E-learning at work: theoretical underpinnings and pedagogical challenges

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Abstract

Purpose – First, to explore the application of e-learning as a medium for workplace learning, as a form of adult learning and organisational learning from a theoretical point of view, second, to review empirical studies on recent solutions to pedagogical problems encountered in workplace learning in general and in e-learning in particular, and finally, to consider the challenges facing the further development of e-learning solutions targeted at the workplace.

Design/methodology/approach – The paper reviews theories of adult learning, workplace learning and organisational learning and brings out main pedagogical implications of these theories from an e-learning point of view. Some empirical studies in which electronic networks and communication tools have been utilised in workplace learning are also described.

Findings – The development of successful e-learning solutions for the use of work organizations requires integrating research knowledge from different sources: theories of the learning organization, sociocultural theories of learning, and cognitive theories of learning.

Practical implications – Based on empirical examples and the literature review pedagogical challenges and theory-based guidelines are presented for the design of e-learning environments for the workplace. These include integration of theoretical knowledge with participants' practical experience, support for the explication of implicit knowledge, and encouragement of collaboration and knowledge exchange between different groups of people.

Originality/value – This paper integrates different theoretical approaches for the design of e-learning environments of work organizations.

Keywords Learning, Workplace learning, Computer based learning, Adult education

Paper type General review

Introduction

Information and communication technology (ICT) has a dual role in the information society. On the one hand, it is assumed that our future information society and its educational contexts in particular will be subject to various unpredictable changes. The increasing challenges produced by rapidly changing, knowledge-intensive and technology-oriented working life presuppose that facilities for life-long learning and the continuous development of competence can be guaranteed to people in different phases of life. On the other hand, it is expected that ICT can help in finding solutions to these challenges.

The history of e-learning is short, and it can be characterized by rapid changes in technological development. This has been also the biggest problem in e-learning. In the history of this field, the dominance of technology-driven approaches is illustrated by the existence of various acronyms such as CAI (computer-assisted/aided instruction), distance learning, blended learning, mobile learning etc. What changes rapidly is the technology, not the basic processes of learning. It is rather worrying that e-learning is

sometimes interpreted in a narrow sense as referring to process of delivering digital information and study materials to people through the electronic media. The most optimistic views suggest that global networks and the use of computers for intellectual communication will automatically expand the ways in which humans connect, communicate, and create a sense of community. Such views oversimplify the notions of knowledge and learning, and lead easily to misunderstandings, disappointments and irrelevant pedagogical practices (Häkkinen, 2002).

Since traditional models of distance learning have not inspired researchers and teachers to develop innovative pedagogical practices, current research and development work in the field has turned towards creating multi-faceted pedagogical practices, utilizing ICT, that can support learners in their efforts to engage in deeper-level learning and interaction (Häkkinen, 2002). One of the recent developments is the emerging research area known as computer-supported collaborative learning (CSCL), which aims at creating powerful learning and communication environments by integrating collaborative learning and the use of ICT (Koschmann, 1996). Two traditions that have strongly contributed to the development of CSCL are research on co-operative (Forman and Cazden, 1985) and collaborative (Dillenbourg, 1999a) learning and research on computer-supported cooperative work (CSCW) (Dourish, 1999). Although there exists no unified theory of CSCL, the common feature for diverse standpoints is to focus on how collaborative learning supported by technology can enhance peer interaction and working in groups, and how collaboration and technology facilitate the sharing and dissemination of knowledge and expertise among members of the learning community. CSCW, on the other hand, is revealing issues concerning the collaborative nature of work supported by groupware. The latter tradition has excluded issues on learning, but has provided a foundation for the development of groupware tools for learning purposes and interesting contexts for knowledge-intensive work and learning at work.

Despite ushering in new possibilities for information sharing, building and mediating meaningful knowledge is not unproblematic in e-learning contexts. Although e-learning, e-working or e-meeting are popular today, research on adult learning and expertise and on organizational learning has not systematically been utilized in designing e-learning systems for organizational use. Therefore, the purpose of this paper is to:

(1) Explore the application of e-learning as a medium for workplace learning from a theoretical point of view, as a form of both adult learning and organisational learning.

(2) Review empirical studies to recent solutions for pedagogical problems encountered in workplace learning in general and in e-learning in particular.

(3) Consider the challenges facing the further development of e-learning solutions for the workplace.

Employees as adult learners

When discussing e-learning in the workplace our starting point is that the learners are adults. Young people, apprentices and trainees, are also found in workplaces, but in this paper we focus on learning solutions designed mainly for adult employees. We start by examining what adult learning is, in the belief that adult learning theories should form the basis for the design of e-learning practices for work environments.

Common to all of the most influential adult learning theories is the emphasis on personal reflection on the learner's experiences. For example, Schön (1983, 1987) describes the significance of reflection-in-action and reflection-on-action for learning. Similarly, the experiential learning model by Kolb (1984) presents reflection on experience as one key element in the learning cycle, other elements being abstraction and experimentation. Mezirow (1991) has coined the concept of transformative learning, which is a process in which a learner challenges and questions his or her existing assumptions and through critical reflection creates new meanings and new assumptions. Research on school learning has similarly paid attention to the significance of examining one's beliefs and conceptions, but usually this has been conceptualised as metacognition (Hacker *et al.*, 1998) or metaconceptual awareness (Vosniadou, 1994) instead of reflection. The basic cognitive processes, though, are the same: critically analysing one's previous knowledge, conceptions and basic assumptions in the light of new approaches and insights, leading to the transforming of one's knowledge.

Another point made by learning theorists is that the process of knowledge construction is basically a social process. Theorists of situated learning have emphasised the role of communities of practice in learning (Brown *et al.*, 1989; Lave and Wenger, 1991; Wenger, 1998). Communities of practice are informally and naturally formed of people working and interacting with each other. We all belong to several communities of practice, whether at home, at work, at school, in our leisure time. The role of peer-to-peer interaction and mutual communication is important in these communities for mediating and forming common values, understandings and practices.

A third point typical of adult learning models is a problem orientation. As adults have more or less experience of work and problems of working life, problem-based approaches are often favoured. For example, Revans (1982, 1985) has presented a model of action learning, which is a process that starts from questions raised by a problem, leading to a hypothesis and experiment, verification and review. The idea is that the starting point of the learning process is a real-life problem of significance to the learner. Similar approaches in formal education are problem-based learning (PBL) (Boud and Feletti, 1991; Dochy *et al.*, 2003) and project-based learning (e.g. Helle *et al.*, 2005; Olesen and Jensen, 1999). In a working life context, Jäntti (2003) has presented a model which integrates PBL and project work.

A fourth aspect that needs to be taken into account when dealing with adult learning and e-learning in the workplace is that most workplaces can be described as organisations and that the learning activities intended and supported are usually aimed at benefiting the organisation, in the form of improving its functions, process, products or practices. Therefore, theories which approach learning at an organisational level provide important insights for e-learning design. Many of these theories see individual learning as a prerequisite for the learning organisation (Argyris and Schön, 1996; Senge, 1990). They also emphasise the role of social processes in transforming individual learning into organisational learning.

A final question often associated with workplace training is flexible delivery (Smith, 2003). Consumers of training are seen as clients who can control when it is learnt, where learning takes place and even what it is learnt. For this approach to training and workplace learning, e-learning is well-suited. Adult learners appreciate

high learner control. Asynchronous communication systems provide a means for learners to access learning materials and discussions at the time they choose, and in the place they prefer.

In sum, adult learning, at its best, is based on – or at least utilises – learners' experience, involves the learner in a reflective process and in social processes, is problem-oriented, aims to benefit both personal development and organisational learning processes, and is organised in flexible ways.

Workplace learning vs school learning – or integrating the strengths of both

At the end of the eighties some researchers began to pay attention to the differences between school learning and workplace learning (Resnick, 1987). The most obvious and the most often mentioned difference between these environments was that school learning is formal, while learning at work is, or has traditionally been, mostly informal and incidental (Eraut *et al.*, 1998; Marsick and Watkins, 1990). Another difference was that, at least in traditional pedagogy, school learning has been abstract and decontextualised. In other words, it has been separated from the context in which the knowledge and skills are to be used. In contrast, learning in the workplace takes place in the context of use and application, simultaneously, and is in a concrete way embedded in everyday problem-solving (Billett, 2002; Brown and Duguid, 2001; Eraut *et al.*, 2002; Gherardi, 2001). School learning has also basically been individual learning; students have worked individually, assessment has been based on individual performance, and collaboration even forbidden, especially in tests and examinations. In the workplace people, conversely, very often work together, and teamwork seems to be especially typical for jobs in the new economy and the information society (Castells, 2000; Reich, 1991). Naturally, learning, too, seems to be more collaborative in workplace settings. The outcomes of learning may also vary between the school environment and the workplace. While learning outcomes at school are to a great extent explicit, the results of workplace learning may often remain implicit. At its best unintentional and informal learning embedded in everyday practices produces functional tacit knowledge and intuition-like strong views typical of expertise (Bereiter and Scardamalia, 1993; Nonaka and Takeuchi, 1995). At its worst, learning may produce, similarly tacit, but unwanted bad habits and rigid practices (Slotte *et al.*, 2004).

Billett (2004) has recently challenged common descriptions of workplace learning as informal, non-formal, ad hoc, concrete and incidental. He argues that learning outcomes are not necessarily concrete and that workplace activities are directed towards continuity and are often inherently pedagogical. We can agree with Billetts's observations – at least partly, but we would elaborate them somewhat. We argue that learning at work as well as at school include both formal and informal aspects, although weighted differently. We also argue that workplace learning is not a single unified phenomenon, as it has often been described, using the labels informal, implicit etc. Instead, workplace learning, as well as school learning nowadays, may take place in different modes and it can take different forms depending on the individual's position in the workplace and on many contextual factors related to the workplace environment. At least three basic modes of workplace learning can be distinguished:

   (1) incidental and informal learning which takes place as a side effect of work (Eraut *et al.*, 1998; Marsick and Watkins, 1990);

(2) intentional, but non-formal learning activities related to work (mentoring, intentional practising of certain skills or tool use, for example); and

(3) formal on-the-job and off-the job training.

Furthermore, the learner in all these modes of learning may be in different positions such as trainee, apprentice, experienced worker, novice, expert, subordinate, superior, etc. The learner's position will have an effect on the conditions and processes of learning.

Slotte *et al.* (2004) acknowledge informal and formal learning as equally important elements of learning at work but also emphasise that they entail different processes and different outcomes. While informal learning occurs as a part of everyday work processes and activities and produces mainly implicit or tacit knowledge, formal learning takes place in the context of organised training and learning activities and is meant to generate explicit and formal knowledge and skills. According to Slotte *et al.* (2004), there are at least three reasons why informal learning alone is not enough. First, because informal learning takes place without conscious effort and yields mainly tacit knowledge, it may result in outcomes that are not desirable. Tacit knowledge does not only have positive outcomes; instead, it can also lead to bad habits and dysfunctional practices that do not necessarily serve the goals of the organisation. Second, in today's working life new knowledge is being produced at so rapid a rate that informal learning alone cannot ensure that the knowledge and skills of organisations and people will keep pace with it. Third, formal education and planned learning situations make it possible to exploit informal learning effectively, turn tacit knowledge into explicit knowledge and integrate conceptual knowledge and practical experience, the foundation for the development of expertise (Bromme and Tillema, 1995; Leinhardt *et al.*, 1995; Tynjälä *et al.*, 1997; Tynjälä *et al.*, 2003). For these reasons, Slotte *et al.* (2004) suggest that the different modes of workplace learning should be combined so that formal training utilises informal learning. This also has importance for e-learning solutions.

We suggest that to be successful, school learning should adopt certain features of workplace learning and of the development of expertise (Hatano and Oura, 2003; Tynjälä *et al.*, 2003) and, correspondingly, workplace learning should be developed by utilising strong features of formal school learning. Recent developments in school and university pedagogy, such as PBL (Boud and Feletti, 1991; Dochy *et al.*, 2003), project-based learning (Olesen and Jensen, 1999; Helle *et al.*, 2005), collaborative learning (Dillenbourg, 1999b) and utilising the idea of the learning community and distributed expertise (Rogoff *et al.*, 1996; Brown *et al.*, 1993) – as well as including work-based learning as a part of the curriculum (Boud and Solomon, 2001; Guile and Griffiths, 2001), are all developments which bring school learning closer to real life situations and practices. Similarly, in recent years, certain school-like features have been introduced into models of workplace learning. These include intentionality, structured learning support and guidance, explication of knowledge, conceptualisation and making use of problem-based and project-based approaches (Poell *et al.*, 1998; Jäntti, 2003). Next, we present some of the views and on the models of learning derived from the literature on both school and workplace learning which we find especially useful from the viewpoint of e-learning in the workplace.

Theoretical basis for e-learning in the workplace

We suggest that the development of successful e-learning solutions for the use of work organizations requires integrating research knowledge from different sources. First, the theories of the learning organisation, organisational learning and learning at work provide a general framework for analysing the contexts and possibilities for learning in the workplace. Second, sociocultural theories of learning (including both school learning and workplace learning) provide conceptual tools for understanding the social nature of learning. Finally, cognitive theories of learning and studies on the development of expertise both in educational settings and in the workplace make it possible to examine learning processes at the level of the individual. We share the view of Billett (1996) that cognitive and socio-cultural theories are compatible and complementary in understanding learning.

We start with the theories of the learning organisation which have recently described the phenomenon as a multilevel one, taking place at individual, group and organizational level (Crossan *et al.*, 1999; Lähteenmäki *et al.*, 2001; Slotte *et al.*, 2004). This means a challenge for e-learning solutions: how can learning be supported at all these levels? Crossan *et al.* (1999) have suggested that the three levels of organisational learning are linked by social and psychological processes which they call intuiting, interpreting, integrating and institutionalization. Intuiting and interpreting are individual processes, interpreting and integrating occur at the group level, and integrating and institutionalizing take place at the level of the organisation. In the learning process individual insights and intuitions are first explicated and interpreted by the person himself or herself and by others through words or actions. Through the process of integrating, individuals develop shared understanding and take coordinated action. Dialogue and joint action are essential for developing shared understanding. If coordinated action becomes recurring and significant, it becomes institutionalised, that is, organisational mechanisms are put in place to ensure that certain actions occur.

The significance of open dialogue, explicating knowledge and sharing ideas is also present in other theories of the learning organisation (Nonaka and Takeuchi, 1995; Senge, 1990). According to Nonaka (1994), sharing individual knowledge with co-workers is an important prerequisite for organisational learning processes. In order to transform individual learning processes into organisational processes, organisations need both recognition of the significance of sharing knowledge and opportunities for individuals to share their experiences (Lehesvirta, 2004). Consequently, e-learning tools should focus not only on delivering course materials and supporting individual self-study but also to make it possible for individuals to present their ideas and explicate their intuitions. Further, they should support not only discussion of different interpretations but also the storing of knowledge, unfinished ideas and shared decisions. In this way, e-learning environments could serve simultaneously as a tool of organisational memory. Some theorists of the learning organisation explicitly refer to the potential of information technology for sharing knowledge and developing mutual understanding (Pedler *et al.*, 1991).

While organisational learning theories pay attention to different levels of learning in organisations, sociocultural theories emphasise the role of community and authenticity in learning. Situated learning theorists have shown that it is not enough to describe learning in terms of individual cognition. Communities of practice to which individuals belong form units of action where people construct their identities and shared work

practices. Therefore, e-learning communities in which people have known each other for a long time are the most likely to function in a way conducive to shared understanding. However, e-learning environments may also be used to create new communities of practice which utilise the diversity and different viewpoints of participants previously unknown to each other. This is a process that takes time and usually requires long-term e-learning programmes. E-learning communities with participants who come from different fields, positions, cultures or levels of expertise, also make possible for people to cross boundaries and this way to develop new understanding and new ways of communication. This requires that people develop new conceptual tools and "boundary objects" for sharing meanings (Boland and Tenkasi, 1995; Engeström *et al.*, 1995; Star and Griesemer, 1989). Boundary crossing and conceptual development usually need to be facilitated by experienced tutors or consultants.

In addition to the social nature of learning, socio-cultural approaches emphasise authenticity: learning should take place in authentic environments or conditions and in ways similar to real life situations. Technology has made it possible to create virtual environments that almost exactly mimic authentic ones. Flight and driving simulators are well-known examples. Simulations have been created also for many other disciplines such as medicine and economics. Computer conference itself is a simulation of a social process. We suggest that different kinds of simulations could be used more as an integral part of e-learning.

In our view, theories of the learning organisation and socio-cultural approaches are essential for the development of e-learning in the workplaces. Equally important is understanding learning as a vertical and horizontal process of development in which individuals develop their expertise in social contexts. Vertical development refers to increase and transformations in a person's conceptual understanding, while horizontal development can be described as expanding a person's ability to act in new and different environments (Engeström *et al.*, 1995). Hakkarainen and his colleagues (Hakkarainen *et al.*, 2002, 2004; Paavola *et al.*, 2002) have described different approaches to expertise research through three metaphors: acquisition, participation and knowledge building (Sfard, 1998). The acquisition approach sees the development of expertise as an increase in cognitive capacities and individual skill development, while the participation approach represents the socio-cultural view, emphasising the role of participation in communities of practice. The knowledge building approach integrates the acquisition and participation metaphors and describes expertise development as a social practice of creating new knowledge. Knowledge building activities and boundary crossing through networking seem to be typical of dynamic work communities (Hakkarainen *et al.*, 2004). Thus, these communities promote both vertical and horizontal development in employees.

Recent accounts of the development of expertise have emphasised that the integration of conceptual knowledge and practical knowledge is fundamental for the process of becoming an expert (Bromme and Tillema, 1995; Leinhardt *et al.*, 1995; Tynjälä, 1999; Tynjälä *et al.*, 2003). How this integration takes place is thus a key question for the pedagogical support of expertise development. Bereiter and Scardamalia (1993) suggest that formal knowledge is transformed into an expert's informal knowledge by being used to solve problems, both practical problems and problems of understanding. Thus, problem-solving can be seen as a mediating tool for

integrating conceptual and practical knowledge. The same has been suggested by recent studies of workplace learning which have brought up the concept of work process knowledge (Boreham *et al.*, 2002). This knowledge is continuously being produced in the workplace through work. It is a synthesis of theoretical and practical knowledge and is held collectively as well as individually. According to Boreham (2002, p. 8), work-process knowledge is generated when theoretical knowledge is integrated with experiential know-how in the course of solving problems at work. Boreham (2003) also argues that the knowledge creation process is not embedded in working practices per se, but within specific practices which have the function of knowledge creation. He calls these practices epistemic working practices. This concept is very similar to that of the knowledge building practices described by Scardamalia and Bereiter (Bereiter and Scardamalia, 1996; Scardamalia and Bereiter, 1996). Common to both is that they describe practices that are intentionally aimed at constructing shared understanding of problems between collaborators and at explicating and documenting this understanding in a way that it can be used and elaborated later.

What follows from the discussion above is that e-learning in work organisations should be built in a way that makes it possible for participants to use their practical, experiential knowledge and integrate it with theoretical, conceptual knowledge. As people acquire conceptual tools for reflecting their experiences they may develop new understanding of their everyday problems and, consequently, may become aware of a need to transform their practices.

Through successful collaborative activities and knowledge sharing individual cognitive capacities can be enlarged and cognitive load shared (Dillenbourg, 1999a, b). Well-developed e-learning environments provide space for knowledge building or epistemic practices in collaboration with others.

Problems and challenges
The problems and challenges of e-learning in the workplace can be divided into two main groups: problems related to workplace learning in general and problems related to the fact that learning takes place in a virtual environment. We shall start with the former.

E-learning is not a miracle remedy to the problems of any work organisation. The success of e-learning is highly dependent on factors related to the overall work and learning culture of an organisation. Organisational structures and the work atmosphere may include both opportunities and barriers to learning. Open dialogue and opportunities to share knowledge are prerequisites for organisational learning (Senge, 1990; Nonaka and Takeuchi, 1995). If these are missing, not even the best e-learning environment can make a difference. Fuller and Unwin (2003) have suggested that in regard to their support for individual learning, organisations can be characterised on a continuum between what they call expansive or restricted learning. Their study was conducted in the context of apprenticeship learning but we believe that the same distinction can be applied across a wider organisational learning context. Organisations with an expansive learning culture provide participation in multiple communities of practice inside and outside the workplace, have arranged planned time off-the-job for reflection and formal learning situations, and support workers' status also as learners. In contrast, restrictive workplaces restrict participation in multiple

communities of practice, offer limited opportunities for reflection and do not especially support learning.

Organisational climate, interpersonal relationships and the communication atmosphere are important elements for a learning organisation. A culture and climate which encourage responsible experimentation and shared learning both from successes and failures are typical of learning organisations (Pedler *et al.*, 1991; Slotte and Tynjälä, 2003). Social relationships which support and encourage self-development are important (Pedler *et al.*, 1991). One function of workplace communication is maintaining a sense of community and a good emotional atmosphere in a working group. Collin (2005) has shown that this can be done by humour and telling stories. The challenge is how to do this in virtual environments.

Both studies on student learning and workplace learning have suggested that conflicts are often initiatives for learning. This has been emphasised by Neo-Piagetian research based on the idea of cognitive conflict (Doise and Mugny, 1984), by ethnographic studies of workplace learning (Collin, 2005) and by studies of student learning in small groups (Lahti *et al.*, 2004). By conflict the authors do not necessarily mean actual confrontations between people but problem situations that need to be solved. Sometimes these are related to personal conflicts and disagreements. This can cause problems for e-learning situations as a virtual environment is not always the best forum for dealing with personal conflicts – other forums are needed as well. Therefore we recommend that whenever possible face-to-face interactions are combined with e-learning programmes.

Above we emphasised the importance of collaborative activities in workplace learning. However, where collaboration is the only way of learning the outcome may not always be as expected. For example, Hakkarainen and his colleagues (Hakkarainen *et al.*, 1998) have shown that at least students at school may prefer to think about problems by themselves before discussing them and collaborating with others. This may be true among employees in the workplace as well. Therefore it is important that a learning environment also allows space for individual reflection before and after collaborative activities.

One challenge for workplace e-learning is how to link employees' personal development with organisational learning and development. This requires active involvement of human resource development personnel as well as of management. Not only HRD people but also managers should have understanding of individual and organisational learning processes in order to create an organisational climate and social and physical environment conducive to learning. Thus, such matters in e-learning as aims, contents, methods and expected results should not be restricted to HRD staff but should be dealt with at all levels of management and staff.

Support for learning is essential in any learning environment, and the workplace is no exception. Bova and Kroth (2001) have pointed out that it is important to provide the learner with just the right amount and kind of guidance that he or she needs. Often the problem is the belief that adults do not need support in their learning. Research findings have shown that workplaces have not been able to provide structural support and guidance for e-learning (Smith, 2003). Perhaps developing adequate and functional support systems for learning is one of the biggest challenges facing e-learning design. These support systems can be divided into two complementary forms:

(1) pedagogical structuring of the e-learning environment; and

(2) online support throughout the learning process.

Dillenbourg (2002) has recently called for methods to structure collaborative learning situations on the grounds that free collaboration does not systematically produce learning. Interaction in e-learning situations can be structured by means of collaboration scripts embedded in e-learning environments. These scripts are sets of instructions for learners on how they should form groups, how they should collaborate and how they should tackle the problem. Scripts can be seen as complementary to the online support provided by mentors or tutors during the learning process.

A major problem related to learning in virtual environments is that, in group work, certain phases of problem-solving may be so difficult that the productive sharing and elaboration of knowledge through electronic tools is almost impossible. Hansen *et al.* (1999) have reported that in an initial problem setting phase computer conferencing was not adequate in enabling interactivity. Another critical phase was the conclusion phase. It seems reasonable to argue that in these phases common problem-solving should take place in face-to-face meetings whenever possible. Many other studies of e-learning support this conclusion; the best results have been gained by integrated solutions, that is, by combined face-to-face learning and e-learning (Dillenbourg, 2002).

Another common problem related to e-learning is that technology tends to determine how learning takes place. From the beginning, technology was created for purposes other than education. At the beginning of the era of computer-assisted instruction learning was commonly developed from the standpoint of technology instead of the other way round. Nowadays markets for educational technology have exploded, which creates more possibilities for learning-driven development and production. However, there is still a danger that the design of e-learning environments will be technology-driven rather than problem-driven or learner-driven. This design problem can be solved only by collaboration with pedagogical and software experts.

E-learning environments have often chiefly been used to deliver learning materials. This is a waste of time and resources as the aim of workplace learning is not to transmit knowledge but to transform and create knowledge. Materials delivery should occupy only a marginal role in e-learning environments. The most important events should take place in collaborative knowledge building modes.

The modes of representation and expression used in e-learning environments have often been restricted, mostly text-based. The theory of multiple intelligencies (Gardner, 1993) as well as the view of multiple repsentations (van Someren, 1998) suggest that more diverse modes of expression and representation would benefit learners. Therefore, the creation of more flexible and diverse multimedia technology represents one important challenge in developing future e-learning solutions.

Freund (2004) has suggested that main reasons for unsuccessful e-learning initiatives have been

(1) lack of personalization;

(2) lack of collaboration and interactivity; and

(3) that e-learning has not been learner oriented.

Individual employees' needs have not been taken into account when designing the learning contents, methods and environments. As a solution for these problems Freund

suggest the idea of mass customization. He argues that through mass customization together with the multiple intelligencies theory it is possible to create more learner oriented solutions which take individual needs and preferences into account.

Empirical studies on e-learning in the workplace

In this section we briefly review some recent studies in which electronic networks and communication tools have been deployed in workplace learning. One of our examples concerns formal education organised for employees, while two others describe informal learning taking place alongside work practices in virtual environments. Slotte and Tynjälä (2003) have described how formal education organised by the university in collaboration with a multinational company can be brought into the workplace. The course was a one-year programme in adult education, tailored to meet the needs of the company's human resource development staff. The course comprised four modules, which included reading materials, web-based discussions and a set of assignments. The 17 participants worked in four countries and represented three nationalities.

As mentioned earlier, integrated solutions which include face-to-face meetings and online tasks seem most promising from the learning point of view. In the present case, only one face-to-face meeting, an introductory lecture, was arranged because participants were distributed in different parts of the world. Support and guidance for learning was arranged by three university tutors, one of whom facilitated the discussions throughout the course and two tutors who joined the discussions at specific periods of time. In addition, three tutors were supplied by the company.

The principle of integrating theoretical knowledge with participants' experiential knowledge was applied in assignments and web-based discussions. For example, the stimulus questions of the discussions concerned participants' own experiences and interpretations of the theoretical material included in the study materials. Participants were also free to bring their own questions up for discussion. The purpose was to create a discursive space which would enable the participants to conceptualise their practical experiences. A process of this kind can lead to making implicit knowledge explicit.

Experiences of this multinational e-learning course were both encouraging and challenging (Slotte and Tynjälä, 2003). The activity of the course participants varied widely and only some of them completed the whole course. Despite the fact that many participants failed to gain the required number of credits, most of them welcomed the insights and new ideas they acquired through the web-discussions. They were also pleased with the conceptual tools they acquired and with the assignments that required them to solve work-related problems. However, many of the participants thought that the study materials were too "academic" and could have focussed more directly on the business world. Altogether, this study indicated that taking a formal degree course in the workplace through e-learning is possible but requires a lot of effort on the part of both the participants and educators. Time management and integrating learning more profoundly to participants' work are especially challenging tasks.

In innovative organizations, geographically distributed team work is on the increase as in the study described above. In this kind of setting, team members face several difficulties compared to face-to-face settings. The lack of awareness of other team members' working processes is one of the drawbacks which a virtual team may face while attempting to collaborate in a shared task (Leinonen *et al.*, 2004). From

the viewpoint of e-learning technology, different networked learning environments provide the learner with a relevant platform for communicating and sharing knowledge. At the same time, more advanced technological solutions which would support many problematic issues in virtual interaction, such as difficulties in reaching shared understanding, in coordinating different perspectives or in establishing the sense of co-presence especially in distributed teams, remain lacking (Fischer *et al.*, 2002; Gutwin and Greenberg, 1999; Häkkinen *et al.*, 2000).

In the study by Leinonen *et al.* (2004) the focus was on supporting knowledge co-ordination and perspective sharing in distributed teams physically located in six different countries. Perspective sharing and group reflection among the virtual team members were supported with a pedagogical model and "an awareness tool" designed to create a structure and phases for virtual working. The aim was to investigate how, supported by the pedagogical model, the members of a virtual team perceived their collaboration. The authors identified three main aspects of awareness of collaboration. These aspects were awareness of the possibility to collaborate, awareness of shared aims and awareness of the process of collaboration.

Another challenge facing today's work organizations is that of organizing and managing continuously changing knowledge in a way that supports the development of shared expertise (tacit knowledge problem; Nonaka, 1994). Furthermore, in terms of workplace learning, organizations often struggle with the problem of integrating formal training situations and real work situations. The ongoing study by Hakkarainen (2004) focuses on making implicit knowledge explicit, but not only for the purposes of group work, but also for the purpose of creating "an organisational memory" and saving experiential knowledge in order to share it with the whole organisation. The aim of the study is to examine the take-into-use of a knowledge management system, also deployed to support learning at work. The system captures processes and procedures from authentic work situations in the paper industry. These authentic cases can then be used in seeking to resolve problem situations in the factory, and they can also be stored to organization's collective memory, which can be further enriched by users facing similar situations.

The study by Hakkarainen (2004) focuses on groupware products, which are knowledge management tools, supplemented with groupware functions and which support tacit knowledge socialization and externalization processes. Knowledge management is the name given to the set of systematic and disciplined actions that an organization can take to obtain the greatest value from the knowledge available to it. "Knowledge" in this context includes both the experience and understanding of the people in the organization and the information artefacts, such as documents and reports, available within the organization and in the world outside. Effective knowledge management typically requires an appropriate combination of organizational, social, and managerial initiatives along with, in many cases, the deployment of appropriate technology. Groupware, on the other hand, can be defined as computer based systems that support groups of people engaged in a common task by providing an interface to a shared environment (Ellis *et al.*, 1991).

Discussion

There are several lessons that can be learned from the history of e-learning. First of all, the focus in novel learning environments should be on the basic mechanisms

and processes of learning. At their best, e-learning environments have the potential to support cognitive, social, motivational and affective processes of learning. For example, shared workspaces and communication tools can provide a natural setting for explanation, knowledge articulation, argumentation and other demanding cognitive activities (Dillenbourg, 1999a, b; Hakkarainen *et al.*, 2002). They can also assist in sharing and distributing cognitive load and in bringing thinking out into the open – in other words they can function as a collective memory for a learning community, helping community to store the history of its knowledge construction process for the purposes of revision and future use.

However, in order to reap these benefits, several pedagogical and contextual prerequisites for successful collaborative learning situation have to be fulfilled (Häkkinen *et al.*, 2004). These include the provision of space for negotiations and misunderstandings, a genuine need for collaboration (real group tasks), and the ability to reach mutual understanding through shared values and goals (common ground), cognitive rather than social conflicts, cognitive diversity, symmetry in knowledge and status, and group commitment and motivation. Table I summarizes the central design principles and theory-based guidelines for the pedagogical design of e-learning environments.

In conclusion, we suggest that to enhance both individual and organizational learning and development e-learning solutions should include the following features:

- support of both individual reflection and collaborative knowledge building or epistemic social practices;
- integration of theoretical knowledge with participants' practical experience;
- learning tasks that lead learners to examine their work in the light of the conceptual tools provided;
- learning tasks that help learners to conceptualise their practical experiences;
- support for the invention and use of boundary objects;
- support for the explication of implicit knowledge;
- encouragement of collaboration and knowledge exchange between different groups of people (different professional groups, people from different domains, experts and novices, for example);
- real dialogue;
- a progressive problem-solving orientation;
- integration of different forms of representation and different forms of learning activities (reading, writing, discussing, using metaphors, audio, visual etc.);
- structured support and guidance for learning in all phases of the learning process; and
- integration of e-learning with face-to-face learning situations whenever possible.

Some of these features are related to software design issues, while some others are purely pedagogical in nature. Because software design and pedagogical solutions are inter-depended, the design process itself has to be carried out as a collaborative process between experts in learning and experts in software design.

Design principle	Theory-based guidelines for pedagogical design of e-learning environments
Support for (meta-) cognitive processes	Activation of prior knowledge Support for conscious reasoning and self-assessment, setting one's own (i.e. not set by the environment) learning goals (What do I know; What should I learn?) Planning and regulating one's own cognitive activities (How do I search for information; How do I proceed; Did I understand?)
Cognitive tools for the organization of knowledge, tools for externalizing thinking	No pre-defined learning paths Critical steps and phases Tracing work phases, reflection Non-linearity and structuring of knowledge Simulation of complex phenomena Multiple representations
Scaffolding	Helping learner to analyze one's own thinking processes and to participate in higher-level cognitive and social processes than s/he otherwise could Providing hints for learning specific skills/knowledge Giving feedback
Development of expertise	Well-organized knowledge structures and general thinking skills Integration of conceptual (theoretical) and experiential (practical) knowledge Learning is situated and context-bound: authentic contexts, cases, problems or simulations Training and working not separate activities: reflection of professional practice
Social construction of knowledge, distributed expertise	Building of new knowledge on the basis of others' contributions, sharing cognitive load Externalizing group processes and increasing awareness of them Tasks that force groups to collaborate and co-ordinate knowledge Shared workspaces
Integration of e-learning and face-to-face situations	Emphasizing the links between authentic work activities and e-learning material and virtual discussion Supplementing e-learning material with other kinds of contextual resources (e.g. peer/group or mentors' contributions, e-mail discussions, videoconferencing) Developing different means which can help the participants in a virtual community to create shared understanding and joint goals

Table I.
Design principles and guidelines for pedagogical design of e-learning environments

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