-wide initiatives at selected pilot stations.

The new information system and accompanying learning resources have not yet been fully integrated into daily work practices in the ServiceCompany; employees therefore rely on other information-seeking methods they are already familiar with. In this regard we provide new insight into the successful co-existence of old and new technologies and the use of multiple information-seeking strategies in everyday work.

ACKNOWLEDGMENT

The authors thank the InterMedia researches and students who participated in the LAP project and contributed to the research presented here: Camilla Brynhildsen, Leif Lahn, Mari Ann Skaanes, Ida Tødenes, and Hege-René Hansen Åsand.

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Manuscript received 15 April 2008. The Research Council of Norway supported this work.

Published as submitted by the authors.