Available online at www.sciencedirect.com
ScienceDirect
Educational Research Review 3 (2008) 130–154
Educational Research Review
www.elsevier.com/locate/EDUREV

Review

Perspectives into learning at the workplace

Päivi Tynjälä*

University of Jyväskylä, Institute for Educational Research, PO Box 35, 40014 Jyväskylä, Finland

Received 8 February 2007; received in revised form 19 December 2007; accepted 27 December 2007

Abstract

The article presents a thematic review of the recent research on workplace learning. It is divided into two main sections. The first section asks what we know about learning at work, and states four propositions: (1) the nature of workplace learning is both different from and similar to school learning; (2) learning in the workplace can be described at different levels, ranging from the individual to the network and region; (3) workplace learning is both informal and formal; and (4) workplaces differ a lot in how they support learning. The second section focuses on workplace learning that is related to formal education. Different models of organising work experience for students and the challenges of creating partnerships between education and working life are described. It is concluded that the worlds of education and work are moving closer each other and that the integration of formal and informal learning is an essential prerequisite for developing the kinds of expertise needed in response to the changes taking place in working life.

Keywords: Workplace learning; Work-based learning; Informal learning; Formal learning. Work experience

Contents

* Tel.: +358 14 260 3219; fax: +358 14 260 3201.
E-mail address: paivi.tynjala@ktl.jyu.fi.

1747-938X/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.edurev.2007.12.001

1. Introduction

Traditionally the concept of 'learning' has been related to formal education, whereas its use in the context of work is a relatively new phenomenon. Interest in workplace learning has expanded since the beginning of the 1990s, and currently the research in this area is both wide-ranging and interdisciplinary. The reason for this expansion is the unprecedented rapid change in society and working life that has taken place during the past few decades. The rapid development of information and communications technology, the growing production of knowledge in the economy, increasing internationalization and globalization as well as changes in occupational structures and in the contents and organisation of work have challenged not only educational institutions but also work organisations to develop new ways of ensuring that the level of competence of the workforce meets these challenges. Thus, continuous learning has become important both for individuals operating in the learning society and for organizations competing in international markets.

Recent research on the outcomes of education, particularly at the tertiary level, has shown that there is a gap between the knowledge needed at work and the knowledge and skills produced through formal education. Eraut (2004a) classifies the types of knowledge which vocational and professional education programmes claim to provide as follows: (1) theoretical knowledge, (2) methodological knowledge, (3) practical skills and techniques, (4) generic skills and (5) general knowledge about the occupation in question. He states that although most of these types of knowledge are described as transferable, there is little evidence on the extent to which methodological knowledge, generic skills and general knowledge about an occupation are acquired by students and about the chances of theoretical knowledge and practical skills being subsequently transferred into the workplace. Empirical studies support Eraut's critical view. Two separate studies on university and polytechnic graduates with 2–10 years work experience produced surprisingly similar findings: both university and polytechnics graduates found their working life skills inadequate, and the majority of them stated that they had learnt the necessary skills at work, and not during their formal education (Stenström, 2006; Tynjälä, Slotte, Nieminen, Lonka, & Olkinuora, 2006). Later on in this paper I will show that the development of vocational and professional expertise requires the integration of different types of knowledge and interaction between theory and practice, and that the development of the workplace as a learning environment both for employees and students is important to ensure the continuous development of competence. This requires close collaboration and partnership between education and work.

At the end of the last decade Anna Sfard (1998) put forward two metaphors of learning to describe how the research community had understood the phenomenon of learning: The *acquisition metaphor* sees learning as a process of knowledge acquisition, while the *participation metaphor* emphasises that learning takes place by participating in the practices of social communities. Paavola, Lipponen, and Hakkarainen (2004) presented an additional metaphor of learning, *knowledge creation*. In this view, learning is seen as the creation of new knowledge. Learning is considered a social process, as in the participation view, but the aim of participation is not to socialise people into existing practices, but to develop new practices. In this way the knowledge creation metaphor integrates the cognitive and social aspect of learning.

Many scholars in the field of workplace learning have emphasised that the mainstream conceptualisations of learning which have been developed in the context of school learning are not transferable to the analysis of workplace learning. For example, Hager (2004) emphasises the need to develop workplace learning research from its own starting points. He distinguishes between what he calls the *standard paradigm of learning* and *the emerging paradigm of learning*. According to him, the standard paradigm is based on the following major assumptions: focus on mind, interiority and transparency. The first point, focus on mind, refers to understanding learning as an individual cognitive process through which mental structures are improved and accumulated. The second point, interiority, is related to the first one by separating mental life from the outside world. The most valuable form of learning is focused on thinking rather than action. The third key assumption of the standard paradigm, transparency of learning, implies measurable learning outcomes and the assumption that non-transparent learning producing tacit knowledge is somehow inferior. By contrast, the emerging paradigm characterises learning as action in the world. The change learning brings about takes place not only in the learner's mind but also in the learner's environment. Thus, the main outcome of learning is the creation of a new set of relations in an environment. On this view, learning is seen as inherently contextual (see also Hager, 2005). If we compare the metaphors of learning and the paradigms presented by Hager we can see that the acquisition metaphor matches Hager's depiction of the standard paradigm, while the participation and knowledge creation metaphors are compatible with the emerging paradigm. Hager points out that while the acquisition paradigm

has decisively shaped educational systems, learning at work is difficult to fit into this standard way of conceptualising learning. In contrast, workplace learning, for the most part, belongs to other categories than intentional learning and the acquisition model (see, Hodkinson & Hodkinson, 2004). Therefore, the ideas contained in the emerging paradigm seem to offer a better approach to understanding and describing workplace learning. Indeed, the participation metaphor has frequently been used in recent research to illuminate the nature of learning at work (Billett, 2004; Collin, 2005; Fuller, Hodkinson, Hodkinson, & Unwin, 2005; Fuller & Unwin, 2003). Also, the increased use of the knowledge creation metaphor implies that learning is being seen more and more as an innovative rather than reproductive activity (cf. Jarvis, 1992). In particular, learning in the workplace can be often characterised as creating new modes of action, new practices, new procedures and new products.

In research, learning can be analysed on several levels. *The learning of individuals* is the traditional and most typical and everyday way of thinking about learning. However, in the workplace context individual learning is just one form of learning. In addition, we can speak about the learning of *groups*, the learning of *communities*, the learning of *organisations*, the learning of *inter-organisational networks* and even the learning of *regions*. As a consequence of the plurality and multilevel nature of learning, the research in the field has expanded from pedagogical and psychological studies to multidisciplinary research efforts involving fields such as adult, vocational and higher education, labour studies, organisational research, economics, management studies, economic geography and so on. Given this enormous spread of research it is not possible in a single article to cover the field completely. Instead, the aim of this paper is to give a general overview of current research on workplace learning.

When we talk about learning in the workplace we should not to make the mistake of assuming that the workplace is a unified environment for all learners. Instead, we should recognize that people's situations and organisational positions with respect to working and learning in the workplace differ. Workplaces in different fields have different working cultures and learners in the workplace come from different age groups, different educational and professional backgrounds and different positions in organizations. Furthermore, an important challenge for workplace learning is that, to a growing extent, workplaces provide a learning environment not only for their regular employees but also for students coming from institutions of vocational and higher education. Accordingly, this article is divided into two main sections: in the first section I survey workplace learning on the general level, concentrating on the characteristics of learning related to work activities in work communities and work organisations, while in the second section I focus on the kind of on-the-job learning that is related to formal education and examine the challenges facing work and school organisations in their joint efforts to produce and develop a competent workforce.

2. Section I: What do we know about learning at work?

In this section I present four main observations pertaining to workplace learning: (1) the nature of workplace learning is at the same time both different from and similar to school learning, (2) learning in the workplace can be described on different levels, (3) workplace learning is both informal and formal, and (4) workplaces differ widely in how they support learning. Each of these propositions will be elaborated and discussed in further detail.

2.1. The nature of workplace learning is both different from and similar to school learning

Nowadays it is widely acknowledged that learning is a phenomenon that is situated in a specific cultural context (e.g. Brown, Collins, & Duguid, 1989; Hager, 2005; Resnick, 1987). Therefore, learning in a workplace environment is different from learning at school or in a university environment. One of the main differences between learning in the formal educational system and learning at work is that the former is based on formal, intentionally planned educational activities while the latter is mostly informal in nature (Eraut, 2004b; Marsick & Watkins, 1990).

Resnick (1987) was one of the first scholars to analyse the differences between school learning and the learning that takes place outside school. According to her analysis there are at least four types of differences. First, school practices are mostly based on individual activities, while much outside-school activity is socially shared. Although group activities of various kinds are gradually becoming more common in schools and colleges, students are still usually judged on the basis of individual tasks and tests. In contrast, many activities at work require collaboration with other people, and each person's ability to function successfully depends on the performances of several individuals. Second, school work emphasises mental activities whereas in real life people use a wide variety of tools. For example, the traditional assessment of learning is based on memory alone—the use of books and notes, calculators or other

Table 1
Differences between formal learning and informal workplace learning (adapted from Hager, 1998; Resnick, 1987)

Learning in formal education	Learning in the workplace
Intentional (+unintentional)	Unintentional (+intentional)
Prescribed by formal curriculum, competency standards, etc.	Usually no formal curriculum or prescribed outcomes
Uncontextualised—characterised by symbol manipulation	Contextual—characterised by contextual reasoning
Focussed on mental activities	Focussed on tool use + mental activities
Produces explicit knowledge and generalised skills	Produces implicit and tacit knowledge and situation-specific competences
Learning outcomes predictable	Learning outcomes less predictable
Emphasis on teaching and content of teaching	Emphasis on work and experiences based on learner as a worker
Individual	Collaborative
Theory and practice traditionally separated	Seamless know-how, practical wisdom
Separation of knowledge and skills	Competences treated holistically, no distinction between knowledge and skills

instruments is not normally permitted. In contrast, tool use in work activities, both physical and mental, is more the rule than the exception. Third, according to Resnick, school learning is characterised by the manipulation of symbols, while other learning is characterised by contextualised reasoning. People outside school often use objects and events directly in their reasoning, without necessarily using symbols to represent them. School learning, by contrast, is mostly symbol-based, and connections to the events and objects symbolised are often lost. For example, in everyday mathematics people may use real physical objects as a part of their calculating process, whereas school mathematics operates purely with numbers. Fourth, school learning aims at the acquisition of generalised skills and principles while learning outside school develops situation-specific competencies.

Table 1 summarises the differences between formal learning and more informal workplace learning identified by Resnick (1987) and more recently by Hager (1998). Informal workplace learning is unplanned and implicit, often collaborative and highly contextualised, and the learning outcomes unpredictable, whereas school learning and organised on-the-job training is often formal, planned, largely explicit, focused on individual learning, and the outcomes are often predictable (Hager, 1998). The different attributes of workplace learning and school learning can be seen both as weaknesses and as strengths. After all, formal education is intended to produce general skills that can be applied and transferred to a variety of situations. However, in order to be a true expert in working life one has to develop situation-specific forms of competence, and this is possible only in authentic situations. On the other hand, situation-specific learning by itself may be very limiting. Something learnt in one situation is not easily transferred to another type of situation.

Despite the considerable differences already noted between school learning and workplace learning, there are similarities as well. The workplace may also function as a context for formal employee training. Large companies, especially, put a lot of effort into corporate training. In recent years, the role of the university has often been important in corporate training programmes. Robertson (1998), for example, speaks about interactive business learning, where the university extends its reach beyond the campus to organisations and workplaces which encourage learning (see also Kautto-Koivula, 1999; Slotte & Tynjälä, 2003). In these workplaces formal training plays an important role in organisational development.

It is likely that increasing co-operation between education and work, and new forms of work-based learning (WBL) will change the nature of learning in both contexts and may create entirely new kinds of learning opportunities (see Candy & Crebert, 1991). Work-based learning may be realised in various modes and through different programmes, ranging from single courses involving a small working life project to more comprehensive programmes which depart substantially from the disciplinary framework of university study (Boud & Solomon, 2001). There are at least two factors which may narrow the gap between learning in higher education and learning at work. First, globalisation and the emergence of the information society seem to be leading to an increasing numbers of jobs that Reich (1991; see also Castells, 2000) has called symbolic-analytic services. In these jobs professionals identify and solve problems by manipulating symbols. They use and transform information with analytic tools such as mathematical algorithms, scientific principles, psychological insights, legal arguments, etc. The nature of this kind of symbol manipulation is much like the nature of school work: context-specific reasoning is not enough but abstract thinking and the ability to analyse and synthesise information is required. In this way the conceptual reasoning and abstraction emphasised in educational settings and school learning is, indeed, an essential element of key jobs in working life today. Another factor

that is narrowing the gap between education and work is the fact that new pedagogical models such as problem-based learning, project learning and collaborative learning have characteristics that simulate authentic situations in working life or may even be based on them.

2.2. Learning in the workplace can be described on different levels: learners may be individuals, groups, communities, organizations, networks and regions

Although the history of research on workplace learning is very short, the amount of research has increased enormously during the last few years. The relationship between work and learning is a phenomenon that has attracted researchers in a variety of disciplines ranging from pedagogical and psychological research to organisational studies and management research. This has resulted in a diversity of concepts, models and theories in the field. Learning as a concept thus refers to processes taking place at different levels, from the levels of individuals and groups to the levels of communities of practice and organisations. The most recent extensions to the learning concept are the notions of network learning and regional learning. Indeed, fundamentally different phenomena have been at the centre of workplace learning studies: individual development, knowledge acquisition, cultural transformation, innovation, etc. (see, Fenwick, 2005). Below, a brief review of the central research findings derived from the different issues addressed by workplace learning studies is presented.

2.2.1. Individual learning at the workplace: what do people learn at work and how?

Studies on individual learning in the workplace have focussed on questions such as what conceptions of learning employees have, what it is that people learn at work and how they learn (e.g. Boulton-Lewis, Pillay, & Wills, 2006; Collin, 2002; Eraut, 2004a). Due to the informal nature of workplace learning it is often hard for workers to recognise that any learning is taking place while they are working. Although workplace learning has recently received much attention in research as well as in public debate, people still tend to equate learning with formal education and training (Eraut, 2004b). Despite this, researchers have been able to detect different forms of learning processes and different kinds of learning outcomes. On the basis of recent studies the answer to the question of how people learn at work can be summarised as follows: (1) by doing the job itself, (2) through co-operating and interacting with colleagues, (3) through working with clients, (4) by tackling challenging and new tasks, (5) by reflecting on and evaluating one's work experiences, (5) through formal education and (6) through extra-work contexts (e.g. Billett, Smith, & Barker, 2005; Collin, 2002; Collin & Valleala, 2005; Eraut, 2004a, 2004b; Heikkilä, 2006; Tikkamäki, 2006).

What, then, do people learn? On the basis of the typology of learning outcomes at work developed by Eraut and his colleagues (2004b) it can be said that there is little that people cannot learn at work! The typology includes the following categories of learning outcomes: (1) Task Performance, including sub-categories such as speed and fluency, range of skills required and collaborative work; (2) Awareness and Understanding, involving understanding of colleagues, contexts and situations, one's own organization, problems risks, etc.; (3) Personal Development with aspects such as self-evaluation and management, handling emotions, building and sustaining relationships, and the ability to learn from experience; (4) Teamwork with subcategories such as collaborative work, and joint planning and problem solving; (5) Role Performance, including priorisation, leadership, supervisory role, delegation, crisis management, etc.; (6) Academic Knowledge and Skills, such as assessing formal knowledge, research-based practice, theoretical thinking and using knowledge sources; (7) Decision Making and Problem Solving, involving, for example, dealing with complexity, group decision making, and decision making under conditions of pressure; and (8) Judgement, including quality of performance, output and outcomes, priorities, value issues and levels of risk. Eraut (2004b) notes that although presented as a typology, the authors view it more as a heuristic device for use in research and consultancy to remind people of possible aspects of learning present in their own context.

The studies cited above have brought to notice many good things people may learn in the course of their work. However, learning does not always result in desirable outcomes. We also learn bad things. This was shown in a study by Tynjälä and Virtanen (2005) in which they asked vocational students what they had learnt during their on-the-job learning period. The students reported that most of all they had learned independence and vocational skills, but also that they had learned some negative things such as bad practices, disadvantages of the field, and how to shirk their duties. Thus, it is worth remembering that learning does not always involve desirable matters but may also strengthen existing negative features of the workplace.

As mentioned above employees commonly learn by working with their colleagues. Conflicting results have been obtained on the extent to which group work or team work has been adopted as a basic method of organising work. In one study conducted in Finland at the beginning of the new millennium, about 80 % of employees in the research sample reported working in groups or teams (Blom, Melin, & Pyöriä, 2001), whereas Poell and van der Krogt (2006) refer to studies by Benders (1999) and Dankbaar (2000), according to which groups and teams as work organisational entities turned out to be less prevalent than expected. Nevertheless, group working in one way or another is a factor which seems to promote knowledge exchange and the sharing of expertise, and thus to enhance individuals' learning (e.g. Eraut, 2004b; Heikkilä, 2006). Furthermore, it has been argued that not only individuals but also groups can learn in organisations. For example, Marsick and Watkins (1990) talk about the double loop learning of groups, referring to learning where groups reflect not only on their actions but also to the assumptions and goals on which they base their actions (see also Lähteenmäki, Toivonen, & Mattila, 2001). The ability to learn in collaboration with other people, both within and outside one's organisation, often makes the difference between success and failure. Employees who cannot network with others to share and construct knowledge will fall visibly behind their peers in the possession of such abilities (Slotte & Tynjälä, 2003).

Interaction between novices and experts is of crucial importance in workplace learning. Billett (2004) has distinguished between direct or close guidance and indirect guidance. The former is salient to knowledge that would be difficult to learn without the assistance of a more experienced and knowledgeable partner. Learning processes or concepts that are hidden require close interaction with more experienced co-workers who can make these practices or concepts accessible. Indirect guidance contributes to how tasks are undertaken and completed.

The well-known notion of legitimate peripheral participation (Lave & Wenger, 1991) describes how novices are socialised into the practices of a social community. At the very beginning novices work in peripheral, less critical, areas of practice, and gain more responsibility as their competence develops. Crucial in the learning process is interacting and working under the guidance of more competent workers, observing their ways of doing the job, and participating in the community of practice. This model depicts learning processes at work mainly as a novitiate activity where the experts have a role of a 'teacher', facilitator or coach. However, it is not only novices in the workplace who learn. Fuller and Unwin (2002) showed in their study that in their daily work people teach each other across the traditional workplace boundaries of age, experience and status. Old-timers guide beginners in some activities, while new-comers may guide experts in some other things. Thus, Fuller and Unwin argue that the concept of pedagogy and pedagogic practice is relevant to all types of employee and workplace and that organisations need to find ways of encouraging people to share their expertise.

The studies cited above deal with informal workplace learning and learning outcomes that come about incidentally, as a side effect of work (see, Marsick & Watkins, 1990). In recent years a lot of attention has also been paid to the ways in which learning can be intentionally promoted in the workplace. For example, Poell (2006; Poell, Van der Krogt, & Warmerdam, 1998) proposed a model of *learning projects* through which employees learn something new by solving work-related problems. A learning project is organised by a group of employees who participate in a set of activities centred on a work-related problem with a specific intention to learn and to improve their working at the same time. The activities include different kinds of learning situations: both on-the-job and off-the-job, both self-organised and facilitator-directed, action-based and reflection-based, group-focused and individual-oriented, externally and internally inspired, and pre-structured and open-ended. The studies conducted by Poell (2006) have shown that in organised learning projects participants are able to combine developing their competences with improving their work.

To summarise, individual and group learning at the workplace can be characterised as a highly social activity which (1) requires interaction and dialogue, (2) requires the kinds of challenges that make learning necessary, and (3) involves reflection on past experiences and the planning of future activities.

2.2.2. *From individual learning to communities of practice and learning organisations*

As earlier mentioned, learning is a phenomenon that is situated in a cultural and social context. How individuals learn is dependent not only on individual characteristics such as intelligence and motivation (which also have cultural and social dimensions) but also, and in a very deep sense, on the social and cultural context in which learning occurs. Thus, in socio-cultural approaches to research on learning the focus is not the individual but a social community. Classic studies in this area are the works Situated Learning—Legitimate Peripheral Participation by Lave and Wenger (1991) and Communities of Practice by Wenger (1998). Taking an anthropological approach, the authors of Situated Learning describe how social communities socialise novices into their cultures. Their examples come from a wide range of

contexts, such as midwifery practices among Mexican Maya Indians, Liberian tailors, US marine quartermasters and AA clubs. Common to all these different cultures was that unskilled beginners play a legitimate role within them, first on the periphery, then graduating to tasks involving more responsibility until, finally, they arrive at the core of the craft or community in question. Thus, the authors describe learning not through cognitive processes but as a process of social participation. This notion of learning as participation was elaborated by Wenger in his later work which brought the concept "communities of practice" into the everyday language of learning research. By communities of practice Wenger refers to the informal communities that people form as they pursue joint enterprises at work and during their leisure time. Through participation in these communities people share their knowledge, negotiate meanings, form their identities, and develop their work practices.

Conceptualising learning as participation in communities of practice has important implications for the development of organisations. In many traditional organisations, learning is the province of the training department, as a unit separated off from actual practice. Training departments deliver courses, document procedures and prepare manuals for learners—but do not engage learners in the organisation's most valuable learning resource, that is, practice itself. In contrast, the model Wenger presents is an integrative approach to training. Newcomers are taken as an integral part of a community of practice, from which it follows that old-timers and newcomers work and learn together. These generational encounters bring about processes of reflection that serve both newcomers and the community. Thus, Wenger recommends that organisations arrange their learning processes as participatory processes, whether the learners be newcomers or old-timers, and that they place their emphasis on learning, rather than teaching, by using the learning opportunities offered by practice.

Considering learning as a participatory process is consistent with recent accounts on the nature of expertise as a collective rather than individual phenomenon. Bereiter and Scardamalia (1993) emphasise that expertise is not confined to the individual but may also be applied to groups that function as units. For example, scientific research teams, sport teams, surgical teams and teams of air traffic controllers form units that carry out joint enterprises. In Wenger's (1998) terms, they form communities of practice. Engeström (2004) goes still further suggesting that expertise may be located and distributed not only in communities of practice but in multiple interacting communities. He argues that *expansive learning* producing radical transformations in and between organisations is a key process of expertise and involves what he calls *negotiated knotworking* as the defining characteristic of collaborative and transformative expertise. Knotworking is characterised by a pulsating movement of tying, untying and retying together otherwise separate threads of activity. People who work in separate departments or organisations come together for certain purposes, to negotiate meanings, solve problems, and then continue with other partners for other purposes, maybe to re-form again later on. Engeström argues that knotworking is a significant new form of organising and performing expert work activity.

In her review of research on learning in work Fenwick (2005) concluded that the relation between the individual and the collective in work-learning processes was a particularly prominent topic in the literature. One group of studies has focussed on analysing workplace learning on different levels – individual, team and organisation – and their interrelations. Much of the research on learning in work organisations is based on the research tradition of *organisational learning* or the learning organisation (e.g. Argyris & Schön, 1996; Nikkanen, 2001; Senge, 1990). Learning at the organisational level embraces the activities of an organisation that is continually expanding its capacity to create its own future (Senge, 1990). This capacity is grounded on the ability of employees and organisations (as collectives of individuals) to change and become more effective, and on the fact that change requires not only open communication and the empowerment of all members of the work community but also a culture of collaboration. Thus, the learning organisation can be defined as "an organisation that facilitates the learning of all its members and continuously transforms itself" (Pedler, Boydell, & Burgoyne, 1991).

2.2.3. Even networks and regions learn?

Recent research on workplace learning has emphasised the importance of networking and other forms of social exchange for both individual learning and organisational development. Concepts such as "innovative knowledge communities" (Hakkarainen, Palonen, Paavola, & Lehtinen, 2004) and "ba" – a space for learning – (Nonaka & Konno, 1998) have been developed to describe the collaborative nature of learning. Learning is seen as a knowledge creation process that takes place in social interaction where explicit and tacit knowledge embedded in organisations meet each other. One important feature in innovative knowledge communities is that people and organisations form and utilise social networks in their work. Thus, studies of networked learning have emerged as a new branch of learning

research (e.g. Holmqvist, 2005; Knight, 2002; Palonen, 2003). Many studies have suggested that innovations emerge in interactive networks (Camagni, 1991; Miles, Miles, & Snow, 2005; Nelson, 1993).

Networks are formed with independent participants who can be either individuals or organisations. A network can be described as a kind of loose organisation and learning in and of networks as a form of organisational learning (e.g. Knight, 2002; Vesalainen & Strömmer, 1999). The general aim of a network is to provide a forum for the exchange, transformation and creation of knowledge. Thus, typically in networks the exchange of knowledge takes place mutually but not necessarily symmetrically. Participating in networks enables people to cross boundaries between different organisations and fields of expertise. Engeström and his colleagues (Engeström, 2004; Engeström, Engeström, & Kärkkäinen, 1995) have called such activities polycontextual work or knotworking, as referred to above. Networking between organisations and people has become an important element of organizational success strategies because of the potential that networking provides for innovative learning (Engeström, 2004; Hakkarainen et al., 2004; Miles et al., 2005). The learners in a network can be described on four levels: the individual, the group of individuals, the organization, and the interorganizational network (Knight, 2002). The broadest context for collective learning has come out of organisational research and studies on economic geography, which have introduced the term "learning region" to describe knowledge creation and innovativeness at the level of geographical regions, such as cities and provinces. A learning region provides an environment that encourages organisations, individuals and their networks to learn from each other (e.g. Gustavsen, Ennals, & Nyhan, 2006; Morgan, 1999).

Brown and his colleagues (2004) describe a project which aimed to facilitate innovative activities in SMEs though inter-company learning networks. In these networks the participants were invited to workshops after which they applied what they had learnt in their own companies. They kept in contact with other participants via a computer conferencing system. Gradually the focus shifted from work in individual companies to collaborative learning across the network. Hytönen and Tynjälä (2005) and Holmqvist (2005) have presented similar cases of learning networks in which people from different organisations regularly get together to share their knowledge and experiences and to develop new practices. Through network meetings people get time and space to free themselves for a moment from their daily activities to reflect on critical aspects of their work.

The potential that networks have for creating innovations can be explained by the fact that in dialogical relationships people with different kinds of expertise get new ideas which they develop further from their own starting points, frameworks and context. Theoretically this potential can be described, for example, by the notion of the zone of proximal development (Vygotsky, 1978) and its applications, the main idea being that through interaction with other people you can achieve more than by working alone.

Network learning is learning by a group of organisations as a group (Knight, 2002). In other words, network learning refers to processes through which the network itself – not only its individual participants – transforms its ways of thinking and acting. However, most of the previous research has focussed on individuals' or organisations' learning *in* networks. On the basis of the recent literature we can outline the features of a learning network. These features can be seen as prerequisites for bringing about innovation in networks. Many of them are, in fact, similar to the characterizations of individual learning. First, perhaps the most essential aspect of the network learning process is *interaction* between the network participants. In fact, without interaction the network is not a real network, that is, a forum for mutual exchange. Second, the interaction in a learning network or partnership should occur around and through *shared goals* (Billett, Ovens, Clemans, & Seddon, 2007; Billett & Seddon, 2004; Paavola et al., 2004). These can be either concrete products or less concrete conceptual tools or models of action. What is essential is that the participants have a shared view or vision of the aim of the networked activity and that the personal visions of individuals and visions of the groups, companies and the network are consistent and aligned (Vesalainen & Strömmer, 1999). Third, it is important that the members of a network are aware of the knowledge and expertise that is distributed in the network (Hakkarainen et al., 2004). In other words, *meta-knowledge*, that is, knowledge of who knows what and where the information can be found, makes it possible to fully utilise the different and complementary expertise of the members of the network. Fourth, full *participation* of the participants in the network's social interaction is required in order to make use of each member's expertise. Thus, participants' motivation to share their knowledge with the network is an important determinant for initiating learning processes. Knowledge sharing does not happen automatically but requires a fifth element of networking, *trust and a collaborative climate* (Sveiby & Simons, 2002). Finally, creating a learning network seems to require the kind of personal and organisational stance which Bereiter and Scardamalia (1993) have called *progressive problem solving*. In other words, an individual, team, organisation or a network does not settle into a routine but is continually setting and solving increasingly complex problems. In this way individuals

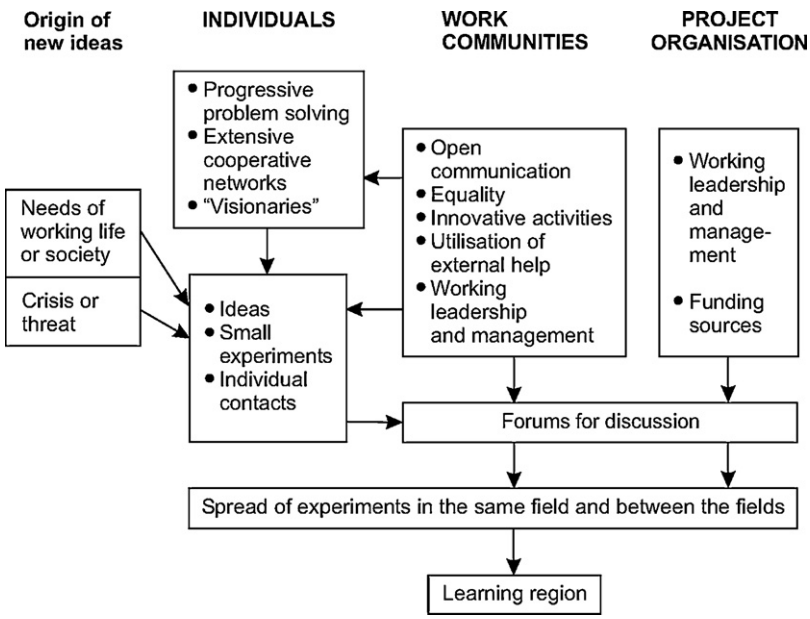

Fig. 1. The origin and process of innovations in the networks of vocational institutes and workplaces in the project Skilful Central Finland (Tynjälä & Nikkanen, 2006; Tynjälä et al., 2005a).

and organisations constantly redefine their tasks and challenges, work at the edge of their competence and surpass themselves.

Some studies suggest that a dedicated infrastructure is important or even necessary to bring about learning in a network (Vesalainen & Strömmer, 1999). In other words, well-developed systems and operating models are needed for planning learning, initiating learning processes and evaluating progress. For example, in a study on networking between vocational institutions and working life, one such infrastructure was provided by the development project called "Skilful Central Finland" carried out by three large vocational education providers and their working life partners in the area of Central Finland (Tynjälä & Nikkanen, 2006). The work consisted of several development projects (mainly funded by the ESF) which aimed to promote co-operation between vocational institutes and working life organisations in different ways. For example, a great amount of in-service-training about organising and supporting students' on-the-job learning was organised both for teachers and workplace trainers and different specialised development projects were launched to enhance the quality of vocational education and co-operation between schools and workplaces. The overall aim of the Skilful Central Finland project combination was to contribute to the development of the Learning Region in Central Finland. In the study, a model of innovations in the networks of vocational institutes and workplaces was produced (Fig. 1). The model describes how innovations originated and how the development of ideas into working innovations proceeded in the networks. The innovations produced in the school–workplace networks can be depicted as social and functional innovations rather than concrete products. Thus, they represent new modes of action, new practices and new collaborative relationships. Examples of such innovations included joint investments in machinery between schools and workplaces, new ways of organising entrepreneurship education, new forms of adult education in the workplace and new ways of guiding students in the workplace, etc.

It can be seen from Fig. 1 that new ideas usually derive from a concrete need in working life or society or as a consequence of a visible threat or crisis. For example, the idea of joint investment between the metal industry and vocational schools was initiated in a situation where, on the one hand, the metal industry was suffering from a lack of skilled labour and, on the other hand, vocational schools, owing to financial constraints, were unable to provide students with up-to-date equipment. By joining forces educational institutes and workplaces were able to provide learning sites with modern machinery for both employees and students and teachers (who got the opportunity to update their knowledge and skills).

Fig. 1 depicts the process of innovation at three levels of actors: *individuals*, *work communities* and the larger *project organisation*, which was set up precisely for the purpose of supporting innovative activities. Producing new

ideas requires individuals who can be described as visionaries. Such individuals are characterized by their ability at progressive problem solving. It is also typical of such experts that they do not keep aloof from other people but rather share their knowledge and ideas with their colleagues and create extensive personal networks (see also Hakkarainen et al., 2004; Palonen, 2003).

Although it is individuals who get ideas in the first place, start small experiments and share them with their personal contacts, it is their larger work communities which create the propitious circumstances for further developing ideas and for disseminating them. For sharing ideas, it is important that there is an open atmosphere of communication in the workplace, that people feel they are equal and that innovative activities are encouraged. Furthermore, it is important that the workplace is open to ideas originating from outside the organisation and is willing to utilise external help in developing its work. All this is promoted by effective leadership and management (see also Billett et al., 2007). A workplace on this model gives birth to the prerequisites for innovative knowledge communities (Hakkarainen et al., 2004) described earlier.

In addition to innovative individuals and work communities a further necessary condition for developing ideas and disseminating good practices was found to be a development project organisation that would systematically manage the development work done in the vocational schools and take care of acquiring the funding needed for individual projects and ventures. Work communities together with their networks and project organisation arranged many forums for discussion and collaboration. Through these forums small individual experiments were presented and shared, thereby ensuring that new practices were disseminated not only among the schools and workplaces in the same field but also across fields.

2.3. Workplace learning is both informal and formal (in this order)

If researchers on workplace learning were asked to name the most typical feature of workplace learning most of them would probably say informality. At the beginning of the 1990s, it was shown by Marsick and Watkins (1990), who were the pioneers in studies of learning at work, that the workplace environment can provide rich opportunities for learning. They made a distinction between informal and incidental learning. According to them, informal learning is experiential and takes place outside educational institutes but can be planned, while the term incidental learning depicts unplanned learning that takes place as a side effect of other activities. The notion that incidental learning mainly produces tacit knowledge is compatible with Sternberg's (e.g. Sternberg & Grigorenko, 2000) triarchic theory of intelligence in which – in addition to analytic and creative intelligence – practical intelligence and related tacit knowledge form an important aspect of human intelligence. This form of intelligence plays an important role in professional success (Sternberg, 2000).

According to Eraut (2004b) informal learning can be characterised by attributes such as implicit, unintended, opportunistic and unstructured learning and the absence of a teacher. He distinguishes between three types of informal learning: implicit learning, reactive learning and deliberative learning. Implicit learning refers to the totally unconscious process of acquiring new knowledge and skills without recognising what has been learned. Eraut argues that most learning from experience has some implicit aspects and that awareness of explicit learning does not mean that implicit learning has not also taken place. Reactive learning is a more conscious and intentional effort to learn but it takes place in a situation where there is little time to think. It involves near-spontaneous reflection on past experience, noting facts, maybe asking questions and observing the effects of actions. It also involves recognition of possible future learning opportunities. Deliberative informal learning refers to situations in which there is a clear work-based goal with learning as a probable by-product. This type of learning involves the discussion and review of past actions and experiences, engagement in decision making and problem solving. Most of these activities are a normal part of work. They are rarely regarded as learning activities although important learning often occurs.

Billett (2004) has recently challenged the commonly presented descriptions of workplace learning as informal, nonformal, ad hoc, concrete and incidental. He argues that learning outcomes are not necessarily concrete and that activities in the workplace are directed towards continuity, are highly structured and often inherently pedagogical. Workplace goals and practices determine the activities in which workers engage. Participation and learning are central to the ongoing existence of these practices. In many workplaces certain structured pathways exist for participation in different levels of activities. For example, in aviation there is a pathway from the role of flight engineer to first officer through to captain. According to Billett, formalisms of this kind structure the processes of participation in and learning from work.

I agree with Billetts's observations but I would elaborate them somewhat. I would argue that learning at work as well as at school contain both formal and informal aspects, although weighted differently. I would 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, like school learning nowadays, 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; Eraut, 2004b; Marsick & 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 learners 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, Tynjälä, and Hytönen (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, formal knowledge and skills. According to Slotte and her colleagues (2004), there are at least three reasons why informal learning alone is not enough. First, because informal learning often takes place without conscious effort and yields mainly tacit knowledge, it may result in outcomes that are not desirable. The outcomes of tacit knowledge are not all positive; instead, it can also lead to bad habits and dysfunctional practices that do not necessarily serve the goals of the organisation. Second, in working life today 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, which is the foundation for the development of expertise (see, Bromme & Tillema, 1995; Leinhardt, McCarthy Young, & Merriman, 1995; Tynjälä, Nuutinen, Eteläpelto, Kirjonen, & Remes, 1997; Tynjälä et al., 2006; Tynjälä, Välimaa, & Sarja, 2003). For these reasons, Slotte and her associates (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 aimed at promoting organisational development (Slotte & Tynjälä, 2005; Stephenson & Saxton, 2006; Tynjälä & Häkkinen, 2005).

I suggest that, to be successful, school learning should adopt certain features of workplace learning and of the development of expertise (see, Hatano & Oura, 2003; Tynjälä et al., 2003) and, correspondingly, workplace learning should be developed by utilising strong features of formal school learning. These include intentionality, structured learning support and guidance, explication of knowledge, conceptualisation and making use of problem-based and project-based approaches (e.g. Jäntti, 2003; Poell et al., 1998). While formal education uses and produces explicit knowledge, informal learning uses and produces tacit knowledge. Often it is critical for individual and organisational learning to transform tacit knowledge into explicit knowledge—and vice versa. The role of human resource development (HRD) can be important in this process, as Slotte et al. (2004) have suggested. Nonaka and Takeuchi (1995) have described different forms of knowledge transformation. According to them, knowledge creation in organisations takes place in four different ways: (1) socialization (sharing of tacit knowledge, e.g. through apprenticeship), (2) externalization (expression and explication of tacit knowledge to convert it to explicit knowledge, e.g. through narratives), (3) combination (involving converting explicit knowledge into more complex explicit knowledge, e.g. through documents) and (4) internalization (converting explicit knowledge into the organization's tacit knowledge, e.g. through learning-by-doing). Eraut (2004b, p. 263) has criticized this model, asserting that the knowledge described in it as tacit knowledge being transformed into explicit knowledge, was already explicit knowledge, although in the mode of personal knowledge which had not previously been shared with others. As a response to this critique it can be said that maybe it is not important whether such personal knowledge was explicit or implicit. Instead, the essential point is that knowledge which has been only the property of an individual becomes knowledge shared with other people.

2.4. Workplaces differ a lot in how they support learning

So far, I have been examining the questions of who learns and how learning takes place on the many levels of the workplace context. The assumption has been that learning occurs on a significant scale. However, we all know from

Table 2
Approaches to workforce development (Fuller & Unwin, 2004)

Expansive	Restrictive
Participation in multiple communities of practice inside and outside the workplace	Restricted participation in multiple communities of practice
Primary community of practice has shared participative memory: cultural inheritance of workforce development	Primary community of practice has little or no participative memory: no or little tradition of apprenticeship
Breadth: access to learning fostered by cross-company experiences	Narrow: access to learning restricted in terms of tasks/knowledge/location
Access to range of qualifications including knowledge-based vocational qualifications	Little or no access to qualifications
Planned time off-the-job including time for knowledge-based courses and for reflection	Virtually all on-the-job: limited opportunities for reflection
Gradual transition to full, rounded participation	Fast—transition as quick as possible
Vision of workplace learning: progression for career	Vision of workplace learning: static for job
Organizational recognition of, and support for employees as learners	Lack of organisational recognition of, and support for employees as learners
Workforce development is used as a vehicle for aligning the goals of developing the individual and organisational capability	Workforce development is used to tailor individual capability to organisational needs
Workforce development fosters opportunities to extend identity through boundary crossing	Workforce development limits opportunities to extend identity: little boundary crossing experienced
Reification of 'workplace curriculum' highly developed (e.g. through documents, symbols, language, tools) and accessible to apprentices	Limited reification of 'workplace curriculum' patchy access to refectory aspects of practice
Widely distributed skills	Polarisized distribution of skills
Technical skills valued	Technical skills taken for granted
Knowledge and skills of whole workforce developed and valued	Knowledge and skills of key workers/groups developed and valued
Team work valued	Rigid specialist roles
Cross-boundary communication encouraged	Bounded communication
Managers as facilitators of workforce and individual development	Managers as controllers of workforce and individual development
Chances to learn new skills/jobs	Barriers of learning new skills/jobs
Innovation important	Innovation not important
Multidimensional view of expertise	Unidimensional top-down view of expertise

experience that not all workplaces or all jobs offer equal opportunities for learning. I shall now review studies which have paid attention to the differences between workplaces in this respect.

Perhaps the most important contextual factor related to workplace learning is how work is organised. The traditional Fordist organization represents an extreme form of division of labour: the workers have narrow job descriptions, repetitive tasks, controlled procedures and little opportunities for autonomous decision making. In such work there are few opportunities for learning and development. At the end of the other continuum there are organizations in which work continuously provides new challenges and learning opportunities. In these workplaces workers are rotated between jobs, tasks are carried out by collaborative and self-managed teams with a lot of autonomy, and workers are encouraged to share their expertise and develop their work. (see, e.g. Ashton, 2002; Heikkilä, 2006; Tikkamäki, 2006).

While the organisation of work sets the context and conditions for learning, it continues to be the reciprocal interaction between the individual and the workplace that determines learning. Billett (2004) argues that the nature of individuals' participation in workplace learning depends both on the extent to which the workplace provides opportunities for such participation and on the extent to which individuals choose to avail themselves of those opportunities. Thus, while the workplace creates the possibilities, it is how individuals participate and interact in their workplaces that is central to their leaning. On this view, knowledge is co-constructed through interactions between social practice and the individuals participating in that practice. It is therefore important to acknowledge workplaces as sites for learning.

Fuller and Unwin (2004) present a continuum of expansive-restrictive work communities, which describes how the work community fosters or constrains its members learning (including apprentices, trainees and students) (Table 2).

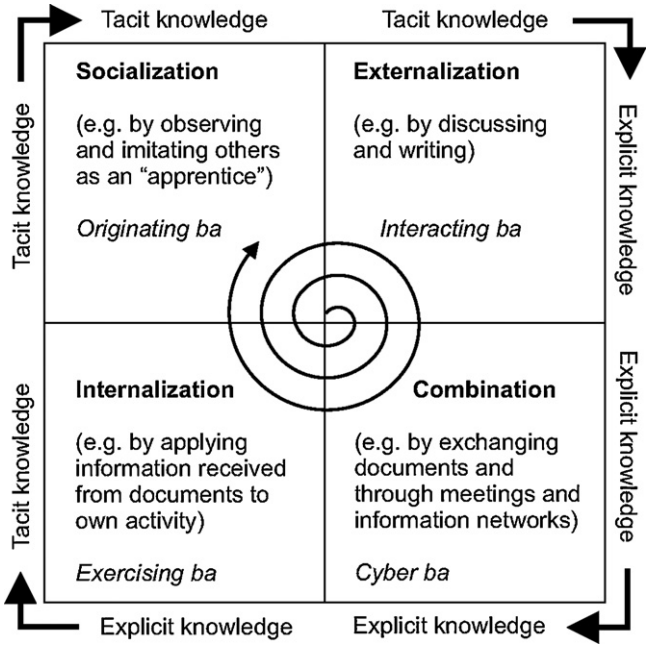

Fig. 2. Different forms of learning space, ba (Nonaka & Konno, 1998).

An expansive work community offers opportunities to take part in many different communities of practice, whereas a restrictive work community limits the opportunities for participation. According to Fuller and Unwin (2004) three types of learning opportunity are central to the creation of expansive learning environments: (1) the chance to engage in diverse communities of practice in and outside the workplace, (2) the organisation of jobs so as to provide employees with opportunities to co-constructing their knowledge and expertise, and (3) the chance to deal with theoretical knowledge in off-the-job courses (leading to knowledge-based qualifications).

Organisational studies on workplace learning have also emphasised that it is the responsibility of the work organisation to create a propitious climate and other prerequisites for learning by individuals, groups and whole work communities (e.g. Argyris & Schön, 1996; Lähteenmäki et al., 2001; Nikkanen, 2001; Senge, 1990). In other words, space for learning and thinking is needed. Nonaka and Konno (1998) refer to this kind of learning space with the Japanese concept *ba* which means a shared space for emerging relationships. *ba* can consist of physical, virtual or mental spaces or a combination of these, and it provides a forum for developing individual and collective knowledge. For example, a team can be a *ba* for the individual members and a network of organisations can be a *ba* for the organisations composing it. The benefit of *ba* is that by participating in it individuals, teams or organisations can surpass their own perspectives or boundaries. The idea closely resembles Vygotsky's (1978) celebrated notion of the zone of proximal development: through collaboration one can achieve to higher level outcomes than by working alone.

Nonaka and Konno (1998) distinguish between different types of *ba* (Fig. 2). There is an *Originating ba* for socialization, a space where people can meet face-to-face and share feelings, experiences and mental models. This is the primary *ba* where the knowledge creation process begins. *Interacting ba* provides a space for externalization, that is, for making tacit knowledge explicit. Here people share their mental models and reflect on and analyse them. *Cyber ba* represents the combination phase of knowledge creation: explicit knowledge is combined with other explicit knowledge. This can take place, for example, in on-line networks, documentation and databases. Finally, *Exercising ba* supports the internalization of explicit knowledge so that it becomes tacit knowledge in a process where explicit knowledge is used in action. If we examine workplaces within the framework of *ba*, it can readily be seen that some workplaces and networks provide different forms of *ba*, while other workplaces do not.

Sambrook (2006) has summarised the factors influencing work-related learning by assigning them to three main categories: (1) organisational factors, (2) functional factors and (3) individual factors (cf. Illeris, 2004; Jørgensen & Warring, 2002). Organisational factors pertain to the organisational culture and structure, senior managerial support, organisation of work, work pressures, tasks, and task vs. learning orientation. In particular, the importance of the

organisational culture has been emphasised in recent studies. For example, Vera-Cruz (2006) has shown that a firm's culture shapes its learning processes and, in worst case, may create rigidities in its response to change. On the other hand, Sveiby and Simons (2002) suggest that the culture of collaboration in particular is a major factor influencing the effectiveness of knowledge work. Functional factors are related to how the role of human resources development is defined and to the general characteristics of the organisation, such as number of staff, expertise, amount of information, and use of ICTs. One of the most important functional factors is the need to achieve a pace of new learning, knowledge acquisition and knowledge application that is both timely and relevant to the strategic purposes of the business (Dealtry, 2002). Thus, one main question to be answered in an organisation is how organisational learning strategy needs are incorporated into the business strategy. Individual factors include managers' and employees' responsibility for learning, motivation to learn, time, IT skills and confidence. How these different factors are organised influences the potential for learning in an organisation.

3. Section II: On-the-job learning and formal education

In the previous section my focus was on workplace learning in general, on the questions of who learns at work, how learning takes place and how workplaces differ in providing learning opportunities. In the following section the focus is on a special kind of workplace learning, that is, learning related to apprenticeship and trainee programmes, work-related projects for students or other forms of practical workplace training as part of formal education and the gaining of qualifications.

3.1. Models of organising work experience for students

On-the-job training has a long history. A well-known example is the medieval guild system through which newcomers were socialized into the craft. Under the supervision of a master, an apprentice first achieved the status of a journeyman and later was able to become a master himself. The system was similar to that described by Lave and Wenger (1991), a process of legitimate peripheral participation, which I mentioned earlier. In many countries the guild system was replaced by school-based vocational education systems, although practical training periods were still retained as an important part of most vocational and higher education degrees. Work experience for students has been organised in different ways in different educational systems. Guile and Griffiths (2001) analysed the relationship between learning that occurs within and between education and work, and identified five different models of work experience. These are briefly described below.

Models of work experience (Guile & Griffiths, 2001):

The traditional model. Students are simply "launched" into the workplace, and it is their task to adjust to the requirements of work. In this model it is assumed that learning occurs automatically, and thus there is no need for any special guidance or facilitation. Instead, work experience is managed through traditional supervision. Co-operation between the vocational institutions and the workplace is minimal, and the role of the education and training provider is limited to providing a formal preparation programme. There is a sharp division between formal and informal learning.

The experiential model. In this model, and according to the experiential learning theories (e.g. Kolb, 1984), reflection on work experience has an important role in the learning process. However, rather than reflection Guile and Griffiths put the student's interpersonal and social development at the forefront of the agenda for work experience. (Probably, they see reflection here as an inherent element supporting the student's development.) Defining the student's development as the central aim of work experience has led to greater dialogue and co-operation between education and workplaces. The aim is not only to get students adapted to the world of work but also to support their self-awareness, and their economic and industrial awareness. Supervision can be described as arms-length supervision, and the role of the education provider is to provide briefing and de-briefing with respect to work experience.

The generic model. In this model work experience is seen as an opportunity for developing and assessing the generic skills needed in working life. Thus, the emphasis is on learning outcomes. Students collect material for their personal portfolios to show their development in acquiring key skills. Students also take part in the assessment of their skills. The role of teachers and the education provider is to facilitate this process. The aim is to support students' self-management. This outcomes-based model is recognisable in the vocational education and training system in the UK.

The work process model. In this model the aim is that the students develop a holistic understanding of the work process and work context. The idea is that the students adjust themselves to the changing context of work through the opportunity to participate in different communities of practice and this way develop the capacity to transfer the knowledge and skills gained in one work context to another. The model requires the integration of theoretical and practical learning, and hence collaboration between educational institutions and the workplace is important. Work experience is managed by coaching students, and the role of the education and training provider is to support reflection-in-action and reflection-on-action.

The connective model. On the basis of socio-cultural learning theories Guile and Griffiths present the connective model as the ideal model of utilising work experience. At the core of this model is making of a "reflexive" connection between formal and informal learning, and between "vertical" and "horizontal" learning, the former referring to students' conceptual development, the latter to the development of students' capacity to work in different contexts. The idea is to resituate learning in a way that requires students to draw upon their formal and conceptual learning. Through working collaboratively the aim is to develop polycontextual and connective skills which enable "boundary crossing" by students, that is, the ability to work in changing and new contexts. This requires close co-operation between educational institutions and workplaces, and therefore the central role of the education and training provider is to develop partnerships with workplaces to create environments for learning.

According to Guile and Griffiths, all these models, except for the ideal connective model, can be recognised in existing European VET systems. However, the classification is more analytical than descriptive: no specific work experience programme fits neatly into any one model and some programmes may contain elements of more than one model. The fifth model, the connective model, represents a new approach which the authors put forward as a new framework for a curriculum designed to emphasise the connection between the learning that takes place in different educational and work contexts.

Recent studies on Finnish vocational education and training have found differences between fields of study in models of organising learning at work for students (Tynjälä, Virtanen, & Valkonen, 2005b; Virolainen, 2004, 2006; Virtanen & Tynjälä, in press). For example, in a study by Virtanen and Tynjälä (in press) it was found that all the models described by Guile and Griffiths were present in VET and that there was a clear trend away from traditional model towards the other models. School-based learning and work-based learning were most closely connected with each other in the field of social and health care, while features of the traditional model were observed most often in the field of technical education. Furthermore, social and health care students gave higher ratings of their boundary crossing skills than did students in other fields, a result consistent with the findings on connectivity.

How, then, can the ideal of connectivity be realised in education? I suggest that this is possible through the pedagogical approach I call *integrative pedagogics* (Tynjälä, 2005, 2007). This is a not a specific method of teaching; instead it is a principle which states that in any learning situation key elements of expertise – that is, theory, practice and self-regulation – should be integrated. Incorporating work-based learning in education requires the development of pedagogical models which take into account both the situated nature of learning and generic knowledge on the development of expertise. Fig. 3 presents such a model. It is based on various accounts of the components of expertise (Bereiter, 2002; Bereiter & Scardamalia, 1993; Eraut, 1994, 2004a; Le Maistre & Paré, 2006). Briefly, professional expertise can be described as consisting of three basic elements which are *closely integrated* with each other: *theoretical knowledge, practical knowledge* and *self-regulative knowledge*. Theoretical knowledge and practical knowledge, located at the top of Fig. 3 represent intrinsically very different types of knowledge. Theoretical knowledge is universal, formal and explicit in nature. It can easily be explicated, for example, in books and lectures. In contrast, practical knowledge that we gain through practical experiences is case-specific—it is not universal in the way theoretical knowledge is. Practical knowledge (often referred to as procedural knowledge or simply as skills) is often not so easy to explicate; rather it is intuitive, implicit or tacit in nature. The arrows between the boxes labeled theoretical and practical knowledge in Fig. 3 illustrate the significance of the interaction between and integration of these different types of knowledge. For example, Gaie Leinhardt and her colleagues (1995) emphasize that professional education should involve both the transformation of theoretical knowledge into a form where it becomes available for use in particular cases, and the explication and conceptualisation of tacit knowledge derived from work experience. In other words, theories should be considered in the light of practical experience and practical experience in the light of theories. While traditional education has treated them separately (e.g. theoretical courses and practice periods have been carried out separately without any connection), modern pedagogical thinking emphasises

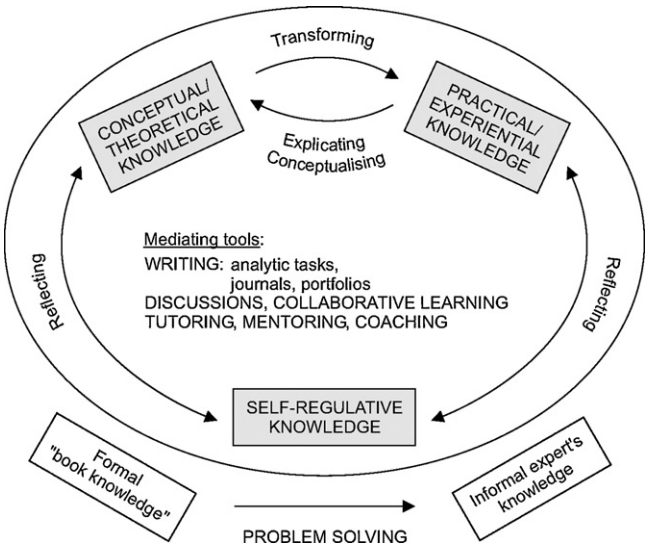

Fig. 3. Integrative components of the development of vocational and professional expertise (Tynjälä et al., 2006).

the unity of theory and practice (see, for example, Guile & Griffiths, 2001; Griffiths & Guile, 2003; Tynjälä et al., 2003).

Besides theoretical and practical knowledge, the third constituent of expertise is self-regulative knowledge, including metacognitive and reflective skills (e.g. Bereiter, 2002; Bereiter & Scardamalia, 1993). Linking the development of self-regulation with theory and practice is shown at the center of Fig. 3. In the process of integrating theory and practice mediating tools are needed. All activities that enable students to make tacit knowledge explicit or analyse theoretical knowledge and practical experience are potential mediating tools. These include, for instance, discussions with a tutor, mentor or a small group, or writing assignments, such as analytic tasks, portfolios and self-assessments. Alternatively, during their apprenticeship students may write a learning journal to reflect on their work and learning. These kind of activities allow students to develop their self-regulatory knowledge in a context provided by the knowledge and problem domain of their future profession.

According to Bereiter and Scardamalia (1993) it is through problem solving that formal knowledge acquired in education is transformed into an expert's flexible informal knowledge. The process of integrating theory, practice and self-regulation can be seen as a problem-solving process where students simultaneously need to solve practical problems and related conceptual problems, that is, problems of understanding. In terms of Sternberg's (2004) triarchic theory of intelligence, this could be described as using analytic, creative and practical intelligence in an integrative way. This is illustrated at the bottom of Fig. 3. Formal knowledge is turned into skills when it is used to solve practical problems and into informal knowledge when it is used to solve problems of understanding (Bereiter & Scardamalia, 1993, p. 66). The result may be a creative solution to the problem. Accordingly, instead of traditional forms of delivering knowledge, problem-solving tasks should form the core of the education of a skilled workforce.

What, then, are the implications of this model for learning in authentic working life situations? There are at least three implications:

(1) The development of vocational and professional expertise must be seen as a holistic process in which theory cannot be separated from practice—or practice cannot be separated from theory.
(2) Second, when students are solving real life problems either in authentic working life or in simulated contexts, they need to be provided with conceptual and pedagogical tools which make it possible for them to integrate theoretical knowledge with their practical experiences.
(3) Participating in real life situations is a necessary but not a sufficient condition for the development of high level expertise.Only deep integration of theoretical, practical and self-regulative knowledge creates expertise.

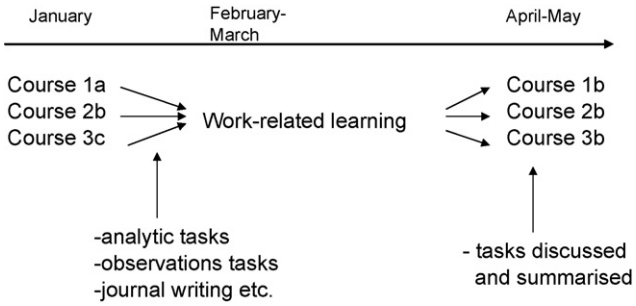

Fig. 4. Example of a connective curriculum.

My main suggestion is that work-related learning should be an integral part of a curriculum and linked with other courses. In other words, apprenticeship or practice periods are not separated from teaching in other courses but related to each other. Fig. 4 presents an example. Here, the semester begins with three parallel courses. Course 1 may be in mother tongue, and course 2 and course 3 in vocational subjects. After these courses the students do an apprenticeship or some other kind of work-related learning, following which the three courses continue. The idea is that in courses 1, 2 and 3 the students are given analytic tasks, observation tasks, application tasks or any learning tasks through which allow them to examine their work practice in the light of a conceptual or theoretical framework, i.e. by applying theoretical concepts. After the work-related learning period the tasks are discussed and the outcome summarised, and the students' work experience is re-analysed in the light of theory.

In some countries newly established work-based degrees in higher education are already in place. For example, in the UK the Foundation Degree based on work experience has recently gained popularity (Zamorski, 2006). Likewise, in Finland polytechnics have established a new Master's level degree for which 3 years of work experience after the Bachelor's degree is a basic entrance requirement and in which a work-based development project forms a central part (Välimaa & Neuvonen-Rauhala, in press). In programmes like these it is particularly important that work experience is connected to conceptual and theoretical learning. However, I suggest that the integrative model should be the basis of any vocational or higher education study programme.

In incorporating workplace learning into the curriculum there is the danger that core subjects, such as mother tongue, languages and mathematics, will somehow be marginalised. However, one important idea in the connective model is that work-based learning is linked not only with vocational subjects but also with core subjects. For example, in their working life project studies, students can practise how to take minutes in a project meeting, analyse communication practices in the workplace or write work-related documents in a foreign language. Another important principle of connective work-related learning is that students are not just sent out into working life but that they receive coaching and guidance and that their learning is facilitated. An ideal is that students are assigned a tutor from their educational institution and a mentor or workplace trainer from the workplace and that these three partners regularly meet and talk to each other. It is also important that the aims of the work-related learning period are set out beforehand and that these aims derive from the curriculum and connect with theoretical knowledge. Thus, work-related learning becomes intentional learning. It is also very important that work-related learning is planned in collaboration with workplaces. Only in this way can all three parties construct shared goals and modes of action.

In addition to a period in the workplace, there are other pedagogical solutions which aim at giving students experience of authentic problems and procedures in working life. These include pedagogic approaches such as problem-based learning (PBL) (see, e.g. Boud & Feletti, 1991), case-based learning (e.g. Markowitsch & Messerer, 2006) and project-based learning (e.g. Helle, Tynjälä, & Olkinuora, 2006; Helle, Tynjälä, & Vesterinen, 2006).

Problem-based learning (PBL) is a curriculum development and instructional approach that applies problematic situations adapted from real world issues as a starting point for learning and studying (see, e.g. Albanese & Mitchell, 1993; Boud & Feletti, 1991; Norman & Schmidt, 2000). The courses are structured around problems rather than subjects or disciplines, and theoretical material is studied to find solutions to real-life cases. Students are encouraged to apply their existing knowledge and to identify their further learning needs in co-operation with other students. Students work in small groups with authentic ill-structured problems, although not usually in authentic environments. Although PBL

is not a work-based learning method itself, the PBL process involves practising many of the skills needed in working life. It strongly relies on a combination of collaboration, co-operation, knowledge sharing and independent work, all of which are very important in the world of work (see, Tynjälä et al., 2006). Furthermore, an important aspect of expertise, self-regulative knowledge, involving metacognitive and reflective skills, develops through PBL. Numerous studies and reviews in the field of medical education, for example, have shown that PBL students perform as well as other students' in their final examinations, but score higher in clinical problem solving. They also significantly better understand the principles that link concepts, and seem to be better at retaining the things they have learnt. PBL students show a greater satisfaction with their studies and greater self-regulation of learning (see, for example, Albanese & Mitchell, 1993; Dochy, Segers, van den Bossche, & Gijbels, 2003; Gijbels, Dochy, van den Bossche, & Segers, 2005). Thus, there seems to be a lot of evidence to show that PBL methods are successful in developing both conceptual understanding and generic working-life skills.

Case-based learning and *project-based learning* are somewhat more authentic than problem-based learning. Students work in small groups on concrete problems or cases which often are authentic commissions from enterprises or public organisations. Work-related project learning differs from problem-based learning in its emphasis on producing a concrete end product for the client organisation (see, e.g. Olesen & Jensen, 1999; Tourunen, 1992, 1996). For example, Miettinen and Peisa (2003) examined one such course in business administration. The student teams first made designs for an enterprise of their own. They then examined the operations and activities of a real-life partner enterprise and some of the problems involved in them. After this they designed, within their own "shadow enterprise", alternative modes of action for the real enterprise or one of its departments. The partner enterprise evaluated the solutions suggested by the student teams and considered their possible implementation in the organisation. According to Miettinen and Peisa, some of the student teams came up with new ideas and action models that interested the partner enterprise, while some of the students' suggestions were not feasible. However, even when the students' suggestions were rejected, the outcome activated their learning potential. It is also possible to combine problem-based and project-based studies. One way to do this is to first study the theoretical foundation needed in the project, using PBL, before taking up a concrete assignment intended to create the product or the plan (cf. Jäntti, 2003).

Markowitsch and Messerer (2006) describe a course in "integrated case studies" given in the Fachochshule Kufstein, Austria. In this course students receive project assignments from companies who also pay them a small amount of financial compensation. The idea is to secure motivation and interest on both sides. Thus, the company has a real interest in getting results; and the students experience quality, deadline and cost pressures, as in the real working world. A master plan for the project is developed at a kick-off meeting with the company after which the student group works as a project organisation with project management, division of tasks, time schedules etc. This way they experience realistic business demands such as keeping deadlines, communication problems, changes in structures or goals etc. Midway, the student groups report on the current status of their project and the problems and difficulties they have encountered in relation to it to other groups of students. At the end of the project, the students write a comprehensive report and a ten to fifteen-page summary for the company. The results are also presented to the other students and to the company. Project groups are assessed 25% on the basis of their project management (division of tasks, realistic planning, keeping of deadlines, etc.) and 75% on the basis of the results (content and form of the report, presentation, creativity in approaches to solutions, etc.). A project usually spans one semester.

Similar project-based courses have been examined by Eteläpelto (1998) and Helle, Tynjälä, Olkinuora, & Lonka, 2007. These courses are part of the information systems design programme at the University of Jyväskylä, Finland. The course involved students not only in designing and conducting the project work but also in reflecting on and evaluating their working process and outcomes. In these two-semester courses assessment was based on the tripartite principle (Tynjälä & Tourunen, 2001). In other words, the students, the teachers and the representatives of the client companies were involved in assessing the students' project work. Here assessment focussed on the process (e.g. planning, project management, co-operation with clients and within the group, commitment), which formed 90% of the evaluation scheme, while the outcome was weighted at only ten per cent. Eteläpelto (1998) found that students' problem-solving methods developed considerably during the project and that the competence they acquired was an adequate foundation for the broad-based expertise they acquired later on. The students reported that in addition to domain-specific skills, they had also learnt many generic working life skills such as co-operation skills, oral and written communication skills, resource management, self-management and self-regulation skills, and social skills (e.g. self-expression, getting along with different people, etc.) (Tynjälä, 2001). Students also reported having gained in professional self-confidence or

self-concept (Helle et al., 2007). Project studies can thus play a role in paving the way to working life for young people. They also seem to have a very positive influence on students' motivation. In a study by Helle et al. (2007), the general level of students' intrinsic study motivation increased substantially in students on a project course, while it remained stable in the control group who took part in a similar course but without the project component. Furthermore those students in the project group who initially scored lowest on self-regulation of learning seemed to benefit most in terms of intrinsic study motivation. Thus, work-related projects seem to add a particular motivational element to university studies.

An interesting point related to case-based and project-based learning is that their benefits not only accrue to students but also to the companies who provide the student groups with project assignments. For example, in the Jyväskylä case the same companies continue to collaborate with the University year after year—despite the fact that they pay a substantial amount of money as compensation for the project work. Interviews with the representatives of the companies indicate that teams of university students can make worthwhile contributions to working life.

3.2. Challenges facing co-operation between education providers and the workplace

The research reviewed above has clearly shown that learning in authentic working life environments is very important in helping students to develop their competencies, skills and vocational identity. However, organising student on-the-job learning, practice periods, apprenticeship programmes, or project assignments is a challenging task. A particular challenge in the case of work-related learning is that, compared to school-based learning, it involves partners who may have different views of learning and of the aim of student placements. While students and teachers find it important to define learning goals at the beginning of the learning period, the negotiation of learning goals is not always in the interest of employers, as some studies have shown (e.g. Virolainen, 2006; Virtanen and Tynjälä, 2007). The primary goal of employers is to make a profit, which may mean, if students are seen as a free or inexpensive workforce, that their learning needs are neglected. This is probably not such a problem in dual VET systems (e.g. in German or Austrian apprenticeship programmes) where there is a long tradition of workplace participation in vocational training. However, in these systems other problems seem to emerge. For example, there may not be enough places for apprentices, vocational training has lost its attraction for young people who nowadays prefer an academic education, and learning has been separated off from actual production in the company (Rauner, 2006). The last of these is in clear contradiction to the ideas of situated learning (Lave & Wenger, 1991; Wenger, 1998), which emphasise the significance of an authentic context for learning.

The tripartite principle in students' workplace learning is important not only in negotiating learning goals but also in the assessment of learning (Stenström & Laine, 2006). Current constructivist learning theories emphasise the importance of developing students' metacognitive and reflective skills (e.g. von Wright, 1992) from which it follows that students' self-reflection and self-assessment of learning becomes important. Furthermore, it is important for students to receive feedback from their workplace trainers, who have been able to follow their progress more closely than has been possible for their school teachers. This does not diminish the role of teachers, as it is they who in the first place are in charge of the pedagogical design of the curriculum and enabling the integration of theory and practice. Their role in student assessment is thus no less important.

The first part of this article emphasised the social nature of workplace learning. At work employees typically learn in collaborative situations. This applies to students as well. Therefore it is important that students gain access to different communities of practice. Student supervision and guidance in the workplace is also important. However, the people who are in charge of supporting students' learning at the workplace may not have pedagogical training themselves. Even those workplace trainers who have been educated in training often feel that their learning guidance and student assessment skills are inadequate (Stenström & Laine, 2006; Tynjälä, Nikkanen, Volanen, & Valkonen, 2005). Therefore, one of the biggest challenges facing educational institutions and teachers is to train and coach workplace trainers. For example, in Finland vocational education providers have made considerable use of ESF funding to train tens of thousands workplace trainers for vocational students. Another model is to include trainers' training modules as a voluntary component in vocational curricula.

In addition to the formal training of trainers it is important that teachers and workplace trainers are in continuing contact with each other. They have a shared responsibility for supporting student learning and therefore they need to have a shared understanding of the goals of learning, ways of supporting learning (e.g. discussions, learning tasks through which theory and practice are integrated) and assessment of learning. Reaching shared understanding is not

possible without open communication, negotiation and collaboration. Close contacts between education institutions and working life are important also for curricular planning. In a rapidly changing world it is important that curricula are congruent with up-to-date occupational and professional requirements. This means that teachers must have direct contact with the needs of working life and that the representatives of working life participate in the planning of curricula. As educational matters are the primary responsibility of educational institutions and only of secondary interest to workplaces, the latter expect that collaboration will be initiated by teachers (Tynjälä, Nikkanen, et al., 2005; Tynjälä, Virtanen, et al., 2005).

What has been said above about teachers' responsibilities imply that the role and expertise of teachers in general, and vocational teachers in particular, is going through a fundamental transformation. Direct teaching has expanded to include guidance in the learning process, individual responsibility for teaching has become shared work with academic colleagues and workplace trainers, the traditional school-based working culture has become a more networked-based community, the supervision and guidance of students has expanded to include coaching by workplace trainers, etc. The new diversity that teachers' work involves, however, is not always easy for teachers themselves to accept. In particular, when teachers feel that the pressures for change originate outside the school community they may not appropriate new ideas or practices (see, Hargreaves, 1994 for different teacher cultures). It has been shown that knowledge creation, dissemination and utilisation is noticeably slower in the field of education than in some other fields (OECD, 2000). This is supported by another finding according to which in some respects vocational school working cultures may be somewhat more conservative and slower with respect to innovation than working cultures outside schools (Tynjälä & Nikkanen, 2006). Thus, there is a need to develop working cultures shared by teachers and researchers in which knowledge is created and used in a joint effort (see, Bereiter, 2002).

Among the most important challenges facing workplace learning is the development of what may be called workplace pedagogy (see, e.g. Billett, 2002; Fuller & Unwin, 2002). The transfer of knowledge between education and workplace settings is problematic. Eraut (2004a) has noted that recognizing what theory you need in any particular situation is mainly learned through participation in practice and receiving feedback on your actions. Theoretical knowledge remains inert or dormant until it is triggered by specific situations. According to Eraut's analysis, the transfer process may entail considerably more learning than the original acquisition of academic knowledge. The model of integrative pedagogy presented earlier suggests that when theory is learned it is necessary to apply it immediately to practical problem-solving situations – either to authentic or hypothetical cases – so as to develop integrated expert-like knowledge. Similarly, it is important that when students are having on-the-job experiences, whether as trainees, apprentices or student project participants, they have opportunities to reflect on their work processes and work contexts in the light of theory. This requires prescribed learning tasks. This kind of pedagogy relates formal and informal learning and promotes the development of reflective competence and boundary crossing skills (see, Guile & Griffiths, 2001). Bringing about an integrative and connective pedagogy is possible only in close partnerships between educational institutions and workplaces.

An important practical issue related to students' participation in working life as a part of their education and training concerns money: Since students work and thus contribute to the profits of the company or to the service provision of a public organization, should they be paid? Alternatively, we may ask: As enterprises or other work organizations need to invest time and effort in supervising, coaching and facilitating students, should they be compensated for this? Different education and training systems have different solutions to these questions. In general, most apprenticeship programmes are based on the idea that apprentices are employees, so they are paid. This is the case, for example, in the German dual system where working life traditionally occupies a strong position in vocational education and training, and thus invests highly in it. A different example is followed in Finland, where the VET system has traditionally been school-based but where a few years ago a new on-the-job learning system was adopted as an integrated part of all vocational study programmes. Of the 3-year study programmes at least half a year is done in an authentic work context. The training is explicitly defined as on-the-job learning instead of a traineeship, as it is emphasised that certain contents of the curriculum (e.g. certain skills, methods or procedures) are to be learnt in the workplace (instead of school). Consequently, workplaces are seen primarily as learning environments and therefore students are not paid. Instead they receive their normal student allowance during the workplace learning period. Employers are not usually compensated either as they are deemed to benefit from students' work. It should be noted, however, that, while these are the main guiding principles, in individual cases there is variation. Moreover, trainees from polytechnics and universities are often paid, and in some cases their employers may receive partial compensation for hiring students as trainees.

4. Conclusions

In this paper I have examined the nature of workplace learning from different perspectives. First, I described the differences between learning at school and learning in the workplace, emphasising the informal, incidental, experiential, social, situated and practice-bound nature of the latter. I also gave consideration to the criticism that emphasising workplace learning as purely informal and incidental neglects the fact that many workplace practices are inherently pedagogical (see, e.g. Billett, 2004; Fuller & Unwin, 2002). Rapid and continuous change in society in general and in working life in particular have made lifelong learning and learning in the workplace a necessity for both organisations, nations and individuals. Therefore, in addition to being seen as environments for making a profit or providing services workplaces should also be seen as environments for learning.

Learning in the workplace can occur at different levels. Learners may be individuals, groups, whole organisations, inter-organisational networks or even geographical regions. The nature of learning varies as well. Learning has been described in three metaphors: as the acquisition of knowledge and skill, as participation in communities of practice and as knowledge creation (Hakkarainen et al., 2004; Paavola et al., 2004; Sfard, 1998). While the knowledge acquisition perspective has been typical in formal education, the participation and knowledge creation metaphors better describe workplace learning. People learn at work by participating in various working practices, collaborating with colleagues and clients and meeting new challenges. Learning is embodied in the development of better practices and the creation of social and material innovations. It is nurtured by progressive problem solving and the intention to integrate conceptual understanding with practical problem solving.

Although formal learning and informal workplace learning are different in nature, both are equally important for the development of vocational and professional expertise. Formal learning mainly produces explicit knowledge, while informal learning mainly produces tacit or implicit knowledge. Ideas stemming from different theoretical frameworks have emphasised the significance of the interaction and integration between formal and informal, or explicit and implicit knowledge (Eraut, 2004a; Guile & Griffiths, 2001; Le Maistre & Paré, 2006; Markowitsch & Messerer, 2006; Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995; Simons & Rujters, 2004; Tynjälä et al., 2006). It seems that this is one key to advancing workplace learning and the development of expertise.

The interplay between formal and informal learning also concerns formal education. It is important that school-based and work-based learning enter into a closer relationship. Formal education should adopt methods of teaching and studying that simulate real life situations. Educational programmes should be planned in such a way that authentic working life experience is provided to all students and that work-related learning involves integrating theoretical, practical and self-regulative knowledge, as suggested in the model of integrative pedagogics outlined earlier in this paper. At the same time, workplaces could benefit from formalising learning at work to some extent. Learning projects, learning networks between organisations, human resource development programmes and so on could be established to promote knowledge sharing, reflection, and innovation in organisations.

Collaboration between education and work is of fundamental importance for enhancing learning in both environments. This collaboration can take various forms, ranging from programmes providing students with *on-the-job training* to programmes providing working adults with *off-the-job training* (see, Helle, 2007). Students need the opportunity to participate in authentic communities of practice in workplaces, while every now and then employees need time and space to reflect on and conceptualise their practices as well as update their professional knowledge and skills. For both of these groups the integration of theoretical, practical and self-regulative knowledge and the integration of formal and informal learning are essential.

References

Albanese, M. A., & Mitchell, S. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine*, (68), 52–81.

Argyris, C., & Schön, D. A. (1996). *Organizational learning II: Theory, method and practice*. Reading, MA: Addison-Wesley.

Ashton, D. (2002). The dynamic of workplace learning: The role of work organizations. In K. Evans, P. Hodkinson, & L. Unwin (Eds.), *Working to learn* (pp. 149–162). London: Kogan Page.

Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Erlbaum.

Bereiter, C., & Scardamalia, M. (1993). *Surpassing ourselves: An inquiry into the nature of expertise*. Chicago: Open Court.

Billett, S. (2002). Workplace pedagogic practices: Co-participation and learning. *British Journal of Educational Studies*, *50*(4), 457–483.

Billett, S. (2004). Learning through work: Workplace participatory practices. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 109–125). London: Routledge.

Billett, S., Ovens, C., Clemans, A., & Seddon, T. (2007). Collaborative working and contested practices: Forming, developing and sustaining social partnerships. *Journal of Education Policy*, *22*(61), 637–656.

Billett, S., & Seddon, T. (2004). Building community through social partnerships around vocational education and training. *Journal of Vocational Education and Training*, *56*(1), 51–67.

Billett, S., Smith, R., Barker, M. (2005, December 12–14). *Interdependencies at work: Constituting reflection, performance dialogue and reward*. Paper presented at the Researching Work and Learning, RWL04, Conference, Sydney, Australia.

Blom, R., Melin, H., & Pyöriä, P. (2001). *Tietotyö ja työelämän muutos. Palkkatyön arki tietoyhteiskunnassa*. Helsinki: Gaudeamus.

Boud, D., & Feletti, G. (Eds.). (1991). *The challenge of problem-based learning*. New York: St. Martin's Press.

Boud, D., & Solomon, N. (Eds.). (2001). *Work-based learning. A new higher education?* Buckingham: The Society for Research into Higher Education & Open University Press.

Boulton-Lewis, G., Pillay, H., & Wills, L. (2006). Changing workplace environments, conceptions and patterns of learning: Implications for university teaching. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 145–161). Amsterdam: Elsevier.

Bromme, R., & Tillema, H. (1995). Fusing experience and theory: The structure of professional knowledge. *Learning and Instruction*, *5*, 261–267.

Brown, A., Rhodes, E., & Carter, R. (2004). Supporting learning in advanced supply systems in the automotive and aerospace industries. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 166–182). London: Routledge.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*, 32–42.

Camagni, R. (1991). *Innovation networks. Spatial perspectives*. London: Belhaven Press.

Candy, P. C., & Crebert, R. G. (1991). Ivory tower to concrete jungle. The difficult transition from the academy to the workplace as learning environments. *Journal of Higher Education*, *62*(5), 570–592.

Castells, M. (2000). *The rise of the network society* (2nd ed.). Oxford: Blackwell.

Collin, K. (2002). Development engineers' conceptions of learning at work. *Studies in Continuing Education*, *24*(2), 133–152.

Collin, K. (2005). *Experience and shared practice. Design engineers' learning at work*. Jyväskylä: University of Jyväskylä.

Collin, K., & Valleala, U.-M. (2005). Interaction among employees: How does learning take place in the social communities of workplace and how might such learning be supervised? *Journal of Education and Work*, *18*(4), 411–420.

Dealtry, R. (2002). Managing the issue of learning relevance in the formulation of learning strategies. *Journal of Workplace Learning*, *14*(5), 205–214.

Dochy, F., Segers, M., van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction*, *13*(5), 533–568.

Engeström, Y. (2004). The new generation of expertise. Seven theses. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 145–165). London: Routledge.

Engeström, Y., Engeström, R., & Kärkkäinen, R. (1995). Polycontextuality and boundary crossing in expert cognition: Learning and problem solving in complex work activities. *Learning and Instruction*, *5*(4), 319–336.

Eraut, M. (1994). *Developing professional knowledge and competence*. London: Falmer Press.

Eraut, M. (2004a). Transfer of knowledge between education and workplace settings. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 201–221). London: Routledge.

Eraut, M. (2004b). Informal learning in the workplace. *Studies in Continuing Education*, *26*(2), 173–247.

Eraut, M., Alderton, J., Cole, G., & Senker, P. (1998). *Development of knowledge and skills in employment* (Final report of a research project funded by "The Learning Society" Programme of the Economic and Social Research Council). Sussex: University of Sussex.

Eteläpelto, A. (1998). *The development of expertise in information systems design*. Jyväskylä: University of Jyväskylä.

Fenwick, T. (2005, December 12–14). *Taking stock: A review of research on learning in work 1999–2004*. Paper presented at the Researching Work and Learning, RWL04, Conference, Sydney, Australia.

Fuller, A., Hodkinson, H., Hodkinson, P., & Unwin, L. (2005). Learning as peripheral participation in communities of practice: A reassessment of key concepts in workplace learning. *British Educational Research Journal*, *31*(1), 49–69.

Fuller, A., & Unwin, L. (2002). Developing pedagogies for the contemporary workplace. In K. Evans, P. Hodkinson, & L. Unwin (Eds.), *Working to learn* (pp. 95–111). London: Kogan Page.

Fuller, A., & Unwin, L. (2003). Learning as apprentices in the contemporary UK workplace: Creating and managing expansive and restrictive participation. *Journal of Education and Work*, *16*(4), 407–426.

Fuller, A., & Unwin, L. (2004). Expansive learning environments. Integrating organizational and personal development. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 126–144). London: Routledge.

Gijbels, D., Dochy, F., van den Bossche, P., & Segers, M. (2005). Effects of problem-based learning. A meta-analysis from the angle of assessment. *Review of Educational Research*, *75*(1), 27–61.

Griffiths, T., & Guile, D. (2003). A connective model of learning: the implications for work process knowledge. *European Educational Research Journal*, *2*(1), 56–73.

Guile, D., & Griffiths, T. (2001). Learning through work experience. *Journal of Education and Work*, *14*(1), 113–131.

Gustavsen, B., Ennals, R., & Nyhan, B. (2006). *Learning together for local innovation: Promoting learning regions*. Thessaloniki: Cedefop.

Hager, P. (1998). Understanding workplace learning: General perspectives. In D. Boud (Ed.), *Current issues and new agendas in workplace learning* (pp. 31–46). Springfield, VA: NCVER.

Hager, P. (2004). The conceptualization and measurement of learning at work. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 242–258). London: Routledge.

Hager, P. (2005, December 12–14). *The importance of contextuality in learning*. Paper presented at the Researching Work and Learning, RWL04, Conference, Sydney, Australia.

Hakkarainen, K., Palonen, T., Paavola, S., & Lehtinen, E. (2004). *Communities of networked expertise: Professional and educational perspectives*. Amsterdam: Elsevier.

Hargreaves, A. (1994). *Changing teachers, changing times. Teachers' work and culture in the postmodern age*. New York: Teachers College Press.

Hatano, G., & Oura, Y. (2003). Commentary: Reconceptualizing school learning using insights from expertise research. *Educational Researcher*, *32*(8), 26–29.

Heikkilä, K. (2006). *Työssä oppiminen yksilön lähtökohtien ja oppimisympäristöjen välisenä vuorovaikutuksena*. Tampere: Tampere University Press.

Helle, L. (2007). *Exploring project-based learning in higher education: The interplay between teacher regulation and student self-regulation of learning*. Doctoral dissertation, Annales Universitatis Turkuensis Ser B. 302. Univerisity of Turku, Finland.

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education—theory, practice and rubber sling shots. *Higher Education*, *51*(2), 287–314.

Helle, L., Tynjälä, P., Olkinuora, E., & Lonka, K. (2007). Ain't nothing like the real thing? Motivation and study processes in university level project studies. *British Journal of Educational Psychology*, *77*, 397–411.

Helle, L., Tynjälä, P., & Vesterinen, P. (2006). Work-related project as a learning environment. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 195–208). Amsterdam: Elsevier.

Hodkinson, P., & Hodkinson, H. (2004). The complexities of workplace learning. Problems and dangers in trying to measure attainment. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 259–275). London: Routledge.

Holmqvist, M. (2005, December 12–14). *Collective learning in innovative networks*. Paper presented at the Researching Work and Learning Conference RWL05, Sydney, Australia.

Hytönen, T., & Tynjälä, P. (2005, December 12–14). A learning network promoting knowledge management. Paper presented at the Researching Work and Learning Conference RWL05, Sydney, Australia.

Illeris, K. a. A. (2004). *Learning in working life*. Copenhagen: Learning Lab Denmark, Roskilde University Press.

Jarvis, P. (1992). *Paradoxes of learning*. San Fransisco: Jossey-Bass.

Jäntti, L. (2003). *Facilitation of collaborative and contextual learning in an enterprise environment*. Espoo: Helsinki University of Technology.

Jørgensen, C. H., & Warring, N. (2002). Learning in the workplace—the interplay between learning environments and biographical learning trajectories. In C. H. Jørgensen & N. Warring (Eds.), *Adult education and the labour market vii, Vol. b. Papers from research project "Work, life; learning environments and democratisation" presented at the 7th seminar of the ESREA Research Network, Roskilde, May, 2002* (pp. 9–33). Kobenhavn: BookPartner A/S.

Kautto-Koivula, K. (1999). Degree-oriented professional adult education in the work environment. In P. Ruohotie, J. Honka, & A. Suvanto (Eds.), *The developmental challenges in the cooperation of education and training and working life* (pp. 57–70). Helsinki: Ministry of Education & Research Centre for Vocational Education.

Knight, L. (2002). Network learning: Exploring learning by interorganizational networks. *Human Relations*, *55*(4), 427–454.

Kolb, D. A. (1984). *Experiential learning. Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

Lave, J., & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lähteenmäki, S., Toivonen, J., & Mattila, M. (2001). Critical aspects of organizational learning research and proposals for its measurement. *British Journal of Management*, *12*, 113–129.

Le Maistre, C., & Paré, A. (2006). A typology of knowledge demonstrated by beginning professionals. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and work: Collaborations, confrontations and challenges* (pp. 103–113). Amsterdam: Elsevier.

Leinhardt, G., McCarthy Young, K., & Merriman, J. (1995). Intergrating professional knowledge: The theory of practice and the practice of theory. *Learning and Instruction*, *5*, 401–408.

Markowitsch, J., & Messerer, K. (2006). Practice-oriented methods in teaching and learning in higher education: Theory and empirical evidence. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 177–194). Amsterdam: Elsevier.

Marsick, V. J., & Watkins, K. E. (1990). *Informal and incidental learning in the workplace*. London: Routledge.

Miettinen, R., & Peisa, S. (2003). Integrating school-based learning with the study of change in working life. The alternative enterprise method. *Journal of Education and Work*, *13*(3), 309–319.

Miles, R. E., Miles, G., & Snow, C. C. (2005). *Collaborative entrepreneurship. How communities of networked firms use continuous innovation to create economic wealth*. Standford, CA: Stanford Business Books.

Morgan, K. (1999). The learning region: Institutions, innovation and regional renewal. *Regional Studies*, *31*(5), 491–503.

Nelson, R. e. (1993). *National innovation systems: A comparative analysis*. Oxford: Oxford University Press.

Nikkanen, P. (2001). Effectiveness and improvement in a learning organization. In E. Kimonen (Ed.), *Curriculum approaches* (pp. 55–76). Jyväskylä: University of Jyväskylä, Department of Education & Institute for Educational Research.

Nonaka, I., & Konno, N. (1998). The concept of "ba": Building a foundation for knowledge creation. *California Management Review*, *40*(3), 40–54.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company. How Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Norman, G. R., & Schmidt, H. G. (2000). Effectiveness of problem-based learning curricula: Theory, practice and paper darts. *Medical education*, *34*, 721–728.

Olesen, H. S., & Jensen, J. H. E. (1999). *Project studies—a late modern university reform?* Roskilde: Roskilde University Press.

Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of innovative knowledge communities and three metaphors of learning. *Review of Educational Research*, *74*(4), 557–576.

Palonen, T. (2003). *Shared knowledge and the web of relations*. Turku: Annales Universitatis Turkuensis 266. Doctoral dissertation.

Pedler, M., Boydell, T., & Burgoyne, J. (1991). *The learning company* (2nd ed.). London: McGraw-Hill.
Poell, R. F. (2006). Organizing learning projects whilst improving work: Strategies of employees, managers, and hrd professionals. In J. N. Streumer (Ed.), *Work-related learning* (pp. 151–180). Dordrecht: Springer.
Poell, R. F., & van der Krogt, F. J. (2006). Learning at the workplace reviewed: Theory confronted with empirical research. In J. N. Streumer (Ed.), *Work-related learning* (pp. 71–94). Dordrecht: Springer.
Poell, R. F., Van der Krogt, F. J., & Warmerdam, J. H. M. (1998). Project-based learning in professional organizations. *Adult Education Quarterly*, *49*(1), 28–42.
Rauner, F. (2006, June 1–2). *Innovative apprenticeship 2010*. Paper presented at the meeting Learning Together for Local Innovation: Promoting Learning Regions, Bremen, Germany.
Reich, R. B. (1991). *The work of nations*. New York: Vintage Books.
Resnick, L. B. (1987). Learning in school and out. *Educational Researcher*, *16*, 13–20.
Robertson, C. (1998). Towards interactive business learning: A university for industry. *Virtual University Journal*, *1*(2), 100–110.
Sambrook, S. (2006). Developing a model of factors influencing work-related learning: Findings from two research projects. In J. N. Streumer (Ed.), *Work-related learning* (pp. 95–125). Dordrecht: Springer.
Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday Currency.
Sfard, A. (1998). On two metaphors for learning and dangers of choosing just one. *Educational Researcher*, *27*, 4–13.
Simons, R.-J., & Rujters, M. C. P. (2004). Learning professionals: Towards an integrated model. In H. P. A. Boshuizen, R. Bromme, & H. Gruber (Eds.), *Professional learning: Gaps and transitions on the way from novice to expert* (pp. 207–229). Dordrecht: Kluwer.
Slotte, V., & Tynjälä, P. (2003). Industry-university collaboration for continuing professional development. *Journal of Education and Work*, *16*(4), 445–464.
Slotte, V., & Tynjälä, P. (2005). Communication and collaborative learning at work: Views expressed on a cross-cultural e-learning course. *International Journal of E-Learning*, *4*(2), 191–207.
Slotte, V., Tynjälä, P., & Hytönen, T. (2004). How do HRD practitioners describe learning at work? *Human Resource Development International*, *7*(4), 481–499.
Sternberg, R. J. (2000). Successful intelligence: A unified view of giftedness. In C. F. M. van Lieshout & P. G. Heymans (Eds.), *Developing talent across the life span* (pp. 43–65). New York: Psychology Press.
Sternberg, R. J. (2004). Wisdom and giftedness. In L. V. Shavinina, E. S. Sprott, & M. Ferrari (Eds.), *Beyond knowledge: extracognitive aspects of developing high ability* (pp. 169–186). Mahwah, NJ: Erlbaum.
Sternberg, R. J., & Grigorenko, E. L. (2000). Practical intelligence and its development. In R. Bar-On & J. D. A. Parker (Eds.), *The handbook of emotional intelligence: Theory, development, assessment and application at home, school and in the workplace* (pp. 215–243). San Francisco: Jossey-Bass.
Stenström, M.-L. (2006). Polytechnic graduates working life skills and expertise. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 89–102). Amsterdam: Elsevier.
Stenström, M.-L., & Laine, K.e. (2006). *Towards good practices for practice-oriented assessment in European vocational education*. Jyväskylä: University of Jyväskylä. Institute for Educational Research. Occasional Papers 30.
Stephenson, J., & Saxton, J. (2006). Online learning-through-work leading to university degrees: A case study. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 247–262). Amsterdam: Elsevier.
Sveiby, K.-S., & Simons, R. (2002). Collaborative climate and effectiveness of knowledge work—an empirical study. *Journal of Knowledge Management*, *6*(5), 420–433.
Tikkamäki, K. (2006). *Työn ja organisaation muutoksissa oppiminen*. Tampere: Tampere University Press.
Tourunen, E. (1992, July 13–17). *Educating reflective system designers by using the experiential learning mode*. Available on web page: http://www.Cs.Jyu.Fi/~eero/eero-pub.Html. Paper presented at the IFIP W.G. Professional Development of IT Professionals, Singapore.
Tourunen, E. (1996, July 1–6). *How to support reflection in project-based learning using learning portfolios and information technology?* Available on web page: Http://www.Cs.Jyu.Fi/~eero/eero-pub.Html. Paper presented at the 5th International Conference on Experiential Learning, Cape Town, South Africa.
Tynjälä, P. (2001). Writing, learning and the development of expertise in higher education. In P. Tynjälä, L. Mason, & K. Lonka (Eds.), *Writing as a learning tool. Integrating theory and practice* (pp. 37–56). Dordrecht: Kluwer Academic Publishers.
Tynjälä, P. (2005, October 6–8). *Integrative pedagogics—learning in real life situations*. Keynote address in Enhancing Physiotherapy Competencies in Innovative Learning Environments. European Network of Physiotherapy in Higher Education, Helsinki, Finland.
Tynjälä, P. (2007). Connectivity and transformation in work-related learning: Theoretical foundations. In M.-L. Stenström & P. Tynjälä (Eds.), *Towards integration of work and learning: Strategies for connectivity and transformation* (Accepted for publication by Springer)
Tynjälä, P., & Häkkinen, P. (2005). E-learning at work: Theoretical underpinnings and pedagogical challenges. *The Journal of Workplace Learning*, *17*(5–6), 318–336.
Tynjälä, P., & Nikkanen, P. (2006, September 12–16). *Towards a learning region—vocational education institutes creating innovative networks in central Finland*. Paper presented at the ECER2006, 2006, Geneva, Switzerland.
Tynjälä, P., Nikkanen, P., Volanen, M. V., & Valkonen, S. (2005). *Työelämäyhteistyö ammatillisessa koulutuksessa ja työyhteisöjen oppiminen. Taitava Keski-Suomi -tutkimus osa II*. Jyväskylä: University of Jyväskylä. Institute for Educational Research.
Tynjälä, P., Nuutinen, A., Eteläpelto, A., Kirjonen, J., & Remes, P. (1997). The acquisition of professional expertise—a challenge for educational research. *Scandinavian Journal of Educational Research*, *41*, 475–494.
Tynjälä, P., Slotte, V., Nieminen, J., Lonka, K., & Olkinuora, E. (2006). From university to working life: Graduates' workplace skills in practice. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 73–88). Amsterdam: Elsevier.

Tynjälä, P., & Tourunen, E. (2001). Three-way partnership assessment in working-life oriented project-based learning. In N. Benton & R. Benton (Eds.), *Te rito o te matauranga. Experiential learning for the third millenium. Selected papers from the seventh conference of the international consortium for experiential learning* (pp. 47–58). Auckland: James Henare Maori Research Centre, University of Auckland.

Tynjälä, P., & Virtanen, A. (2005). Skill learning at work: Investigation into student experiences of on-the-job learning. *Learning the Skills: Special Edition of the Finnish Journal of Vocational and Professional Education, 7*(Special edition), 106–116.

Tynjälä, P., Virtanen, A., & Valkonen, S. (2005). *Työssäoppiminen keski-suomessa. Taitava keski-suomi -tutkimus osa i*. Jyväskylä: University of Jyväskylä. Institute for Educational Research.

Tynjälä, P., Välimaa, J., & Sarja, A. (2003). Pedagogical perspectives into the relationship between higher education and working life. *Higher Education*, *46*, 147–166.

Vera-Cruz, A. O. (2006). Firms' culture and technological behaviour: The case of two breweries in Mexico. *International Journal of Technology Management*, *36*(1–3), 148–165.

Vesalainen, J., & Strömmer, R. (1999). From individual learning to network learning—networks as learners and as forums for learning. In T. Alasoini & P. Halme (Eds.), *Learning organizations, learning society. National workplace development programme yearbook 1999* (pp. 117–139). Helsinki: Ministry of Labour.

Virolainen, M. (2004). Työhön sopeutumisesta oppimisen tilanteiden luomiseen. Ammattikorkeakoulujen työelämäjaksot ja työstä oppimisen mallit. In P. Tynjälä, J. Välimaa, & M. Murtonen (Eds.), *Korkeakoulutus, oppiminen ja työelämä. Yhteiskuntatieteellisiä ja pedagogisia näkökulmia* (pp. 213–233). Jyväskylä: PS-kustannus.

Virolainen, M. (2006, May 22–24). *Workplace learning and its many models in Finnish polytechnics*. Paper presented at the Seventh International Conference on HRD Research and Practice Across Europe.

Virtanen, A., & Tynjälä, P. (in press). Students' experiences of workplace learning in Finnish VET. *European Journal of Vocational Training*.

von Wright, J. (1992). Reflections on reflection. *Learning and Instruction*, *2*, 59–68.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Välimaa, J., & Neuvonen-Rauhala, M.-L. (in press). Polytechnics in Finnish higher education. In J. Brites Ferrara, M. de Lourdes Machado, & R. Santiago (Eds.), *Non-university higher education in Europe* (pp. 73–95). Springer.

Wenger, E. (1998). *Communities of practice. Learning, meaning and identity*. Cambridge: Cambridge University Press.

Zamorski, B. (2006). Bringing industry and academia closer together: The introduction of the foundation degree in the UK. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 57–72). Amsterdam: Elsevier.