Computer-Supported Collaborative Learning Series

Sean P. Goggins
Isa Jahnke
Volker Wulf *Editors*

Computer-Supported Collaborative Learning at the Workplace

CSCL@Work

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Foreword

It is hard to imagine a topic more perfectly timed than the central issue this book explores. In a world of constant change where many of our skills now have a half-life measured in a few years and many of our institutions are experiencing creative destruction at a daunting pace, we need to find ways to merge the best insights from formal education, where the goal is to learn what is already known, with those of organizational and workplace learning, where at least one of the main goals is to create new knowledge (Chap. 1 by Goggins & Jahnke). Indeed, building a bridge between learning what is known and learning that creates new knowledge is of crucial importance for both the computer-supported collaborative learning community and the computer-supported collaborative work community (Chap. 2 by Fischer). Collaborative learning in small groups (and not only community learning or organizational learning) is "the" important unit of analysis and design in CSCL and CSCW (Chap. 3 by Stahl).

Schooling can no longer survive on a one-way knowledge transfer model and learning in the workplace cannot rest solely on its incessant pursuit of the new (Chap. 5 by Mumford). In both cases we find that a purely cognitive model of knowledge acquisition must be augmented by the social dimension of learning environments. This social dimension extends to workplace learning and regional economic development; benefiting individuals, organizations, and society (Chap. 4 by Rohde & Wulf).

I have spent much of my career exploring both individual learning and organizational/workplace learning, and exploring how technology and the design of learning spaces could accelerate capability building and productive inquiry.

As soon as I saw this manuscript I couldn't wait to read it since one of my current undertakings is a project in which we are exploring ways of cultivating a questing disposition around sustainability that scales. The project involves approximately a million or more employees spread out in 40,000 factories that make up a loosely coupled worldwide process network. Not surprisingly, I expect that the social aspect of learning, which leverages distributed peer-based mentoring and collaborative storytelling, will be a crucial part of this learning platform. The book includes four empirical cases (Part II in this volume) from CSCL at Work practices especially focused on reflection processes. For instance, there are two cases within the health care sector. The cases show how collaborative learning practices extend the evaluation skills and deepen the knowledge of doctors and nurses (Chap. 6 by Hartswood, Procter, Taylor, Blot, & Anderson) through collaborative reflections (Chap. 7 by Prilla, Herrmann, & Degeling).

Another major goal of this book is to lay out the foundations for bridging between formal classroom learning and informal learning in schools or the workplace; for instance, reflective community building at the workplace (Chap. 8 by Hokstad, Prasolova-Førland, & Fominykh) and the role of communication and facilitation in work-based learning (Chap. 9 by Kienle). We tend to forget just how natural this bridge can be. For example, the best indicator of success at college is one's ability to join (or form) a study group where class material is discussed within a small group of peers or problem sets are jointly worked on (Richard Light). These study groups rely on peer-to-peer mentoring. No one individual is the expert. Instead, each student contributes some knowledge and experience that, when woven together, create a coherent and complete model. Note that this process also helps to make the information being discussed personal, a major facilitator in helping each participant absorb new material.

A similar and equally effective method applies in the workplace where both peer-based and master-based mentoring, situated in real work and socially embedded, springs into action whenever a new problem arises. In both study groups and in workplace learning, provisional attempts to make sense of something unknown or unforeseen lead to significant ah-ha experiences while they also cultivate a willingness to improvise and reflect rather than to panic. As Part III (in this volume) illustrates such a learning experience occurs in unexpected places triggered through role-playing games (Chap. 10 by King) and social media and social networking sites (Chap. 11 by Gurzick & White), which offers new ways to think about how learning as a social activity may be influenced by new technologies for enabling social interaction.

The need to improvise workarounds to problems that emerge in situ is, of course, not new. What is new is just how often the need to improvise and to construct new knowledge now arises. While the pace of change, which is driven by our digital infrastructures is partly responsible, it is also these increasingly powerful, networked infrastructures that provide the tools to help us meet these challenges. For example, as Gerhard Fischer noted many years ago, one way to amplify the power of situated learning is through a form of learning-on-demand. When the learner/worker is stuck, he/she can pull insight from a vast network of information, and then use social networks to discuss with others their opinions on what to believe. This process is made more effective through the wide use of collectives (Thomas & Brown) and communities of interest that form on the net, and through the emergence of Open Education Resources (OER), scaffolded by discussion groups which come together through social media.

Indeed, our own work at PARC, deeply informed by anthropologists Julian Orr, Lucy Suchman, Brigitte Jordan, and Jack Wayland along with numerous computer scientists, pioneered the use of social media to create a new kind of distributed knowledge creation space among Xerox tech reps spread around the world. This system, appropriately named Eureka (Bobrow & Whalen), enabled Xerox tech reps to capture insights and experiences that emerged from handling troubleshooting problems that were either not satisfactorily covered in their troubleshooting manuals or had never been seen or envisioned before. These stories were then peer-vetted and passed around the world on Xerox's internal networks. But the role of computer support systems is just one part of what makes systems like Xerox Eureka so powerful. The real power comes from the social and reputational capital that was created by its participants and from the identities being constructed through becoming active members of this network of practice. This is also illustrated by three empirical cases in Part IV (in this volume) with a strong emphasis of creative work including product design and mechanical engineering. One case shows that to "make the process of decision making visible" affects the quality of solving problems when the answer is not known, but also helps to develop these capacities in new people and facilitate expert communication about their expertise (Chap. 12 by Lund, Prudhomme, & Cassier). The CSCL system called PeTEX addresses how teleoperated laboratories can bridge learning to the workplace and shows the critical dimension of distributed creative work (Chap. 13 by Terkowsky et al.).

Learning at the workplace often focuses on learning such as the primary activity. But CSCL at Work also considers the fact that learning means to provide employees with timely access to information for conducting everyday work while respecting business goals; learning in these cases is a secondary activity (work is the primary activity). An empirical case of customer service work and software product development describes this in detail (Chap. 14 by Mørch).

The above social life of learning is, today, further amplified with the use of video, such as YouTube, that is uniquely suited to capture and render more of the tacit dimension of knowledge. Inexpensive and easy to use digital cameras along with powerful but easy to use video editing now make it simple to capture, edit, and show what you have discovered.

What is needed now, more than ever, are theories and practices that bridge between formal and informal learning, didactic and experiential learning, peer-based and master-based mentoring, local and distributed learning, and the cognitive and the social dimensions of learning. We also need to explore new kinds of computational platforms that can enhance the potential synergy between these contrasting pairs. This is where the research efforts of CSCL at Work lie. They will help us craft learning contexts that lead to a new kind of learningscape, one that creatively exploits the inherent tension between process and practice. Yes, each of these pairs calls for a socio-technological lens, but what is also needed is a design sensibility that can help all the parties involved cocreate learning spaces that enhance both institutional and personal capabilities for thriving in a knowledge economy in constant change.

Palo Alto, CA, USA John Seely Brown

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Chapter 1
CSCL@Work: Computer-Supported Collaborative Learning at the Workplace—Making Learning Visible in Unexpected Online Places Across Established Boundaries

Sean P. Goggins and Isa Jahnke

Introduction

Computer-Supported Collaborative Learning at the workplace—CSCL at Work—bridges the knowledge of CSCL researchers, who are focused on learning, to the domain of workplace learning. CSCL at Work research, as proposed in this book, aims to understand how organizations create the knowledge they require when that knowledge is not already known within the organization. With this chapter we propose a framework for research focused on knowledge sharing by looking closely at the process of knowledge sharing, and defining CSCL at Work as a mechanism for *making learning practices visible*, and centering research on the collaborative creation of new knowledge. In other words, CSCL at Work frames a new area of inquiry, focused on making *collaborative learning* in the workplace explicit through social media and other collaborative technologies integrated into workplaces.

Creating a culture of learning within the organization was the focus of Organizational Learning, beginning with Argyris and Schön (1978) and continuing through its development by Brown and Duguid (1991, 2000) and others. Historically, knowledge management solutions focus on the capture, cataloguing, and retrieval of information and work processes to promote the identification of known information within an organization.

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But what do firms do when the answer is not known, the problem is not yet framed, or there are no existing solutions? For example, traditional book and newspaper publishers lose customers and authors in the Social Media age. Some publishers have adapted by adopting social media and blogging strategies, but these solutions did not emerge from knowledge management systems, which are insufficient for acquiring new knowledge. When an industry goes through these types of fundamental changes, entire workforces need to learn new methods and approaches for performing their work. To accelerate this process, CSCL at Work asks, how can *collaborative learning* be supported explicitly in the workplace? "Learning from the past is not enough to help stakeholders accomplish their tasks and practices" (dePaula & Fischer, 2005, p. 30). In this new world, "knowledge is not a commodity to be consumed but is *collaboratively* designed and constructed in the *doing of work*" (p. 30). What sounds simple is often implicitly done instead of *designing solutions for collaborative knowledge construction as an explicit way of learning*. Some firms even avoid the term "learning." A few large technology firms build and use interactive learning environments (SAP, in Gorman & Fischer, 2009; also, Ideo, Google, Apple), but a greater number of firms do not focus on fostering *collaborative* learning in the workplace. Learning today is not made into a visible, integrated part of work practices.

Technology solutions are one component of supporting work-based learning. While there are a lot of new technologies making collaboration through Social Media outside of work more common (e.g., social networking systems, Blogs), most organizations do not yet focus clearly on using technologies like these to foster learning in general or collaborative learning, specifically. New kinds of knowledge management systems—reframed as CSCL at Work systems—might contribute to this.

The basic questions for industrial and information-society firms include the following: (a) are they able to create new knowledge when the answer to a problem is not available? and (b) what concepts of collaborative learning exist and are they supported? Reframing work as an active learning activity is a significant challenge for firms that need to adapt quickly in a dynamic world (Easterby-Smith, Lyles, & Peteraf, 2009). We argue that new concepts of learning—supported by new technologies—at the workplace and a new understanding of work are required to foster a work-based learning culture for creative thinking, creative actions, and innovations. To make progress toward these important goals, we propose a CSCL at Work research agenda at the boundary between research on knowledge management, CSCW (Computer-Supported Cooperative Work), and CSCL.

From a meta-analysis of eight cases, we frame an inquiry of CSCL at Work. Additionally, the lens of our combined 36 years of experience designing and implementing collaborative solutions for work and learning in industry inspired our questions. The analysis of the cases suggests that a future work-based learning approach—where employees need new knowledge on problems where the answers are not known—requires new conditions for learning.

The chapter is organized as follows. We introduce the conceptual framework of CSCL at Work starting with framing emerging problems followed by a case study and finally implications for conceptualizing CSCL at Work are illustrated.

Related Research and Contributions from CSCL and CSCW

Empirical research on cooperative work practices (Davenport, 2005; Lave & Wenger, 1991), the sharing of information at work (Brown & Duguid, 2000), and the development of communities of practice in workplace settings (Wenger, 1998) shows how knowledge can be shared in communities of practice when that knowledge is already known inside of an organizational context, but problems related to the *distribution* of *knowledge holders* and their knowledge (dePaula & Fischer, 2005) remain unsolved. The slogan "if Siemens only knew what Siemens knows" illustrates this problem. Prior, well-known findings like these rely on the premise that knowledge within an organization's walls can be actively diffused across the organization (Gibson & Cohen, 2003); then proceed to describe various models explaining how that occurs. Those knowledge management approaches are premised on a certain degree of *environmental stability inside a company*. The notion that you can "store knowledge" implies that it is likely to be useful for some period of time sufficient to justify the effort of capturing it.

Consider the example of the organization that manages the Wikipedia Web site as an example of an organization oriented towards knowledge-building. Recent studies of the Wikipedia virtual organization demonstrate that even highly distributed, heavily technologically mediated organizations build knowledge within them by actively soliciting knowledge from a wider community (Kittur & Kraut, 2008; Kittur, Lee, & Kraut, 2009). Despite the fact that Wikipedia is not a typical company like Hewlett Packard or other traditional organization, it provides an example of how knowledge diffusion occurs, and can occur across organizational boundaries in highly dynamic and virtual organizations. Viegas, Wattenberg, Jesse, and van Ham (2007) look at organizational boundaries in Wikipedia and the emergence of formal structures like moderators, who contribute content have the authority to delete articles.

The examples illustrate how collaborative learning in the workplace may be enabled through the systematic use of new technologies, how such socio-technical systems may drive the creation of new kinds of organizations and serve to frame CSCL at Work as critically different from traditional knowledge management research. In particular, research on Wikipedia illustrates the movement of informal, socially constructed practices into formal, institutionalized practices over time (e.g., Jahnke, 2010a, 2010b).

CSCL at Work challenges researchers and practitioners to frame learning as a part of work that is integrated into working processes, and not a separate, disconnected activity. This is what we call collaborative work-based learning, which is a specialized form of workplace learning, which develops on a daily basis at work when employees acquire new skills to solve current problems (Mumford, 2011). Formal schooling normally does not prepare workers for such learning. The history of learning the past 100 years includes the mingling of how we think about learning with traditional educational institutions. Instead, learning needs to be designed across a human's life since the concept of a divided lifetime—"education followed

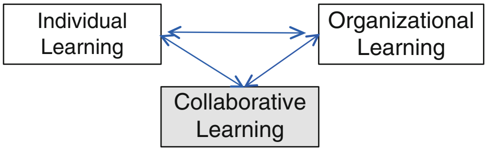

Fig. 1.1 CSCL at Work focuses on collaborative learning

by work"—is no longer the dominant reality (Fischer, 2011). Knowledge-intensive workplaces make learning an everyday component of much work, but relatively little research and development outside this volume emphasizes this changed reality explicitly.

Finally, organizations face the challenge of creating a work-based learning culture that includes informal structures to support the explicit design of learning. In such a culture, knowledge sharing is expressed as collaborative learning, with a focus on people. Collaborative learning is distinguished from organizational learning and individual learning by the knowledge that develops through interactions within groups that are supported by Social Media or other interactive technology. Collaborative learning is distinct from traditional workplace learning, where the focus is on how one person learns and organizational learning, where the focus is on how the entire firm shares knowledge that is already known by others within the firm. These distinct capabilities influence each other, as illustrated in Fig. 1.1.

Learning at work can be developed and designed in a way that is closely integrated to the daily-life of work or as a learning process that is completely separate from the work itself. More learning takes place using an integrated approach; one that makes learning an explicit part of work processes (e.g., Herrmann, Hoffmann, Kunau, & Loser, 2004). Traditional notions of learning prepared materials are insufficient in these contexts because the right answer is known in traditional learning; and in the modern workplace, this is increasingly not the case. Workplace learning is different from "textbook learning" in particular when there is no clear reference information related to the identified problem. Providing employees with opportunities for creative thinking and creative action is central to conceptualizing CSCL at Work, and the diversity of these conceptualizations across domains emerges through the included chapters.

CSCL at Work as Knowledge Construction

We understand collaborative learning as "an active process of constructing rather than acquiring knowledge, and instruction as a process of supporting that construction rather than communicating knowledge" (Duffy & Cunningham, 1996). Here, instruction is not restricted to teaching but encompasses scaffolding and enabling *opportunities for learning*. Following this, collaborative learning is defined as co-construction of knowledge and competence development where different people have the opportunity for creative thinking, introducing new ideas and taking creative actions.

This new perspective transforms learning from a concept focusing on knowledge transfer to one that can foster innovation. Learning outcomes are newly developed skills that learners use to solve a specific problem, to create new ideas together with other people, or to create new actions (Anderson & Krathwohl, 2001; Barr & Tagg, 1995). The result of learning is visible in the changed behavior of a learner (Biggs & Tang, 2007; Collins & Halverson, 2009).

Operationalizing this new view of collaborative work-based learning inspires a new set of questions about the behaviors, culture and infrastructure needed to support building a framework for CSCL at Work (adapted from Fischer, 2010):

- What is the underlying concept of collaborative learning within organizations?
- What kinds of *opportunities* to enable collaborative learning in the workplace are available?
- Do sociotechnical designers, researchers and workplace learners need to focus on a *new balance of formal and informal learning*? To what extent?

Situating CSCL at Work: Integrating Disparate Research

Understanding, reflecting and designing CSCL at Work needs to integrate as well as extend existing research in CSCL and CSCW. There are a few important distinctions between CSCL and CSCW research that frame our contribution to each community, and lead to an integrated research focus on CSCL at Work.

We wish to avoid the rhetorical danger associated with making general statements about any field, as it is especially perilous to *bridging* research. Since both CSCL and CSCW incorporate a munificent number of theories and approaches, our work must reflect and respect the diversity.

Stereotypes of how each field is commonly framed by those not centered within the field helps to illustrate differences in this case. Stereotypes do not reflect the whole truth, but perceptions that emphasize a subset of community characteristics. For the reader familiar with one of the two fields or neither of them, the following stereotypes are illustrative.

- CSCL: It is not true that CSCL is only about K-12 learning at schools. However, a lot of CSCL studies are done in schools and there are few examples of workplace studies in the proceedings of the CSCL biannual conference or the International Journal of CSCL
- CSCW: It is not true that CSCW is just about knowledge transfer within an organization but many studies presented at ACM sponsored CSCW conferences like CSCW and Group, or the European Conference on CSCW focus on knowledge management, but do not present studies of collaborative learning at the workplace.

A key distinction between the fields is their different focuses on the relationship between novice and expert. CSCL is focused on helping novices learn—mainly knowledge that already exists in the world and in specific disciplines. CSCW, in contrast, is focused on helping experts learn, sharing what others know, what is known elsewhere in the world, or what will be new knowledge in the world.

While emphasizing certain aspects of each field in a general way, these stereotypes highlight the contrast between CSCL and CSCW research. They also point to a middle-ground gap that can be filled by a bridge called CSCL at Work. In the following sections, we review the distinct contributions of each field of inquiry to CSCL at Work.

Contributions from CSCL

CSCL focuses on how learning can be improved through computer mediated collaboration. New theories of how knowledge is constructed by groups (Stahl, 2006), how teachers contribute to collaborative learning and the application of socio-technical scripts for learning (Dillenbourg & Hong, 2008) are all emerging from CSCL researchers. Most of this work, however, remains focused on K-12 institutions. Hence, CSCL research focuses on the application of computer support for learning in the context of traditional educational institutions, like public schools, private schools, colleges, and tutoring organizations. CSCL research is often addressed in specific domains, without explicit cross-domain classification or pattern identification, or learning in contexts where the answer is not known.

CSCL research investigates the application of computer support for learning in the context of traditional educational institutions, like public schools, private schools, colleges, and tutoring organizations. The work of the CSCL scientific community has generated exciting new theories of how knowledge is constructed by groups ("group cognition," Stahl, 2006), and how teachers contribute to collaborative learning (Kreijns, Kirschner, & Jochems, 2002; Laffey, Lin, & Lin, 2006) and the application of socio-technical scripts for learning (Dillenbourg & Hong, 2008). There is little discernable movement of this knowledge to learning contexts outside of traditional school environments.

Contributions from CSCW

Knowledge management research, in contrast, examines the practices, technologies, and cultural conditions required to ensure that knowledge moves from experts and formal information sources through an organization. Coakes (2002) defines knowledge management as "the capture, consolidation, and reuse of knowledge and the translation of new best practices to tangible programmable processes to be automated through IT where possible." Such sociotechnical information systems focus on the storage and distribution of discrete information or processes as a basis for knowledge sharing within an organization.

Examples include groupware systems used for knowledge management, or content and enterprise management systems. There exist different methods, guidelines, and principles to organize the knowledge of members within a firm (e.g., Bygstad, 2006; Cherns, 1987; Eason, 1988; Mumford, 1995) that support the development of sociotechnical systems. A good overview is provided by Fischer and Hermann (2011), but as Herrmann, Loser, and Jahnke (2007) point out, "whether these types of systems really contribute to knowledge sharing or not, depends on the corporate culture and on how well organizational and technical structures are adjusted to each other and how they are integrated." Regardless of the contributions of these systems and the organizational adoption, these systems do not focus on collaborative learning. Knowledge management is a field of research that emphasizes the accumulation and redistribution of identifiable tacit and explicit knowledge. Further, this research initially emerged during a time when organizations did not need to adapt to changing conditions as quickly or as often as they do today (Easterby-Smith et al., 2009; Easterby-Smith & Prieto, 2008). Empirical work on knowledge management is widespread in CSCW literature, which is primarily centered in workplace settings (e.g., Coakes, 2002; Herrmann et al., 2004) that is changing (Grudin, 2010). For example, Herrmann et al. (2004) illustrate how to design technology along work processes. A not useful technical design is a system that is not linked tightly enough to work processes. Such systems act like a satellite around the organization.

There is some research available that connects both disciplines (for example, Fischer, Rohde, & Wulf, 2007). In addition, the works by Wenger et al. (2002) on communities-of-practice show how people work together and how new employees move from the outside of the knowledge circle into the center, but this concept supports more or less only the apprenticeship model. This model only explains how new employees learn the rules and existing knowledge by the experts. There is no "movement" or learning among the experts or insiders within a firm. Nonaka and Takeuchi (1995) introduced the "knowledge-creating company" but today with new Social Media much more possibilities emerged and we have to ask if the concept is useful or valid for designing CSCL at Work. To summarize, what has already been done with regard to work-based learning is relatively small when compared to the opportunity for discovery and positive social effects from a multidisciplinary CSCL at Work research program.

Extending CSCL and CSCW to Make Learning more Explicit in Work

CSCL literature has focused on school based learning contexts, which are distinguished from workplace learning. For example, learning at work is directly connected to the performance of a specific job in a specific organizational context (school based learning focuses more or less on textbook learning).

The CSCW community, for its part, has been too timid with regards to considering the application of "learning approaches" in studies of cooperative work. The connection among the interdisciplinary domains of CSCW and CSCL, and articles that span these disciplines are often more implicit than explicit (overview in Stahl, Koschmann, & Suthers, 2006).

One research focus in this boundary-spanning field is developed by Yrjö Engeström, who introduced a conceptual approach titled "activity theory—expanding learning" as a framework for analyzing and redesigning work (Engeström, Miettinen, & Punamäki, 1999). In his more recent books, he and his team illustrate the connections among learning and work, e.g., "Between School and Work: New Perspectives on Transfer and Boundary Crossing" (Tuomi-Gröhn & Engeström, 2003; see also the works by Mørch & Skaanes, 2010, "learning across sites"). Their case studies reflect new concepts for (a) new pedagogical practices and (b) for new work practices, such as "mirror therapy." New pedagogical practices include his use of a cultural laboratory, methods for what he describes as horizontal working and the notion of "boundary zone activities." Boundary zone activities could be conceptualized as related to the work of Lee (2007) who described boundary-negotiating artifacts.

Making new, explicit connections between work and learning, which we frame as *collaborative work-based learning*, holds much potential for research. For example, the potential measurable impact on organizations and individuals is large. Organizations that demonstrate an institutional capacity for learning are more apt to adapt well as market conditions change (Easterby-Smith & Prieto, 2008). As Fischer (2010) notes, the boundary between work and learning is dissolving. Just as the boundary between work and learning, in general, is disappearing, so is the justification for a sharp boundary between CSCL and CSCW research.

A General Design Model for Collaborative Work-Based Learning

CSCL and CSCW each have traditions of including *design interventions* and the subsequent study of *new designs*. This shared frame of reference provides a starting point for CSCL at Work's basic design model.

When designing learning at work the overall research question is how to design (develop, introduce, evaluate) it *successfully* and what elements can be designed (general model). But the central problem is what does "successful" mean, to what extent is a *design* successful or not?

Jahnke, Terkowsky, Pleul, and Tekkaya (2010) describe one possible model. In their study of designing remote-controlled laboratories in mechanical engineering, they demonstrate a design model with three elements, which provide a set of opening factors for CSCL at Work inquiry. The model includes three basic elements and its interconnections (*key factors*):

- Technical elements include learning management systems like Moodle, or Social Media technologies like Facebook. The researcher then uses the model to scrutinize the concept of technology (e.g., passive, reactivity, pro-activeness, interactive, transactive, autonomy).
- Social elements include forms of communication, roles of learners, organizational issues and social structures.

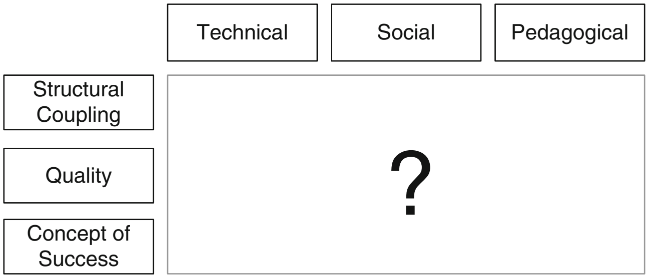

Fig. 1.2 General design model for CSCL at Work

- Pedagogical elements embrace concepts of learning, phases of individual/group learning, support of developing new skills (which ones), and interconnections between instruction from work and opportunities for co-construction of new knowledge (collaboration).

The *key factors* are placed on the *x*-axis of a two dimensional model we propose. On the *y*-axis, the model maps a meta-view focused on important considerations for designing those three elements. First, the model maps the degree of structural coupling (degree of interdependency) of the three elements on the *y*-axis with its complex interconnections to the *key factors* on the *x*-axis. This design dimension can be used to ask to what extent the elements are connected: are they strong and formalized or flexibly usable, and how closely/loosely are the elements connected?

Second, the concept of quality is described. This intersection between the *y*-axis dimension of quality and its *x*-axis *key factors* is useful for driving analysis of design elements. For example to what extent is knowledge sharing, and co-construction of knowledge and learning connected?

Third, the model describes the concept of success. Success, compared with each of the key factors, drives the designer to consider whether technologists, teachers or peers within a system would view the design as a success. Analysts should consider this difficult to pin down design element forces critical thinking about the overall design. Different target groups and people in different roles have different cognitive conceptions of success. Managers, pedagogical experts, employees, knowledge management experts define success in different ways. A good design includes a visible concept of what is meant by learning and involves different views, or at least, supports a common understanding (Herrmann et al., 2007) (Fig. 1.2).

The three structural elements and three key factors in CSCL at Work design interact, conceptually, to drive designers to ask focused questions about the design process and resulting designs. In many respects, the framework could be useful outside of CSCL at Work settings. However, it is also useful for CSCL at Work designs because it emerges from an understanding of important design considerations for social media, learning and knowledge management. It is an integrated, meta-design model that is explicitly targeted at CSCL at Work's unique characteristics.

Cases in the Book

The cases presented in this book are divided into five parts, labeled A to E. Part A frames the challenges for CSCL at Work and illustrates different ways of thinking about the changes that lead to the emergence of this area of inquiry (four chapters). Those viewpoints do not exclude each other instead, but reflect conceptual designs for CSCL at Work that researchers and practitioners may build on. Part B presents four empirical cases from CSCL at Work practice especially focused on reflection processes. Part C includes two cases where learning occurs in unexpected places including role playing games and social media, offering new ways to think about how learning as a social activity may be influenced by new technologies for social interaction. Part D includes three cases with a strong connection to creative work, including product design and mechanical engineering, and Part E is a chapter written for practitioners in the field of computer-supported work-based learning.

Part I: Framing Emerging Problems in CSCL at Work

Accomplished researchers who have bridged both the CSCW and CSCL communities frame CSCL at Work in the current state of each field.

Fischer (Chap. 2) focuses on a simple twenty-first century situation: Learning and work are no longer separate phases in life. To face this challenge, Fischer proposes a conceptual framework for CSCL at Work researchers to consider. The framework includes four pillars of distributed cognition, integration of problem framing and problem solving, framing around communities of interest and facilitation of learning when the answer is not known. He elaborates on the challenges of designing technology support for collaborative learning at work through two illustrative vignettes. Fischer focuses on tool design to support CSCL at Work.

The chapter written by Stahl (Chap. 3) provides an epochal survey of philosophy that ultimately focuses with the precision of a surgeon on a fundamental question for both communities: What is our unit of analysis? Stahl argues for a deliberate focus on the small group unit and their interactions in CSCL at Work research. Stahl inspires us to think about the impact of how we study phenomena in the world through CSCL at Work. Many studies focus on large, amorphous “community size” groups. Others talk of “the group,” but are focused on individual characteristics. As Stahl makes clear, the small group is a unit of analysis that is under explored by research in both CSCL and CSCW.

Rohde and Wulf (Chap. 4) describe a concrete case study of how workplace learning is connected to regional economic development. Their case illustrates one of our principle motivations for pursuing this book and a line of inquiry in CSCL at Work: we want to more closely connect university research to industry; learning to opportunity in the workforce; and lifelong learning that is mutually beneficial for individuals, organizations and society.

Mumford (Chap. 5) examines the existing structures for learning through work. Universities do not refer to work-based learning in a way that reflects the changed relationship between learning and work. Mumford looks at both (a) the experience of individuals in full time employment who did a part time university degree and (b) the experience of senior managers going through staff development courses and other developmental interventions in a large multinational company. One result is that "the key feature was *not the transfer of knowledge* from others; it was *the way the interaction with others* stimulated deeper understanding of one's own experience." There is little integration between learning at the workplace and "university knowledge" or vice versa. This kind of non-implementation needs to be better addressed than it is today, we argue through CSCL at Work research and program development.

Part II: CSCL at Work in Practice—Facilitation and Reflection

This section describes how work practices can contribute to CSCL at Work through facilitation and reflection.

Hartswood, Procter, Taylor, Blot, and Anderson (Chap. 6) bridge these two concepts of facilitation and reflection in a study of how mammogram reading experts use a technology to support review and feedback to novice mammogram readers. The goals of the program are to minimize false positive readings without causing false negative readings. Experts are good at making these judgments in hard cases, and it is increasing the competence of novices who read hard cases that are the focus of this study (Hartswood et al., 2010).

Prilla, Herrmann, and Degeling (Chap. 7) focus also on cases in health care workplaces, elaborating on how facilitated reflection on work practices occurs differently, depending on the role and status of members. This kind of collaborative reflection—sometimes not even explicitly done—is needed in situations where knowledge and competency must be acquired to solve problems where the answer, or processes for performance are not known by a trainer, consultant or supervisor. "Reflection is one important element to support critical thinking and to help workers in new situations where innovative behavior is needed." They describe a framework for supporting workplace reflection, and underscore the importance of reflection for CSCL at Work.

Hokstad, Prasolova-Førland, and Fominykh (Chap. 8) present results of designing a reflective community integrated at the workplace. The community offers rapid access to learn how to perform project management and sustainable manufacturing. Using a serious games approach, they design a game on "how to do project management" in SecondLife, with the aim of facilitating a *reflective dialogue* in communities to support lifelong workplace learning (Prasolova-Førland & Hokstad, 2010).

Kienle (Chap. 9) describes two types of CSCL at Work. The first is expert location, which is a long-standing issue in knowledge management. The second is discovering knowledge when the answer is not known, which Fischer (Chap. 3) describes as a central concern for CSCL at Work. To address different types of CSCL at Work, she presents a model of facilitated, asynchronous triadic communication. She emphasizes that the design for facilitation support should take into consideration the tasks for each member role, technical features and their potential interference with user activities.

Part III: Unexpected Learning Places

Applying collaborative technology to workplace learning is a central theme in CSCL at Work.

King's example (Chap. 10) shows how the skills required to collaborate through technology are acquired through play. MUDs, MOOs and MMORPGs are two decades into cultures around the globe. King's case centers on World of Warcraft as a place for developing collaboration skills in the twenty-first century. This approach adds both perspective and practical significance to a popular activity that participants often regard as *merely* fun. An astonishing 37 % of US boys and 24 % of US girls participate in such games at least weekly. Similar numbers likely hold true in other digital economies. King's case provides an illustration of how a fun, gaming environment helps to cement *Homo Interneticus* in both work and life (King, 2010).

Gurzick and White (Chap. 11) analyze the positive effects of social media on workplace productivity. Social media enables workers to tap into their personal social networks (PSNs) to acquire knowledge they do not already have; and cannot find in their workplace. This perspective on social media in the workplace, particularly as a site for knowledge acquisition, is little explored elsewhere. In fact, social media is often viewed as a drain on productivity. The incorporation of the PSN as a mechanism for raising organizational performance levels is compelling, and provokes reflection on contemporary workplace policies related to the use of social media (Gurzick & White, 2010).

The researcher and practitioner alike should be inspired to consider how CSCL at Work might be instantiated in unusual and unexpected places. These chapters share recognition that learning is a social activity. The strength of each chapter's perspective is the central position of social engagement as a component of CSCL at Work.

Part IV: CSCL at Work in Product Design and Mechanical Engineering

CSCL at Work is a necessary change in our model of knowledge management because a good deal of work involves solving problems when the answer is not known. Designers have known this problem intimately. One can say, this problem is well known since the first Homo sapiens built the first hut and rebuilt it because it collapsed in the rain.

Computer support for design practice is a specific type of CSCL at Work, and in many ways is the foundational example of learning when the answer is not known.

Lund, Prudhomme, and Cassier (Chap. 12) illustrate the importance of "making the process of decision making visible." In an empirical study they show following: when making the process of design for novices visible they will enable more rapid design processes and shorter periods of apprenticeship. The goal here is not merely to solve problems where the answer is not known, but to develop these capacities in new people, and facilitate expert communication about their expertise (Cassier, Lund, & Prudhomme, 2010).

Terkowsky, Jahnke, Pleul, May, Jungmann, and Tekkaya (Chap. 13) describe PeTEX—a Platform for e-Learning and Telemetric Experimentation. This CSCL system aims to foster educational and training programs in the field of manufacturing engineering. The authors present the challenge of how to transform actual laboratory test beds, domain specific content, and social interaction modes into a Web-mediated socio-technical system to bring learning and the workplace together as CSCL at Work. This chapter also addresses the critical dimension of distributed creative work (Jahnke & Haertel, 2010; Terkowsky, Jahnke, & Pleul, 2010).

Mørch (Chap. 14) problematizes the concepts of eLearning at work and CSCL. CSCL is about computer support for two or more people to engage in a collaborative inquiry process (co-located or distant), where learning is the primary activity. E-learning at work, in contrast, is about providing employees with timely access to information for conducting everyday work while respecting business goals. Traditionally, learning in these cases is a secondary activity (work is primary activity). Their chapter reports two case studies—customer service work and software product development. Results are (a) a description of challenges associated with the multiple means for information access and engagement in collaborative knowledge construction within and outside the organization (e.g., with customers), and (b) identification of opportunities for collaborative learning that arise in conjunction with adoption of social media in the organizations.

Implications for CSCL at Work

Our inquiry into CSCL at Work is framed by three guiding questions and our analysis of eight early case studies of CSCL at Work, which resulted in three core findings presented as derived theses. The guiding questions surely frame our inquiry and meta-analysis of the cases, and there is a connection between the theses and our three guiding questions, though it is not entirely linear. These questions have salience for researchers, practitioners and managers faced with the kinds of knowledge creation challenges for which CSCL at Work is a solution.

The first question is: What is the underlying concept of collaborative learning within organizations? Thesis 1 gives the answer: *Learning in a CSCL at Work setting can be enabled by unexpected and unusual online learning places*. This thesis suggests that the cases of CSCL at Work selected here lead the researcher to frame collaborative learning more as arising out of interaction in social media across established boundaries than in traditional organizations or technologies. Such a concept of learning does not focus on a particular place, but focuses on discovery of natural knowledge construction and, ultimately, designing systems to facilitate more of it, e.g., enabling unstructured connections between an employee's work, personal networks, and collaborative reflections emerging in social media that span them both.

The second question is: What kinds of opportunities to enable collaborative learning in the workplace are available? One answer is given by thesis 2: *Learning in a CSCL at Work setting can be enabled by fostering learning activities that incorporate feedback from diverse sources across established boundaries*. Such new sources are available through personal connections and developed using social media. These new sources are disruptive to classic conceptualizations of what an organization is. This thesis suggests that *opportunities for learning* are at once member defined, but can also be facilitated by engaging more diverse sources deliberately. The subtle distinction between this second thesis and the first one is the implication for design of CSCL at Work. There are opportunities for collaborative learning available in the cases examined, but both in practice and technological mediation, they are not fully sought out. There is unrealized potential for collaborative learning. Reflective practice of CSCL at Work will help us to close the gaps and enable work-based learning

The third question is: Do sociotechnical designers, researchers and workplace learners need to focus on a new balance of formal and informal learning? To what extent? Regarding question 3, the answer is yes, we need a new balance of informal and formal learning at work with a greater emphasis on informal learning than it is presently practiced. Thesis 3 states: *Learning in a CSCL at Work setting is enabled by designing technology-embraced collaborative learning across established boundaries*. New connections can be made across non-workplace centered social- and technology-constructed boundaries that foster learning. A central theme in CSCL at Work research, therefore, is that collaborative learning in this context occurs in new places, with a dynamic set of people and in a markedly more informal manner than other forms of learning or knowledge management.

Categories and Application Contexts for CSCL at Work Inquiry

This section frames the *domain boundaries* of CSCL at Work research with the goal of helping direct inquiry more concretely.

There are three main categories of inquiry, two of which are central to our framing of CSCL at Work, and one of which has a foundation more in the history of CSCL at Work research. The categories can be categorized as (1) having a focus on building networks within a geographically or discipline bounded community, or (2) as focused on internal knowledge management type activities and (3) workforce development/training.

The first category we focus on is community based learning, which has implications for technology transfer and economic development. The second focus is on knowledge management reframed as CSCL at Work, and focuses on solving problems when the answer is not known. In the second case, CSCL at Work plays a vital role in the maintenance of organizational competitive advantage. The third category embraces workforce development and training and is the most peripheral, as these activities often remain individually focused. In CSCL at Work, such continuing trainings will be designed as a collaborative activity while doing the work. In the context of CSCL at Work these collaborative activities are subsumed under one of the other two categories.

First, the category of community based learning as articulated by Fischer et al. (2007) is illustrated. Community-based learning *repositions* the role of the university in education from an institution with a mass media, instructionalist perspective on learning toward one that is more tightly woven into the knowledge society. This brings universities into partnerships with businesses and other regional economic forces. Such interaction with local enterprises increases the connection between university education and professional practice, but also more tightly integrates the university with regional economic development. CSCL at Work aims to study the advancement of connections between universities and industry.

In this first case, CSCL at Work may be used to accelerate technology transfer from research universities to industrial practice. Jahnke observes these phenomena with teams in the field of material science in the Telemetric Online-Learning Project at Production Engineering (e.g., Jahnke et al., 2010). Goggins (2010; Goggins, Galyen, & Laffey, 2010) observes these phenomena in computer science and engineering technology transfer. Fischer et al. (2007) advocate the cultivation of such connections between university research and industry. In each case, collaborative learning in the workplace is applied as a mechanism for moving research findings into day-to-day industrial practice.

The second integrative approach capitalizes on a relationship between traditional knowledge management and dynamic capabilities in organizations. Easterby-Smith et al. (2008, 2009) describe this approach, and its impacts on organizational competitiveness. Previously, the notion of organizational adaptability in the face of change was not closely connected to workplace learning in the business literature. Easterby-Smith et al. make an explicit connection between learning and organizational strategy by framing deliberate workplace learning as an essential vehicle for strategic organizational adaptation. They highlight extensive evidence showing organizations that acquire new knowledge quickly do better in the marketplace.

What remains unexplored beyond this volume is the critical implementation gap in organizations that may build new knowledge, but not be able to effectively diffuse this knowledge through the ranks of their employees. CSCL at Work aims to close this gap by framing collaborative learning as a part of collaborative work. Community based learning from university to industry, and internal organizational adaptation are both connected to anticipated benefits at different levels; community and company. CSCL at Work research has the potential to address questions of how to successfully reach these goals.

In this second case, CSCL at Work may be used as a formal device for sustaining competitive advantage in fast changing, high technology industries. Engineering, research and technology service firms are especially likely to utilize computer-mediated training that goes beyond textbooks, recorded Powerpoint lectures and prepared material. In contrast with traditional workplace learning, focused on task oriented, practice oriented or regulatory compliance objectives, CSCL at Work recognizes that the nature of innovation means that creativity and new innovation will at times emerge from collaborative learning. In this case, the line between collaborative work as research and collaborative learning is blurred. Our experience is that this is especially common when researchers, engineers or designers contribute to CSCL efforts aimed at those who apply their inventions.

Conclusion

We introduced CSCL at Work as a conceptual framework for bridging the knowledge of researchers in the field of CSCL, CSCW, and knowledge management to Social Media enhanced workplace learning and work-based learning. Starting from the historical development of research in the field of Organizational Learning emerged in 1978, gathered increased attention beginning in the 1990s, the questions were focused on how to create working practices for sharing existing knowledge within a firm. But in addition to managing existing knowledge sharing, managing the creation of *new* knowledge is important for firms today. What cultures of learning exist to support this when the answer to a problem is not available? Contemporary answers to these questions must recognize that learning is an implicit, often invisible component of work. Some firms even avoid the term "learning."

From the empirical cases presented in this book titled CSCL at Work, we derived three theses: (1) Learning occurs in unexpected and unusual online learning places through social media. (2) Learning activities incorporate feedback from diverse sources, which are not available within traditional organizational boundaries. (3) Making learning visible across established boundaries is necessary in this new age. Designing explicit construction of new knowledge needs to be integrated into workplace practices today through pedagogical and technological design.

In this meaning, CSCL at Work aims to fill a gap we believe exists between current research in CSCW and CSCL by taking an integrative look at the application of technologically mediated collaborative learning in the workplace. CSCL at Work is a timely challenge for researchers to develop a new, integrated understanding of working and learning that embraces Social Media and new mechanisms for computer mediated collaboration in the service of learning.

The presented conceptual framework contributes a foundation for a CSCL at Work research agenda. We offer this framework as a starting point and possible guide to help communicate early study results effectively. In this sense, the work outlined here is an essential component of defining the future role of CSCL research more broadly. Future CSCL at Work studies can use this in order to design collaborative learning at the workplace in manner that reflects both changing societal needs and emerging information and communication technologies for learning.

One challenge is: How can we *teach* firms what learning integrated into the workplace (work-based learning) really means? What sounds simple is often implicitly done instead of *designing knowledge construction as an explicit way of learning*.

With this framework, we provide a start for making *learning visible*.

- Making learning in unexpected, unusual online learning places visible—enabling unstructured connections to the employee's work places by Social Media.
- Enabling learning by leveraging new connections in the Internet—enabling the change of the feedback partners and established learning loops.

The key principle of CSCL at Work is to design collaborative learning across established boundaries (social- and technology-constructed boundaries). In addition, we have shown the following:

1. Existing theories in both CSCL and knowledge management can help to frame empirical research questions in CSCL at Work.
2. Empirical studies of CSCL at Work are helpful to reflect on extend existing theories of collaborative work.
3. A new conceptual framework structures this new discourse, since existing theoretical frames are limiting for the design, development, and application of work-based learning.

We are optimistic that, as research focused on the unique potential of CSCL at Work emerges, findings from CSCL at Work will be systematically incorporated into the discourse of the broader CSCL and CSCW community and the broader community on knowledge management. Furthermore, operationalizing CSCL at Work research requires effective communication of findings in both the CSCW and CSCL communities. These two disciplines have historically been separate and emerge from different traditions, but share the common dimension of applying computing to collaboration. We encourage CSCL at Work researchers to participate in both communities, and recommend participation in conferences and publication venues that bridge these communities.

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Part I
Challenges for CSCL@Work from Different Perspectives

Accomplished researchers who have bridged both the Computer-Supported Cooperative Work (CSCW) and the Computer-Supported Collaborative Learning (CSCL) communities frame CSCL at Work in the current state of each field.

Fischer (Chap. 2) focuses on a simple twenty-first century truth: Learning and work are not longer separate phases in life. To face this challenge, Fischer proposes a conceptual framework for CSCL at Work researchers to consider. The framework includes four pillars of distributed cognition, integration of problem framing and problem solving, framing around communities of interest, and facilitation of learning when the answer is not known. He elaborates on the challenges of designing technology support for collaborative learning at work through two illustrative vignettes. Fischer focuses on tool design to support CSCL at Work.

Stahl (Chap. 3) reflects in his theoretical framing the distributed cognition, which is more amenable than group cognition to explicit consideration of tools (Stahl may disagree). He provides an epochal survey of philosophy that ultimately focuses with the precision of a lasik surgeon on a fundamental question for both communities: What is our unit of analysis? Stahl argues for a deliberate focus on the small group unit of analysis in CSCL at Work research. He inspires us to think about the impact of how we study phenomena in the world on CSCL at Work. Many studies focus on large, amorphous “community size” groups. Others talk of “the group” but are focused on individual characteristics. The small group is a unit of analysis that is under explored by research in both CSCL and CSCW.

Rohde and Wulf (Chap. 4) show a concrete case study of how workplace learning is connected to regional economic development. Their case illustrates one of our principle motivations for pursuing this book and a line of inquiry in CSCL at Work: we want to more closely connect university research to industry; learning to opportunity in the workforce; and lifelong learning that is mutually beneficial for individuals, organizations, and society.

Mumford (Chap. 5) examines the existing structures for learning through work. Universities do not refer to work-based learning in a way that reflects the changed relationship between learning and work. Mumford looks at both (a) the experience of individuals in full time employment who did a part time university degree and (b) the experience of senior managers going through staff development courses and other developmental interventions in a large multinational company. One result is that “the key feature was *not the transfer of knowledge* from others; it was *the way the interaction with others* stimulated deeper understanding of one’s own experience”. There is little integration between learning at the workplace and “university knowledge” or vice versa. This kind of non-implementation needs to be better addressed than it is today, we argue through CSCL at Work research and program development.

Chapter 2
A Conceptual Framework for Computer-Supported Collaborative Learning at Work

Gerhard Fischer

Introduction

Learning needs to be examined across the life span because previous notions of a divided lifetime—education followed by work—are no longer tenable (Gardner, 1991). Professional activity has become so knowledge intensive and fluid in content that learning has become an integral and essential part of adult work activities (Drucker, 1994). "Learning is a new form of labor" (p. 395) (Zuboff, 1988) and working is often (and must be) a collaborative effort among colleagues and peers. Knowledge, especially advanced knowledge, is acquired well past the age of formal schooling, and in many situations through educational processes that do not center on the traditional school (Collins & Halverson, 2009; Illich, 1971; National-Research-Council, 2009). Fundamentally new learning opportunities are required making *computer-supported collaborative learning at work* (*CSCL at Work*) a necessity rather than considering a luxury.

I had two opportunities in the past to reflect upon situating CSCL at Work between the primary objectives of the CSCW and the CSCL research communities. In an invited lecture at the ECSCW'2003 conference entitled "Working and Learning When the Answer is Not Known" (http://l3d.cs.colorado.edu/~gerhard/presentations/ecscw-keyn-slides-final.pdf) I argued that the CSCW community should be more concerned with *learning* for the following reasons:

- Learning is an essential part of work, particularly in contexts where the answer is not known.
- Despite learning's important role, the CSCW community has largely neglected to use it as a theoretical and analytical construct.

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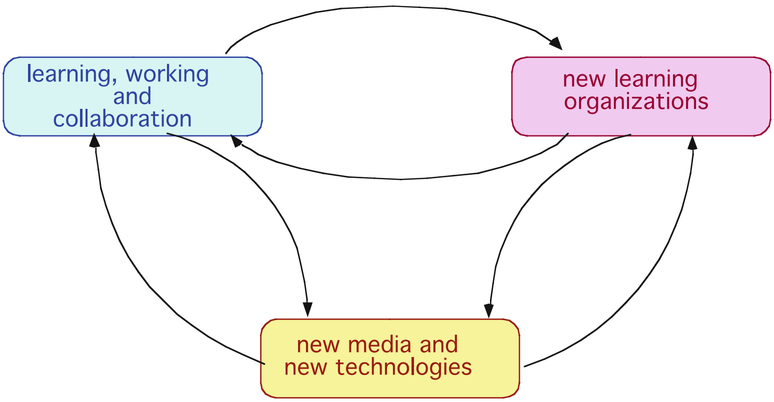

Fig. 2.1 The integration and coevolution between activities, organizations, and media

- Future research challenges for CSCW should give more attention to learning, integrate working with learning and collaboration, and create innovative media to support this integration.

In an invited lecture at the CSCL'2007 conference entitled "Designing Socio-Technical Environments in Support of Meta-Design and Social Creativity" (http://l3d.cs.colorado.edu/~gerhard/presentations/slides-cscl-final.pdf) I argued that the CSCL community should understand learning in *work* environments and not just in schools and that many advanced learning technology developments are too timid and are not thinking radically enough for the following reasons (Fischer, 2007):

- They accept too many established approaches—e.g.: A theory of human learning based solely on school learning is too limited but the success of universal schooling has led us to identify learning with schooling.
- They insufficiently embrace new learning opportunities—e.g.: Exploiting the unique opportunities of social production in which all learners can act as active contributors in personally meaningful problems.
- They reduce digital literacy and fluency to accessing and comprehending existing information rather than empowering learners to reformulate knowledge, to express themselves creatively and appropriately, and to produce and generate information.
- They often do not move beyond "gift-wrapping" and "techno-determinism" to explore the coevolution of learning, new media, and new learning organizations (see Fig. 2.1).

This paper is an elaboration of those ideas, and provides additional arguments about the importance and identity of CSCL at Work as a scientific discipline to rethink and reframe learning to better account for the demands of the knowledge societies of the future. The development of a framework for CSCL at Work has been influenced by numerous other sources including the following:

- Illich's vision of "learning webs" conceiving a different style of learning, showing that "the inverse of school is possible," and defining educational resources (reference services to educators-at-large and to educational objects, skill exchange, peer matching) were articulated 40 years before the World Wide Web made them possible (Illich, 1971).
- Resnick's differentiation of "learning in and out of schools" contrasted specifically: (1) individual cognition in school versus shared cognition outside; (2) pure mentation in school versus tool manipulation outside; (3) symbol manipulation in school versus contextualized reasoning outside school; and (4) generalized learning kin school versus situation-specific competencies outside (Resnick, 1987).
- Engeström's concept of "expansive learning at work" grounded his approach in learning at work in the observation that "people and organizations are all the time learning something that is not stable, not even defined or understood ahead of time.… There is no competent teacher. Standard learning theories have little to offer if one wants to understand these processes" (Engeström, 2001).

The following sections outline a *conceptual framework* (including the impact of new media and the articulation of research questions) and describe *specific developments* to address the challenges derived from the conceptual framework.

Challenges for CSCL at Work

Understanding "Work"

The development of a conceptual framework for CSCL at Work requires some understanding of work and how it gets accomplished (Fischer, Greenbaum, & Nake, 2000; Greenbaum, 1995; Orr, 1996). Work covers a great variety of different activities in an enormous number of application domains. This article focuses primarily on work that can be characterized as *creative problem solving* (in which processes are not well defined) rather than on *routine cognitive skills* (in which processes are well defined). For example, most design and decision-making problems (Simon, 1996) (1) transcend the power of the unaided individual human mind requiring *distributed cognition*; (2) represent wicked, problematic situations rather than given problems requiring the *integration of problem framing and problem solving*; (3) are systemic problems requiring *communities of interest* (CoIs) consisting of participants with multiple expertise; and (4) represent problems to which the answers are not known. The "answer is not known" to these problems because design and decision-making problems represent a *universe of one* supported by the evidence that "85 % of the problems a doctor sees in his office are not in the book" (Schön, 1983). These requirements are addressed by the development of *meta-design, cultures of participation,* and *social creativity*.

CSCL at Work: In Search for a New Understanding of Learning

CSCL at Work is limited in what it can learn from most current approaches to CSCL that are primarily focused on school learning where learning is conceptualized from the perspective that "answers are known" by teachers. School learning is focused on the core objective that the students should learn what the teachers know. This limitation has been articulated by a variety of researchers including Scribner and Sachs who assert: "A decade of interdisciplinary research on everyday cognition demonstrates that school-based learning, and learning in practical settings, have significant discontinuities. We can no longer assume that what we discover about learning in schools is sufficient for a theory of human learning" (Scribner & Sachs, 1990).

Learning can no longer be dichotomized into a place and time to *acquire* knowledge (school) and a place and time to *apply* knowledge (the workplace) (Gardner, 1991). Coverage of relevant subjects in schools is impossible and obsolescence is guaranteed.

The research in our Center for LifeLong Learning & Design (L3D) (http://l3d.cs.colorado.edu/) focuses on making learning a part of life, and is grounded in the exploration of the following basic assumption (Derry & Fischer, 2007):

> If the world of working and living relies on collaboration, creativity, definition, and framing of problems, and if it requires dealing with uncertainty, change, and intelligence that is distributed across cultures, disciplines, and tools—then education should foster transdisciplinary competencies that prepare students for having meaningful and productive lives in such a world.

In addition to being limited by what CSCL at Work can learn from learning in schools, it is also limited in what it can learn from current practices in adult education and workplace learning (Resnick, 1987). Workplace learning is often reduced to *training* by delivering courses that are separated from the contexts in which their subject matter is relevant (Fischer, 2000) and to knowledge management approaches that support only learning from the past (dePaula & Fischer, 2005).

Lifelong learning provides a perspective for CSCL at Work with its basic assumption that learning is inherent in human nature, an ongoing and integral part of our lives, not a special kind of activity separable from the rest of our lives. From this perspective, learning, working, and collaborating are integrated and complement each other (Brown & Duguid, 1991) to cope with the problems articulated in the next section.

The Collaborative Aspect of CSCL at Work: Transcending the Individual Human Mind

CSCL at Work offers important possibilities to cope with *major problems* our societies are facing today that can be classified as follows (Fischer, 2011):

- Problems of a *magnitude* that individuals and even large teams cannot solve (requiring support for distributed cognition)
- Problems being *poorly understood and wicked* requiring the involvement of the owners of problems because they cannot be delegated to others (requiring support for the integration of problem framing and problem solving; see "Narrative 1" for illustration)
- Problems of a *systemic nature* that do not fall within the boundaries of one specific domain (requiring the collaboration of many different minds from a variety of background in CoIs)
- Problems modeling *changing and unique worlds* for which the answers are not known (requiring open, living information repositories, support for end-user development, and meta-design; see "Narrative 2" for illustration)

CSCL at Work and New Media

CSCL at Work can be facilitated and supported by a variety of different technological environments, and should not be reduced to

- "Gift-wrapping" *approaches* that reduce the impact of new media to mechanize old ways of learning, working, and collaborating and where new media have been used primarily as add-ons to existing practices (Fischer, 2000)
- "Technology-driven" *developments* that are grounded in the questionable assumption that new technologies are not only necessary but also sufficient for causing fundamental changes toward a new culture of learning (Thomas & Brown, 2011)

Innovative socio-technical environments for CSCL at Work should support the *coevolution* of a new understanding of (1) learning, working, and collaborating; (2) new media and new technologies; and (3) new learning organizations (see Fig. 2.1).

An example of *gift-wrapping* would be the use of student response systems (such as Clickers) to enhance classroom learning by supporting students to provide feedback and allowing teachers to get a quick assessment of the students' understanding. An example of *technology-driven developments* would be an objective such as "all schools on the Internet" (as promoted by Al Gore around 1994) which is necessary to explore different learning opportunities but *not sufficient* (without accompanied changes in content and pedagogy) to improve learning.

Research Questions

The preceding argumentation provides the foundation for research questions (RQs) that I have first articulated in my presentation at the workshop "CSCL at Work" at the GROUP'2010 conference (Fischer, 2010):

- *RQ-1*: Does *distributed cognition* provide an interesting perspective for CSCL at Work?
- *RQ-2*: Does the *integration of problem framing and problem solving* allow stakeholders to cope with poorly understood and ill-defined problems?
- *RQ-3*: Will *CoIs* be more successful in coping with systemic problems than communities of practice (CoPs)?
- *RQ-4*: How do we create frameworks, media, and organization to learn from each other when *the answer is not known*?

These research questions will be illustrated with two narratives and with developments of components of our conceptual framework in the following sections.

Narrative 1: Writing This Chapter About CSCL at Work

Writing a book chapter like this one is an essential part of my *work* as a researcher. This brief narrative analyzes and describes what this activity will contribute to the conceptual framework for CSCL at Work.

While I am the single author of this article, the work done is best understood from a *distributed cognition* perspective: I have (1) collaborated with many colleagues and students in developing the ideas and systems described (see the "Acknowledgements"); (2) relied on many other sources documented in the literature (see the "References"); and (3) built upon my own work of the past in developing these ideas (see "Introduction"). I made extensive use of tools (which need to be learned, used, and extended if necessary) such as exploiting the review tools of Microsoft-Word and taking advantage of a large, collaboratively constructed Endnote library. My colleagues, students, and the reviewers and the editors of this book provided me with feedback and criticism and facilitated this process with collaborative writing tools.

Going through many iterations of this article not only consisted of solving a problem but also led to numerous versions based on a *reframing* of the problem. The feedback for reflecting more deeply about the problem came for a *CoI*: colleagues with different views of the problem working in the learning sciences, in school learning, in adult education, and in the development of new media. And last but not least: the answer to the question "what is an interesting conceptual framework for CSCL at Work?" was *not known*—and the writing of this article represented learning, working, and collaborating to develop *one* argumentative context for the problem.

The Conceptual Framework

This section describes four components of a conceptual framework for CSCL at Work that we have explored analyzing and supporting the coevolution between learning, working, collaboration, new learning organizations, and new media (see Fig. 2.1).

Distributed Cognition

CSCL at Work should be grounded in a distributed cognition framework because "people think in conjunction and partnership with others and with the help of culturally provided tools and implements" (p. xiii) (Salomon, 1993). Distributed cognition (Hollan, Hutchins, & Kirsch, 2001) is based on the assumption that knowledge does not reside solely in a person's head, but is created in social practices, and mediated by artifacts all situated in socio-technical environments. The objective of workplace learning is to take as much advantage as possible of the knowledge that other people have and exploit the existence of powerful tools. *School learning* and its assessment, in contrast (Resnick, 1987), is often focused on (1) the unaided mind, measured by studying memory, attention, perception, action, and thought, unaided by external devices and other people; (2) individual cognition: people are expected to learn and perform individually; and (3) demand for tool free performance. Creating externalizations (Bruner, 1996) (one of the main objectives of the EDC described in Narrative 2) is of special importance for groups, because "a group has no head." For collaborative design activities, externalizations are a necessity because they create a record of our mental efforts, one that is "outside us" rather than vaguely in memory, and they represent situations which can talk back to us, critiqued, and negotiated (Fischer, Nakakoji, Ostwald, Stahl, & Sumner, 1998; Schön, 1983).

Integration of Problem Framing and Problem Solving

Many problem-solving methodologies assume that problems can be clearly defined a priori—before any solution attempt is made. In work environments, as opposed to the classroom, problems and tasks themselves are ill defined and wicked, and solution attempts represent moving targets requiring an integration of problem framing and problem solving (Rittel, 1984). Work in progress (as it manifests itself in externalizations) suggests ways to proceed, and the development of a solution causes the understanding of the task to grow and change.

Learning on demand (Fischer, 1991) often occurs in the context of integrating problem framing and problem solving as it represents an important opportunity to be exploited by reflection in action (Schön, 1983). Learning on demand is the only viable strategy in a world where we cannot learn everything. It is a promising approach for the following reasons:

- It contextualizes learning by allowing it to be integrated into work rather than relegating it to a separate phase.
- It lets learners see for themselves the usefulness of new knowledge for actual problem situations, thereby increasing the motivation for learning new skills and information.
- It makes new information relevant to the task at hand, thereby leading to better decision making, better products, and better performance.

Table 2.1 Multiple learning strategies

Level	Description	Strengths	Weaknesses
Fix-it level	Fixes the problem by giving performance support without detailed understanding	Keeps focus on task; learning does not delay work	Creates little understanding
Reflect level	Explores argumentative context for reflection ("reflection-in-action")	Understanding of specific issues	Piecemeal learning of (disconnected) issues
Tutorial level	Provides contextualized tutoring (not lecturing on unrelated issues)	Systematic presentation of a coherent body of knowledge	Substantial time requirements

Domain-Oriented Programmable Design Environments

In our own work we have pursued learning on demand in the context of developing conceptual frameworks and innovative systems for *domain-oriented, programmable design environments* (Eisenberg & Fischer, 1994). These environments explore middle ground between *open learning environments* (supporting self-directed learning opportunities but lacking guidance and support) and *intelligent tutoring systems* (providing extensive guidance and support but doing so for problems that might be irrelevant to the workers' tasks at hand). Domain-oriented, programmable design environments support learner control, expressiveness, assistance, modifiability, domain-oriented descriptions, information delivery, contextualization of information to the task at hand, and collaboration between users. They are particularly effective in exploiting the motivation of users by allowing learning to take place in the context of actual problem situations.

Learning on demand supports *multiple learning strategies* in response to the specific situation learners are facing: at certain times, they may be interested in a quick fix or they want to restrict their learning effort to reflect on a specific context, whereas in other situations they may want to explore a domain in a systematic fashion.

Table 2.1 describes three learning strategies with their respective strengths and weaknesses for workplace learning.

Communities of Interest

Working on systemic problems requires the collaboration and coordination of stakeholders from different *CoPs* (Wenger, 1998). We define a *CoI* (Fischer, 2005) as a group of stakeholders brought together from different CoPs, on the basis of a common concern or interest, to solve a particular complex design problem. In contrast to project teams, wherein employees are held together by a formal contract such as a business project, CoI stakeholders are held together by a shared interest.

CoIs are often more temporary than CoPs and cannot rely on a shared social practice. Their raison d'être is a common interest in the framing and resolution of a design problem. They are less in danger to suffer from *group-think* (Janis, 1972) and can be more innovative and more transforming than CoPs if they can leverage the "symmetry of ignorance" (Rittel, 1984) as a source for collective creative innovations. Challenges facing CoIs are in building a shared understanding of the problem at hand, which often does not exist at the beginning but evolves incrementally and collaboratively. Members of CoIs must learn to communicate with and learn from each other (Engeström, 2001), although they may have different perspectives and perhaps different vocabularies for describing their ideas.

Learning within CoIs is more complex and multifaceted than *legitimate peripheral participation* in CoPs (Lave & Wenger, 1991) which assumes that there is a single knowledge system within which newcomers move toward the center over time. Acting knowledgeably in CoPs is less demanding compared to the challenges of operating within CoIs, which do not share a common language and practice. Strategies to mitigate these challenges and facilitate the sharing of knowledge and allowing knowledgeable performances within CoIs include (1) developing *boundary objects* (Bowker & Star, 2000), (2) engaging *knowledge brokers*, (3) supporting *transdisciplinary collaboration*, and (4) developing new media in support of these processes in order to circumvent the social and technical obstacles that often impede an effective exchange of information within CoIs and create new opportunities for social creativity.

Learning When the Answer Is Not Known

For many problems in work environments, the knowledge to understand, frame, and solve these problems does not already exist, but must be collaboratively constructed and evolved during the problem framing and solving process. Informed participation in a collaborative work setting requires information, but mere access to information is not enough. The participants must go beyond the information that exists to solve their problems. In supporting *learning when the answer is not known*, the primary role of media is not to deliver predigested information to individuals, but to provide the opportunity and resources for social debate, collaboratively created externalizations, and the discussion and reflection about them. To transcend the existing information, tools and artifacts must be able to address the unique demands of idiosyncratic problems allowing stakeholders to incrementally acquire ownership in problems and contribute actively to their solutions. The following sections briefly describe three themes contributing to cope with these challenges:

- *Meta-design* empowers people to act as active contributors engaging in knowledge and tool creation (Fischer & Giaccardi, 2006).
- *Cultures of participation* provide all people with the means to participate and to contribute actively in personally meaningful problems (Fischer, 2011).
- *Social creativity* exploits distances, diversity, and emergence as important sources for new knowledge and provides foundations for mutual learning when the answer is not known (Fischer, Giaccardi, Eden, Sugimoto, & Ye, 2005).

Meta-design

Meta-design (Fischer & Giaccardi, 2006) is focused on "design for designers." Meta-design is grounded in the basic assumption that owners of personally meaningful problems struggle and learn tools that are useful to them, rather than believing in the alternative of "ease of use," which limits them to preprogrammed features (National-Research-Council, 2003). Users are empowered with opportunities, tools, and social rewards to extend a system to fit their needs at use time, rather than being forced to use closed systems created at design time (von Hippel, 2005). As owners of problems, users can be active contributors engaged in creating knowledge rather than passive consumers restricted to the consumption of existing knowledge (dePaula & Fischer, 2005). Meta-design (1) creates artifacts that can be subjected to critical reflection, and be open to adjustment and tweaking; (2) supports unintended and subversive uses (not just anticipated ones); and (3) allows learners to engage in personally meaningful activities.

Meta-design transcends the *limitations of closed systems* that do not give ownership to those who own the problem, but to a selected group of designers whose major challenge is to foresee all possible tasks and breakdowns in order to store answers to questions that might arise thereafter (Suchman, 1987; Winograd & Flores, 1986). Closed systems are likely to contain information that is chronically out of date and they are therefore not suited to the emerging idiosyncratic demands of workplace learning.

Cultures of Participation

Cultures are defined in part by their media and their tools for thinking, working, learning, and collaborating. In the past, the design of most media emphasized a clear distinction between producers and consumers (Benkler, 2006). For example, instructionist, curriculum-driven formal education treats learners as consumers, fostering a mindset in students of "consumerism" rather than "ownership of problems" for the rest of their lives (Illich, 1973). As a result, learners, workers, and citizens often feel left out of decisions by teachers, managers, and policymakers, denying them opportunities to take active roles.

The rise in *social computing* (based on social production and mass collaboration) has facilitated a shift from *consumer cultures* (specialized in producing finished artifacts to be consumed passively) to *cultures of participation* (in which all people are provided with the means to participate and to contribute actively in personally meaningful problems) (Fischer, 2011; Jenkins, 2009). These developments represent unique and fundamental opportunities, challenges, and transformative changes for CSCL at Work as we move away from a world in which a small number of people define rules, create artifacts, and make decisions for many consumers toward a world in which everyone has interests and possibilities to actively participate.

Fostering cultures of participation is supported by meta-design by creating the following mechanisms:

- *Making changes must seem possible*: Contributors should not be intimidated and should not have the impression that they are incapable of making changes; the more users become convinced that changes are not as difficult as they think they are, the more they may be willing to participate.
- *Changes must be technically feasible*: If a system is closed, then contributors cannot make any changes; as a necessary prerequisite, there need to be possibilities and mechanisms for extensions.
- *Benefits must be perceived*: Contributors have to believe that what they get in return justifies the investment they make. The benefits perceived may vary and can include social benefits (increased status in a community, possibilities for jobs) and personal benefits (engaging in fun activities).
- *Sharing of changes must be encouraged*: Evolutionary growth is greatly accelerated in systems in which participants can share their contributions without substantial additional efforts.
- *Meta-designers must exist and be rewarded*: Meta-designers should use their own creativity to create socio-technical environments in which other people can be creative. They must create contexts in which users acting as designers can create content and they must be willing to share control of tools and content.

Social Creativity

Although creative individuals are often thought of as working in isolation, much human creativity arises from activities that take place in a social context in which interaction with other people and the artifacts that embody collective knowledge are important contributors to the process (Csikszentmihalyi, 1996). As argued before, the fundamental problems of the twenty-first century are complex and open ended, requiring ongoing contributions of many minds, particularly from the people who own the problems and are directly affected by them.

CSCL at Work should provide frameworks to invent alternative social organizations and new media that will permit the flourishing of deep interdisciplinary specialties (Derry, Schunn, & Gernsbacher, 2005), as argued for by Campbell (Campbell, 2005): "Even within disciplines, disciplinary competence is not achieved in individual minds, but as a collective achievement made possible by the overlap of narrow specialties." Campbell's fish-scale model (an architecture to achieve "collective comprehensiveness through overlapping patterns of unique narrowness") provides a viable path toward a new competence, based on the integration of individual and social creativity (Fischer et al., 2005).

Distances (across spatial, temporal, and technological dimensions) and *diversity* (bringing stakeholders together from different cultures in CoIs) are important sources for *social creativity* (Fischer, 2005). Over the last decade, we have designed and developed socio-technical environments exploring and supporting different aspects of social creativity including (1) the *Envisionment and Discovery Collaboratory* (EDC) described in Narrative 2; (2) the *CreativeIT Wiki* to support the research community in "Creativity and IT"; and (3) collaborated with Google in analyzing the *3D Warehouse* (a set of interconnected tools that include *SketchUp* and *Google Earth*), which stores user-generated 3D models of buildings (and other artifacts) contributed from participants distributed all over the world. In these projects, we have studied different aspects of social creativity, including the impact of cultures of participation, the motivation to contribute, the learning requirements to become a contributor, and the role of curators to organize the emerging large repositories.

Narrative 2: Framing and Solving Urban Planning Problems with the Envisionment and Discovery Collaboratory

The EDC (Arias, Eden, Fischer, Gorman, & Scharff, 2000) represents a new generation of *collaborative* domain-oriented design environments. It shifts the emphasis away from the computer screen as the focal point and creates an immersive environment in which stakeholders can incrementally create a shared understanding. It attempts to maximize the richness of communication between stakeholders in face-to-face interaction, mediated by both physical and computational objects. It is grounded in Schön's "reflection-in-action" problem-solving approach (Schön, 1983) and has been applied to a variety of different design and decision-making problems in urban planning, emergency management, and transportation planning. Stakeholders using the EDC (see Fig. 2.2) convene around a computationally enhanced table that serves as the *action space*. The action space allows users to manipulate an interactive model of the design problem by proposing, exploring, reflecting, and critiquing alternative solutions. The horizontal table is flanked by touch-sensitive vertical tables that serve as the *reflection space*. The reflection space displays information that is relevant to the context as defined by artifact constructed in the action space.

The EDC explores and instantiates the components of our conceptual framework for CSCL at Work in a variety of different dimensions:

Distributed cognition is facilitated and enhanced by a tabletop computing environment that supports groups of people to work and learn together and contains information and tools relevant to the domain under investigation.

The *integration of problem framing and problem solving* is supported by a linkage between the *action space* (see Fig. 2.3) and the *reflection space* (see Fig. 2.4). When the participating stakeholders consider how land should be used in planning a new urban environment, they deal with a complex and wicked situation in which geographic, topological, financial, economic, and political issues are all mixed up together. During their collaborative activities in defining a land use scheme in the action space, they can analyze and reflect upon their decision making at any time with an alternative view of their action in the reflection space. Figure 2.4 illustrates

Fig. 2.2 The envisionment and discovery collaboratory

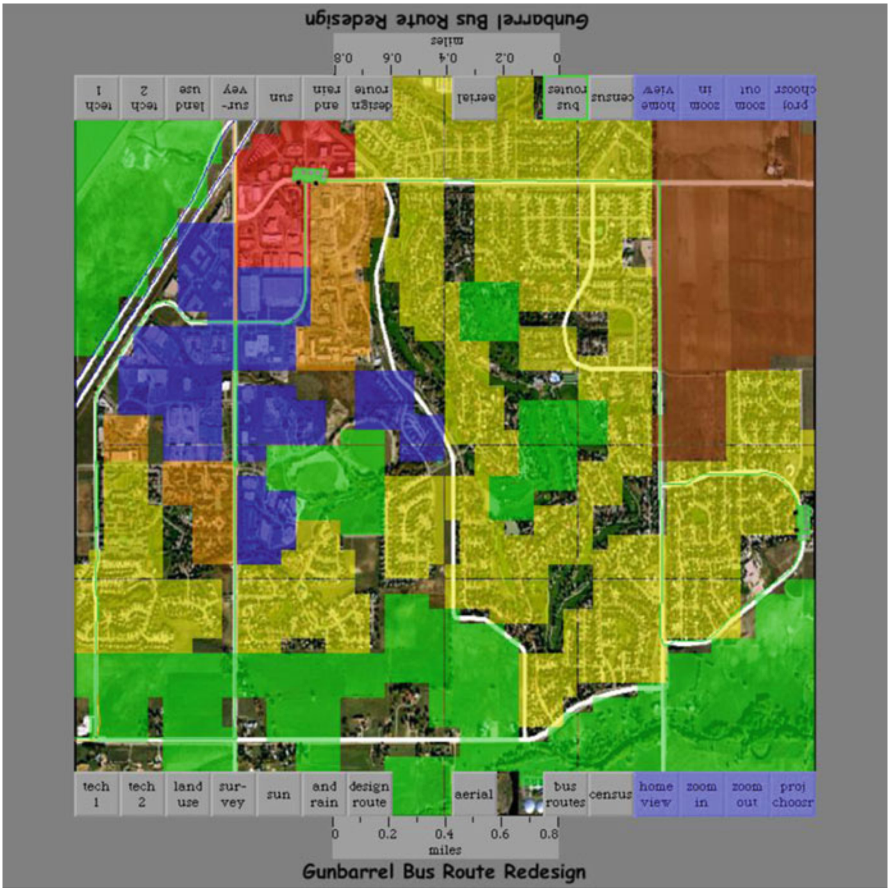

Fig. 2.3 A land-use scenario in the action space

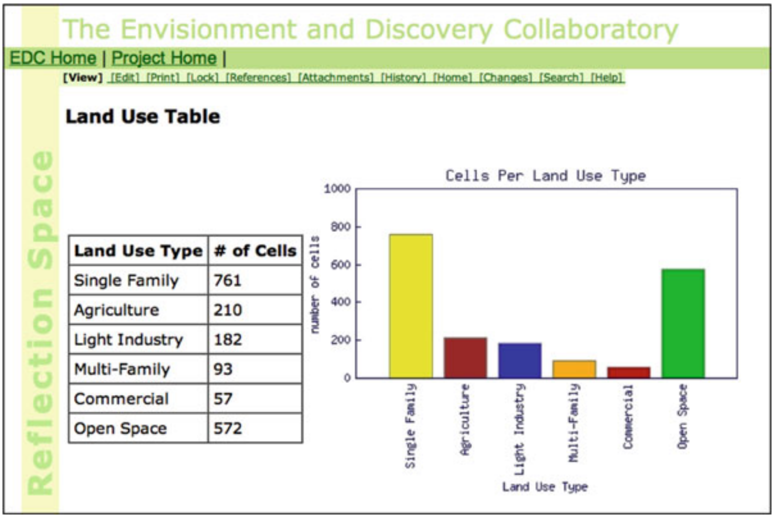

Fig. 2.4 Summary view of land use generated in the reflection space

how the reflection space provides a quantification of decisions made in the design space, giving designers a framework for reflection based on the impacts of their design decisions. Going back and forth between the two spaces provides the participants with numerous learning possibilities. The transition from the action to the reflection space is often triggered by *critics* (Fischer et al., 1998) that signal a breakdown situation (such as the violation of existing knowledge).

CoIs: The EDC brings together stakeholders with different expertise, including professional planners, transportation planners, and financial experts. It exploits the symmetry of ignorance as a source of power for mutual learning by providing all stakeholders with means to express their ideas and their concerns.

Learning when the answer is not known: The three themes identified for helping people cope with this objective are supported by the EDC as follows:

- *Meta-design*: The EDC was envisioned to be an end-user-modifiable version of Simcity, allowing participants (1) to contextualize the existing environment to their own situation, (2) to integrate different information sources, and (3) to develop new structures and processes.
- *Cultures of participation*: The EDC is an environment that is not restricted to the delivery of predigested information to individuals, but it provides opportunities and resources for design activities embedded in social debates and discussions in which all stakeholders can actively contribute rather than being confined to passive consumer roles.
- *Social creativity*: The EDC supports emerging insight as illustrated by the example in Fig. 2.5 in which participants collaboratively try to decide the best location

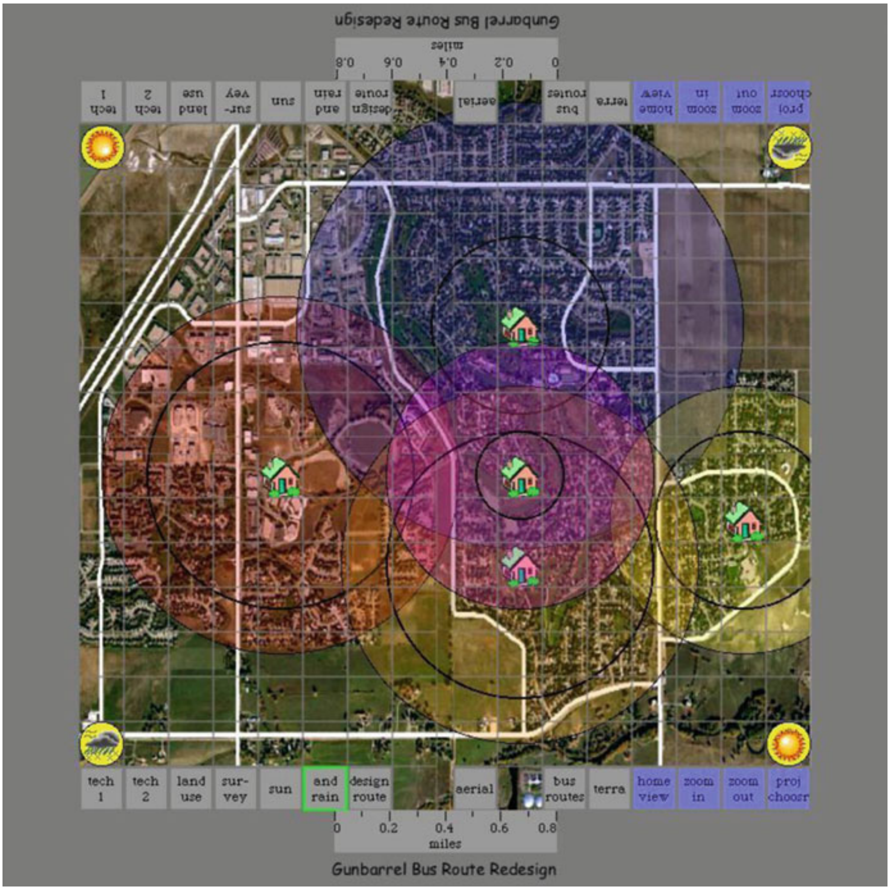

Fig. 2.5 Emerging collaborative insights based on individual contributions in a walking-distance scenario

of a bus stop by analyzing multiple walking distances. Participants indicate where they live on the map (resulting in a house icon appearing at that location). They are supported with task-focused interaction mechanisms to indicate how far they would be willing to walk in good and bad weather. After specifying this information, colored circles (generated by the system) appear around their individual house icons, indicating the range of area that they might be willing to walk to catch a bus. The display (bringing together the results of their individual decisions) shows *emerging patterns* of areas that are suitable for bus routes and bus stops, providing information and perspectives that no individual had in her or his head prior to the problem-solving session. The externalization created by individual actions serves as a source of social creativity for further design and decision making.

Trade-Offs of CSCL at Work

CSCL at Work opens up unique new opportunities for the integration of learning, working, and collaborating—but similar to other major innovations, it will face trade-offs. This section briefly discusses some potential drawbacks.

Being Taken of Task

A researcher needing to finish a paper faces an upcoming deadline when her graduate student informs her that there are much improved versions of the tools (she is using for writing, graphics, and creating references) available. She then faces the *production paradox* (Carroll & Rosson, 1987): how to balance effort and time to get the work done (finishing the article) and do so with suboptimal tools versus engage in learning to use the new tools. The dilemma of the active user is related to the rational choices workers make while facing competing or conflicting situations: analyzing the trade-offs between dealing with pressing problems and investing in long-term solutions (such as learning to use a new technology). Our approaches to CSCL address this paradox by allowing users to choose between different strategies for learning something new (such as Fix-It, Reflect, or Tutorial; see Table 2.1). Another way to tackle the production paradox is to better integrate learning and working by embedding innovations into practices so that learning and use become the same activity through which users can see tangible benefits and long-term impact in their work practices and careers.

Learning on Demand: Making Information Relevant to Users and Tasks Versus Serendipity

Information access and information delivery are two approaches for obtaining information. *Information access* is a user-initiated search, while *information delivery* is a system-initiated presentation of information. In information access schemes, workers articulate information needs, while in information delivery schemes, systems infer information needs. Information delivery is important when workers are not motivated to look for information or when they are not aware of the existence of information or tools relevant to their tasks.

Information delivery approaches create the following trade-off: whether to make *information relevant to users and tasks* or whether to facilitate *serendipity*. In a world of information overload, throwing decontextualized information at users (as in broadcast systems or in tool such as "Microsoft's Tip of the Day") is of little use. Models of learners and task (for which information is readily available in today's computational environment from all sources) can be used to tailor information in order to avoid bombarding users with irrelevant information (Fischer, 2012). The drawback associated with these approaches takes control away from users what they will see and be confronted with by encapsulating them in "filter bubbles" [Pariser (2011) characterizes this as a shift from human to algorithmic gate-keepers leading to isolation in a "web of one"].

Tools for Learning and Tools for Living

Grounded in our research to create socio-technical environments to support caregivers and persons with cognitive disabilities (Carmien, Kollar, Fischer, & Fischer, 2007), we have identified and explored a fundamental distinction between the following:

- *Tools for living*: Grounded in a distributed cognition perspective, in which intelligence is mediated by tools for achieving activities that would be error prone, challenging, or impossible to achieve
- *Tools for learning*: Grounded in a "scaffolding with fading" perspective leading to autonomous performance by people without tools

This distinction raises fundamental questions about the future of education, learning, working, and the development and use of new media by asking what it means to learn in the twenty-first century. We now live in a world where powerful tools are available for many intellectual activities—allowing people to have instant access to facts, assisting people in spelling, doing arithmetic, and performing numerous other intellectual activities (Pea, 2004).

The Impact and the Future of CSCL at Work

A major impact of CSCL at Work will be (1) to conduct research on the monopoly and exclusiveness of formal school learning (Collins & Halverson, 2009), and (2) to complement and enrich current practices in adult education [that often is reduced to training (Fischer, 2000)]. Inspirations, concepts, and organization may come from analyzing, fostering, and supporting cultures of participation (Fischer, 2011).

CSCL at Work provides the unique opportunity to explore and define conceptually alternative modes of computer-supported, collaborative learning that will enrich learning and working in the twenty-first century. It has the potential to close the gap between school and workplace learning by allowing learners to engage in activities requiring collaboration, creativity, problem framing, and distributed cognition. It will provide insights and alternative models of cognitive activities by illustrating what can be learned as a result of intentional teaching and what can be learned from working on interesting problems with other humans utilizing powerful and innovative computational media.

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Chapter 3
Theories of Collaborative Cognition: Foundations for CSCL and CSCW Together

Gerry Stahl

Theory for CSCL and CSCW

There is no one theory of collaboration in learning and working. Research in CSCL and CSCW is guided by and contributes to a diverse collection of theories. Even the word *theory* means different things to different researchers and plays various distinct roles within collaborative-learning work. The reading of the history of theory presented here is itself reflective of one theoretical stance among many held, implicitly or explicitly, by collaboration researchers.

I originally tried to develop my theory of group cognition (Stahl, 2006) in response to issues of CSCL and CSCW software design. In particular, one of my research studies was an attempt to transform a basic CSCW system (BSCW) into a basic CSCL system (BCSCL or Synergia) (Stahl, 2006, Chap. 7), exploring both mutual compatibilities and differences of emphasis between CSCL and CSCW. My other case studies can be categorized as either CSCL (Chaps. 1, 2, 6, 12, 21) or CSCW (Chaps. 3–5) systems. These software development attempts—with their various disappointments—led to my attempts to analyze the interaction and cognition taking place (Chaps. 8–13) and then—based on a recognition of the inadequacy of available methods and conceptualizations—to investigations of relevant theory (Chaps. 14–21), using data from these studies and later from a project specifically about cognition in online teams (Stahl, 2009).

The nature and uses of *theory* have changed over history and continue to evolve. The theories most relevant to computer-supported collaborative learning and working—in the view developed in this chapter—concern the nature of *cognition*, specifically cognition in collaborating groups.

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Through history, the analysis of cognition has broadened, from a focus on single concepts (e.g., Platonic ideas) or isolated responses to stimuli (behaviorism), to a concern with mental models (cognitivism) and representational artifacts (post-cognitivism). Theories that are more recent encompass cognition distributed across people and tools, situated in contexts, spanning small groups, involved in larger activities and across communities of practice. For collaborative-learning and cooperative-work research, theory must take into account interaction in online environments, knowledge building in small groups and cognition at multiple units of analysis.

A Brief History of Theory

Consider the role of theory in a research field like CSCL or CSCW. These fields are multidisciplinary by their nature and as a result of their origins (see Stahl, Koschmann, & Suthers, 2006, for a history of CSCL from a perspective similar to the one here). Consider the name of CSCL, *Computer-supported Collaborative Learning*: it combines concerns with *computer* technology, *collaborative* social interaction, and *learning* or education—very different sorts of scientific domains. CSCL and CSCW grew out of work in fields like informatics and artificial intelligence, cognitive science and social psychology, the learning sciences and organizational management—domains that are themselves each fundamentally multidisciplinary. Theory in these fields may take the form of predictive mathematical *laws*, like Shannon and Weaver's (1949) mathematical theory of information or Turing's (1937) theory of computation; of *models* of memory and cognition; or of *conceptions* of group interaction and social practice. They may have very different implications for research: favoring either laboratory experiments that establish statistical regularities or engaged case studies that contribute to an understanding of situated behaviors.

In the European tradition, theory (θεωρία) begins with the ancient Greeks—especially Socrates, Plato, and Aristotle—and continues through the 2,500-year-long discourse of philosophy. In recent times, theory has veered into unexpected directions as it has morphed into sciences based more on empirical research than on intellectual reflection. For instance, the work of Freud, Darwin and Marx replaced traditional philosophic assumptions about fixed natures of minds, organisms and societies with much more dynamic views. Theory always transcended the opinions of common sense—so-called *folk theories* based on the everyday experience of individuals—to synthesize broader views. But folk theories have also changed over time as they adopt popularized pieces of past philosophies; thus, a trained ear can hear echoes of previous theories in the assumptions of common-sense perspectives, including within current CSCL and CSCW research literature.

After the dogmatic centuries of the medieval period, philosophy took several significant turns: the rationalism of Descartes, the empiricism of Hume, the Copernican revolution of Kant, the dialectical development of Hegel, the social situating of Marx, the existential grounding of Heidegger and the linguistic turn of Wittgenstein. These all eventually led to important influences on theory in CSCL and CSCW.

In particular, for instance, the field of educational research followed this sequence of philosophic perspectives. Empiricism and positivism in philosophy of science culminated in behaviorism in biology and the human sciences. The central metaphor was that of *stimulus* provoking *response*, all objectively observable and unambiguously measurable (as critiqued in Chomsky, 1959). The major theoretical move of the generation before ours was to assert the necessity of taking into account cognitive processes in studying human behavior, from Chomsky's (1969) theories of language based on deep grammar and brain mechanisms to the mental models and internal representations modeled by artificial-intelligence programs. Human-computer interaction, the part of computer science dealing with designing for usage, has gone through a similar sequence of behaviorist and cognitivist theories (see Carroll, 2003, for numerous examples). More recently, post-cognitive theories have been influential in CSCL and CSCW, as discussed later.

The Unit of Analysis

The history of theory can be tracked in terms of the following issue: At what unit of analysis should one study thought (*cognition*)? For Plato (340 BC/1941), in addition to the physical objects in the world, there are concepts that characterize those objects; philosophy is the analysis of such concepts, like goodness, truth, beauty or justice. Descartes (1633/1999) argued that if there is thought, then there must be a mind that thinks it, and that philosophy should analyze both the mental objects of the mind and the material objects to which they refer, as well as the epistemological relation between them. Following Descartes, rationalism focused on the logical nature of mental reasoning, while empiricism focused on the analysis of observable physical objects. Kant (1787/1999) re-centered this discussion by arguing that the mechanisms of human understanding provided the source of the apparent spatio-temporal nature of observed objects and that critical theory's task was to analyze the mind's constructivist structuring-categorization efforts. Up to this point in the history of theory, cognition was assumed to be an innate function of the individual human mind.

Hegel (1807/1967) transcended that individualist assumption. He traced the logical/historical development of mind from the most primary instinct of a living organism through stages of intentional-consciousness, self-consciousness and historical-consciousness to the most developed trans-national spirit of the times (*Zeitgeist*). To analyze cognition henceforth, it is necessary to follow through its biological unfolding and go beyond to the ultimate cultural understanding of a society. Figure 3.1 identifies Hegel's approach to theory as forming the dividing line—or watershed—between philosophies or theories oriented on the individual and those oriented to a larger unit of analysis.

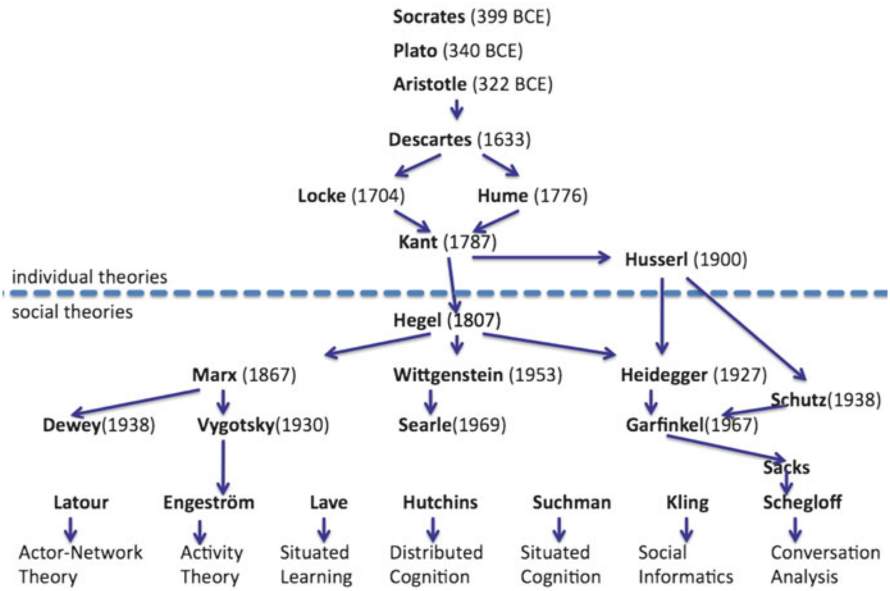

Fig. 3.1 Adapted from (Stahl, 2006, p. 289, Fig. 14.1)

Philosophy after Hegel can be viewed as forming three mainstreams of thought, following the seminal approaches of Marx (critical social theory), Heidegger (existential phenomenology) and Wittgenstein (linguistic analysis). As taken up within CSCL and CSCW, one can trace how these approaches established expanded units of analysis.

Marx (1867) applauded Hegel's recognition of the historical self-generation of mankind and analyzed this historical process in terms of the dialectical co-development of the social relations of production and the forces of production. His analysis took the form of historical, political and economic studies of the world-historical processes by which human labor produces and reproduces social institutions. Here, the study of the human mind and its understanding of its objects becomes focused at the epochal unit of analysis of social movements, class conflicts and transformations of economic systems.

Heidegger (1927/1996) radicalized the Hegelian dialectic between man and nature by starting the analysis of man from the unified experience of *being-in-the-world*. The Cartesian problem of a distinction between an observing mind and an objective world was thereby reversed. Heidegger, instead, had to show how the appearance of isolated minds and an external world could arise through abstraction from the primary experience of being-there, human existence inseparable from the worldly objects that one cares for and that define one's activity. The primordial unit of analysis of cognition is the involvement of people in their world.

Wittgenstein (1953) focused increasingly on language as it is used to accomplish things in the world through interpersonal communication. He rejected his own early view (Wittgenstein, 1921/1974), which reduced a rationalist conception of propositional, logical language to a self-contradictory position. Now, linguistic meaning no longer dwelt in the heads of users or the definitions of the words, but in communicational usage. Echoing the *lived world* of phenomenology, Wittgenstein acknowledged the role of the human *form-of-life*. He also conceptualized language as the playing of *language games*, socially established forms of interaction. The unit of analysis shifted from mental meanings to interpersonal communications in the context of getting something done together.

Marx, Heidegger, and Wittgenstein initiated the main forms of post-Kantian, post-Hegelian philosophy and scientific theory (Stahl, 2010c). Kant represents the culmination of the philosophy of mind, in which the human mind is seen as the active constructor of reality out of its confrontation with the objects of nature, which are unknowable except through this imposition of human structuring categories. With Kant—over 200 years ago—the human mind is still a fixed unit consisting of innate abilities of the individual person, despite how much his philosophy differs from naïve realist folk theories, which accept the world as fundamentally identical with its appearance to the human observer. Hegel overthrows the Kantian view of a fixed nature of mind by showing how the mind has itself been constructed through long sequences of processes. The Hegelian construction of mind can be understood in multiple senses: as the biological development of the brain's abilities as it grows from newborn to mature adult; as the logical development from simple contrast of *being* and *non-being* to the proliferation of all the distinctions of the most sophisticated understanding; or as the historical development from primitive homo sapiens to modern, civilized, technological, and cultured person. After Hegel, the theory shifted from philosophy to science, to explore the biological, logical, and historical processes in more detail and to verify them empirically. Followers of Marx, Heidegger and Wittgenstein adopted approaches to this that can be characterized as *social*, *situated* and *linguistic*. They are all constructivist, following Kant's insight that the structure of known objects is constructed by the knowing mind. However, they all focus on a unit of analysis broader than the isolated individual mind of Descartes.

Seminal Theories for CSCL and CSCW

The social, situated and linguistic theories of Marx, Heidegger, and Wittgenstein entered the discourse of CSCL and CSCW literature with researchers coming from the various scientific traditions that went into forming these research domains, including psychology, education, social science, design studies, computer science, and artificial intelligence (e.g., Dourish, 2001; Ehn, 1988; Floyd, 1992; Schön, 1983). Although these fields each introduced various theoretical perspectives, we can see the major philosophic influences largely through several seminal texts: *Mind in Society* (Vygotsky, 1930/1978), *Situated Learning* (Lave & Wenger, 1991), *Lectures on Conversation* (Sacks, 1962/1995), and *Understanding Computers and Cognition* (Winograd & Flores, 1986).

Mind in Society is an edited compilation of Vygotsky's writings from the early 1930s in post-revolutionary Russia, which has been influential in the West since it appeared in English in 1978. Critiquing the prevailing psychology as practiced by behaviorists, Gestalt psychologists and Piaget, Vygotsky did not try to fit psychology superficially into the dogmatic principles of Soviet Marxism, but rather radically rethought the nature of human psychological capabilities from the developmental approach proposed by Hegel and Marx. He showed how human perception, attention, memory, thought, play, and learning (the so-called mental faculties) were products of developmental processes—in terms of both maturation of individuals and the social history of cultures. He proposed a dynamic vision of the human mind in society, as opposed to a fixed and isolated function. The Hegelian term, *mediation*, was central for Vygotsky, as it is for CSCL and CSCW. Even in his early years still talking about stimulus and response, he asked how one stimulus could mediate the memory of, attention toward or word retrieval about another stimulus (p. iii). In Hegelian terms, this is a matter of mediating (with the first stimulus) the relation (memory, attention, retrieval) of a subject to an object (the second stimulus). This is fundamental to CSCL and CSCW because there the learning of students or the work of professionals is mediated by technological networking as well as by collaborative interaction. Another popular term from Vygotsky is the *zone of proximal development* (pp. 84–91). This is the learning distinction and developmental gap between what individuals can do by themselves (e.g., on pretest and posttest) and what they can do in collaboration (e.g., situated in a small group). A group of children may be able to achieve cognitive results together that they will not be able to achieve as individuals for a couple more years. This is consistent with Vygotsky's principle that people develop cognitive abilities first in a social context—supported or mediated by peers, mentors or cognitive aids like representational artifacts—and only later are able to exercise these cognitive abilities as individuals. Vygotsky's theory, if carried beyond where he had time to develop it, implies that collaborative learning—including in workplaces—provides the foundation upon which all learning is built. Methodologically, it argues against judging the outcomes of collaborative learning by evaluating or assessing individuals outside of their collaborative settings.

Situated Learning went beyond Vygotsky in expanding the unit of analysis for learning at work. For Vygotsky and his followers, analysis must include the mediating artifact (tool or word) and the mentor or group. For Lave and Wenger, the unit of analysis is the even larger community-of-practice. Adopting the theoretical and analytical centrality of social practices in Marx, they focused on learning-at-work as the development of processes and relationships within the communities in which individuals participated. Learning-at-work was viewed on the model of apprenticeship, in which an individual gradually—and primarily tacitly—adopts the practices that are established within the community in which the individual is becoming a member. Within CSCL, this approach can be seen in the idea that one learns mathematics by adopting the (predominantly discursive) practices of mathematicians, such as using mathematical symbolisms, making conjectures about mathematical objects and articulating deductive arguments (Sfard, 2008). The CSILE project (Scardamalia & Bereiter, 1996), a pioneering CSCL effort, tried to support the communicative practices seen in professional research communities within the learning communities of school classrooms; the unit of analysis for knowledge building mediated by the CSILE discussion software was the discourse of the classroom as a whole. This illustrates a kind of CSCL at Work in reverse, where learning incorporates work practices.

Lectures on Conversation laid the cornerstone of conversation analysis (CA), which studies the linguistic practices of communities. It was based on the ethnomethodological (Garfinkel, 1967) perspective, grounded in both Wittgenstein's linguistic analysis and Heidegger's (1927/1996) and Husserl's (1936/1989) phenomenological approach. Like Wittgenstein, CA analyzed language at a unit larger than the isolated word or speech act. CA often focuses on *adjacency pairs* used in conversation—see (Schegloff, 2007) for a systematic presentation based on 40 years of research by the CA community on adjacency-pair structure. An adjacency pair is a sequence of two or three utterances that elicit or respond to each other, such as a question and answer. The significance of the adjacency pair as a unit of analysis is that it includes contributions by multiple people involved in an interaction, and thereby avoids treating speech as an expression of an individual mind. This is analogous to Marx's (1867) focus on the act of commodity exchange between people as a unit of interaction in contrast to theories that dwell on rational decisions of an individual (Stahl, 2010c). What is important in CA is the mode of interaction carried out by the adjacency pair situated in its on-going, sequential discourse context. This should be contrasted with approaches that code isolated utterances based on assumptions about mental models inside the individual mind of the speaker. A CA analysis explicates how a dyad or small group builds upon and solicits each other's contributions, thus providing insight into patterns of collaboration. In a sense, the CA unit of analysis is not simply the adjacency pair, which includes multiple speakers, but the linguistic community, which establishes the member methods underlying adjacency-pair practices.

Understanding Computers and Cognition presents a Heideggerian critique of the rationalist foundations of artificial intelligence by a leading AI researcher. The book reviews three theories that endorse contextual analysis: Heidegger's (1927/1996) situated being-in-the-world, Gadamer's (1960/1988) historically grounded conception of interpretation and Maturana and Varela's (1987) ecological version of cognition. These theories emphasize the inseparability of the mind from its larger context: human being engaged in the world, interpretation oriented within the horizon of history and the organism bound in a structural coupling with its environment. In contrast, AI software represents mental functions as isolatable units of rational computation, which in principle cannot capture the richness and complexity of situated human cognition and collaboration. The larger, primarily *tacit* (Polanyi, 1966) unit of context cannot be adequately represented in a computer system (Stahl, 2010d). Accordingly, the role of computer software should be to *support human interaction and collaboration*, rather than to replace or fully model human cognition.

The writings of Vygotsky, Lave and Wenger, and Sacks further develop the perspectives of Marx, Heidegger and Wittgenstein that view cognition as social, situated and linguistic. Winograd—like other CSCW researchers, including Ehn and Dourish—reviews the foundational post-cognitive theories and considers the implications for computer-supported collaboration. But these theories can be—and have been—taken in different directions by researchers when it comes time to follow their implications for research conceptualizations and methods. These directions can perhaps best be seen in terms of alternative theories of individual, small-group, and community cognition in collaboration research.

Theories of Individual Cognition

Many research questions within CSCL and CSCW involve individual cognition. Collaboration research is often treated as a sub-discipline of educational or social-psychological research, oriented to the mind of the individual student or worker, within group contexts. Such research can follow traditional scientific research paradigms based on pre-Kantian empiricism (Hume) and/or rationalism (Locke). This research often adopts a constructivist approach, based on the Kantian principle that the student or worker constructs his or her own understanding of reality. Such constructivist theory is cognitivist, in that it involves assumptions about cognitive processes in the mind of the individual underlying the individual's observed behaviors. For instance, a student's responses in a test situation are assumed to be reflective of the student's mental models of some knowledge content, as construed by the student.

Work within CSCL or CSCW certainly acknowledges the importance of the larger social, historical and cultural context. However, it often treats this context as a set of environmental variables that may influence the outcomes of individual student or worker cognition, but are analytically separable from that cognition. In this way, cognition is still treated as a function of an individual mind. This approach may be called *socio-cognitive*. It acknowledges social influences, but tries to isolate the individual mind as a cognitive unit of analysis by controlling for these external influences.

Followers of Vygotsky, by contrast, are considered *socio-cultural*. They recognize that cognition is mediated by cultural factors. Yet, they still generally focus on the individual as the unit of analysis. They investigate how individual cognition is affected by cultural mediations, such as representational artifacts or even by collaborative interactions. Vygotsky himself—who was after all a psychologist—generally discussed the individual subject. For instance, his concept of the zone of proximal development measured an individual's ability when working in a group, not the group's ability as such. Vygotsky was trying to demonstrate that individual cognition was derivative of social or intersubjective experiences of the individual, and so his focus was on the individual rather than explicitly on the social or intersubjective processes in which the individual was involved.

In this sense, much cognitive research investigates individual cognition in settings of collaboration. In fact, if the research is based on testing of the individual before and after a collaborative interaction and does not actually analyze the intervening interaction itself, then it is purely an analysis at the individual unit of analysis, where the collaboration is merely an external intervention measured by presumably independent variables.

If one looks closely at most studies that claim to be about small-group collaboration, one finds that they adopt this kind of methodical focus on the individual within a group setting and treat the group interaction as an external influence on the individual. This is particularly clear in the writings of *cooperative learning* that preceded CSCL (e.g., Johnson & Johnson, 1989). As defined within CSCL (Dillenbourg, 1999), in "cooperative" learning students divide up group work and then put the individual contributions together, whereas in "collaborative" learning students do the work together. Similarly on the methodological level, in cooperative learning the analyst distinguishes the contributions to the work and focuses on the learning by the individuals as a result of the cooperative experience, whereas in collaborative learning the analyst may chose to focus on the group processes. The same is true for small-group studies of sociology and social psychology in CSCW: they usually treat the group as a context and analyze the effects on the individual, rather than analyzing the group phenomena and treating the individuals as contributors to the group processes.

A final example of a theory of individual cognition is psycho-linguistic contribution theory (Clark & Brennan, 1991). This particular paper is often cited in CSCL and CSCW literature. Although the paper claims to be in the conversation analysis tradition, it translates the adjacency-pair structure of grounding shared understanding into the contributions of the individuals. It analyzes the individual contributions as expressions of their mental representations or personal beliefs and treats the resultant *shared understanding* as a matter of similar mental contents or acceptance of pre-conceived beliefs rather than as a negotiated group product of collaboratively co-constructed meaning making. In a later paper, Clark (1996) tries to unite cognitivism with Conversation Analysis, but he analyzes the situated, engaged interaction as an exchange of signals between rationally calculating minds, who identify deliberate actions based on "knowledge, beliefs and suppositions they believe they share" (p. 12). Interestingly, Clark (1996) concludes in favor of recognizing two independent theories with different units of analysis (the individual or the community, but ironically not the small group): "The study of language use must be both a cognitive and a social science," he says (p. 25).

Theories of Community Cognition

In striking contrast to the insistent focus on the individual as the unit of analysis is the social-science perspective on social processes. Marx provides a good example of this. Where economists of his day analyzed economic phenomena in terms of rational choices of individual producers and consumers, Marx critiqued the ideology of individualism and in its place analyzed sweeping societal transformations such as urbanization, the formation of the proletariat, the rise of the factory system, and the drive of technological innovation. Lave and Wenger (1991) brought this approach to educational theory, showing for instance how an apprenticeship training system reproduces itself as novices are transformed into experts, mentors and masters. Learning is seen as situated or embedded in this process of the production-and-reproduction of structures of socially defined knowledge and power. For Lave and Wenger, the community or community-of-practice is the structure within social organizations (corporations, cultural institutions, etc.) where interaction, task accomplishment, professional exchanges, training and institutional learning take place; it is a prime location for CSCL at Work.

The theoretical importance of the *situation* in which learning and work take place is widely acknowledged in CSCL and CSCW. Suchman (1987) demonstrated its centrality for human-computer interaction from an anthropological perspective heavily influenced by both Heidegger [via Dreyfus (1991) and Garfinkel (1967), leading to conclusions similar to Winograd's (Winograd & Flores, 1986)]. Suchman (1987) and Nardi (1996) have helped to establish ethnographic methods—oriented to community phenomena—as relevant to CSCL and CSCW research. Unfortunately, even perspectives like situated cognition can take a reductive turn: Recent commentaries on situated cognition (Robbins & Aydede, 2009) and distributed cognition (Adams & Aizawa, 2008) frame the issues at the individual level, to the extreme of reducing all cognitive phenomena to neural functions.

Building on Vygotsky and his Russian colleagues, Activity Theory (Engeström, 1987, 1999; Kaptelinin & Nardi, 2006) insists on taking an entire activity system as the unit of analysis. In his triangular analysis rubric, Engeström extends Vygotsky's mediation triple of subject, mediator and object to include mediating dimensions from Marx's theory: the division of labor, the rules of social relations and the community of productive forces. Like discourse analysis (Gee, 1992), activity theory is repeatedly looking at small-group interactions but only seeing the larger, societal issues. For instance, when activity theory addresses the study of teams in the most detail in Chap. 6 of Engeström (2008), it is mostly concerned with the group's situation in the larger industrial and historic context; rather than with analyzing how the group interactionally builds knowledge, it paraphrases how the group deals politically with organizational management issues.

There is something of this avoidance of the small group as the scientific focus in other theories popular in CSCL and CSCW as well, for instance even in distributed cognition. In seminal statements of post-cognitivist theory, Hutchins has indeed explicitly pointed to group-cognitive phenomena:

- "Cognitive processes may be distributed across the members of a social group" (Hollan, Hutchins, & Kirsh, 2000, p. 176).
- "The cognitive properties of groups are produced by interaction between structures internal to individuals and structures external to individuals" (Hutchins, 1996, p. 262).
- "The group performing the cognitive task may have cognitive properties that differ from the cognitive properties of any individual" (Hutchins, 1996, p. 176).

However, rather than focusing on these group phenomena in detail, he prefers to analyze socio-technical systems and the cognitive role of highly developed artifacts (e.g., airplane cockpits or ship navigation tools). Certainly, these artifacts have encapsulated past cultural knowledge (community cognition), and Hutchins' discussions of this are insightful. But in focusing on what is really the community level—characteristically for a cultural anthropologist—he does not generally analyze the cognitive meaning making of the group itself (but see his analysis of group or organizational learning in Chap. 8 of Hutchins, 1996, for an exception and an exemplary analysis of CSCL at Work).

Even ethnomethodology (Garfinkel, 1967, 2006) and conversation analysis (Sacks, 1962/1995; Sacks, Schegloff, & Jefferson, 1974; Schegloff, 2007) consider themselves social sciences, versions of sociology or communication studies, but not sciences of the small-group unit of analysis. They aim to analyze social practices, defined across a whole society or linguistic community. This may be a quibble over words, for they do in fact define many important processes at the group unit, although they call them *social*.

Vygotsky, too, used the term *social* in an ambiguous way when he said that learning takes place socially first and then later individually. *Socially* can refer to two people talking as well as to transformations of whole societies. But for the sake of distinguishing levels of description or units of analysis in CSCL and CSCW, it seems important to make clear distinctions. Table 3.1 suggests sets of different terms for referring to phenomena at the individual, small-group, and societal levels. The distinction of these three levels has previously been argued for by (Dillenbourg, Baker, Blaye, & O'Malley, 1996; Rogoff, 1995; Stahl, 2006) and others. We start with these three levels, which seem particularly central to much CSCL and CSCW work, although other levels might also usefully be distinguished, such as "collective intelligence" at the classroom/shop-floor level or "collective practices" at the school/company level (Guribye, 2005; Jones, Dirckinck-Holmfeld, & Lindström, 2006; Looi, So, Toh, & Chen, 2011). Perhaps consistent usage of such terminological distinctions would lend clarity to the discussion of theories in CSCL and CSCW.

Theories of Small-Group Cognition

As suggested above, the CSCL and CSCW-related literature on small groups and on post-cognitive phenomena provide some nice studies of the pivotal role of small groups, but they rarely account for this level of description theoretically. They are almost always in the final analysis based on either a psychological view of mental processes at the individual level or a sociological view of rules at the community level. They lack a foundational conception of small groups as a distinct level of analysis and description. They often confuse analysis at the small-group level and at the societal level, and they lack a developed account of the relationships among the individual, small group, and community of practice. Yet there are distinct phenomena and processes at each of these levels, and analyses at different levels of description reveal different insights.

Table 3.1 Terminology for phenomena at the individual, small-group, and community levels of description from (Stahl, 2010a, p. 27, Table 2.1)

Level of description	Individual	Small group	Community
Role	Person/student	Group participant	Community member
Adjective	Personal	Collaborative	Social
Object of analysis	Mind	Discourse	Culture
Unit of analysis	Mental representation	Utterance response pair	Socio-technical activity system, mediating artifacts
Form of knowledge	Subjective	Intersubjective	Cultural
Form of meaning	Interpretation	Shared understanding, joint meaning making, common ground	Domain vocabulary, artifacts, institutions, norms, rules
Learning activity	Learn	Build knowledge	Science
Ways to accomplish cognitive tasks	Skill, behavior	Discourse, group methods, long sequences	Member methods, social practices
Communication	Thought	Interaction	Membership
Mode of construction	Constructed	Co-constructed	Socially constructed
Context of cognitive task	Personal problem	Joint problem space	Problem domain
Context of activity	Environment	Shared space	Society
Mode of presence	Embodiment	Co-presence	Contemporary
Referential system	Associations	Indexical field	Cultural world
Form of existence (Heidegger)	Being-there (*Dasein*)	Being-with (*Mitsein*), Being-there-together at the shared object	Participation in communities of practice (*Volk*)
Temporal structure	Subjective experiential internal time	Co-constructed shared temporality	Measurable objective time
Theory of cognition	Constructivist	Post-cognitive	Socio-cultural
Science	Cognitive and educational psychology	Group cognition theory	Sociology, anthropology, linguistics
Tacit knowledge	Background knowledge	Common ground	Culture
Thought	Cognition	Group cognition	Practices
Action	Action	Inter-action	Social praxis

It seems obvious that the small-group level should be considered particularly central to CSCL and CSCW theory, because these fields are explicitly concerned with supporting collaboration, knowledge co-construction or group cognition. There are few other domains in which such activities by small groups are in principle such a central concern. We have seen resistance to this focus on the small group, for instance, in the case of activity theory—which could profitably be used to investigate group processes—where Engeström (2008) argued against a focus on small groups because workplace teams tend to come and go quickly, forming changing *knots* of coworkers around ephemeral tasks.

Engeström's argument echoes the attitude of Schmidt and Bannon (1992) in their programmatic opening article of the inaugural issue of the CSCW journal. In rejecting the use of the term "group" as a defining concept for CSCW, they reduced the theoretical perspective to one focused on individuals "articulating" (i.e., coordinating) their "distributed individual activities" (p. 15). They made this move despite claiming that their concept of "cooperative work" was congruent with Marx's (1867) definition of cooperative work as "multiple individuals working together in a conscious way in the same production process." In 1867, Marx was analyzing in detail the historic shift of the unit of production from the individual to the group, but in 1992 Schmidt and Bannon insist on still focusing on the individual. They complain that the units of cooperative workers are not well-formed, clearly defined, persisting groups. But that is beside the point.

The theoretical point is that interacting people accomplish work tasks and associated cognitive tasks (including articulation tasks and power struggles) through group interaction processes, and that these should be analyzed as such, as local achievements of group interaction, not simply as sums of individual actions and reactions or as effects of external societal forces. In particular, as cooperative work shifts from the manual factory production of Marx's time to knowledge building and other forms of intellectual production in the information age, group-cognition phenomena call more strongly for analysis at the small-group unit. A small group is not defined ontologically as a certain number of human bodies adjacent to each other for a certain period of clock time, but as a cognitive unit capable of achieving specific tasks of cooperative work and collaborative knowledge building through the interaction among individuals within a larger community context.

There are distinct phenomena and processes at the individual, small-group, and community-of-practice levels, and analyses at these different levels of description can reveal different insights. As Grudin (1994) put it in terms of the needs of CSCW,

> Computer support has focused on organizations and individuals. Groups are different. Repeated, expensive groupware failures result from not meeting the challenges in design and evaluation that arise from these differences (p. 93).

There are theoretical, methodological and practical reasons for both CSCL and CSCW to focus on the small-group unit of analysis.

If group phenomena are treated seriously as first-class objects of theory, then one can study how small groups engage in cognitive activities such as: interpersonal trains of thought, shared understandings of diagrams, joint problem conceptualizations, common references, coordination of problem-solving efforts, planning, deducing, designing, describing, problem solving, explaining, defining, generalizing, representing, remembering and reflecting *as a group*. In CSCL and CSCW studies of text chat or discussion forums, for instance, analysis can show group-cognitive accomplishments emerging from the network of meaningful references built up by postings, demonstrating how the group's self-formation and its cognitive accomplishments are enacted in situated interaction. An analytic focus on the group unit of analysis need not imply that groups exist as ontological entities whenever people are observed in proximity or in communication with one another. The small group is a theoretical construct, not a simple physical observable. Of course, effective groups have to constitute themselves as such and they can change dramatically over time. It is not the more-or-less persistent physical group that is important, but the group processes, which may extend over seconds, days or years. A single momentary exchange of greetings may be a group process of interest, as shown by the early conversation analyses of telephone answering on a help phone line (Hopper, 1992).

A theoretical approach that focuses on small-group interaction is that of *dialogicality* (Linell, 2001, 2009; Mercer, 2000; Wegerif, 2007). Dialogical theory goes back to Bakhtin (1986), a contemporary of Vygotsky. It stresses the linguistic nature of interaction. It also reiterates the idea that a person's identity as an individual arises through the confrontation with one's partners in dialogue—a view that goes back beyond Mead (1934/1962) to Hegel's (1807/1967) master–slave dialectic (Stahl, 2006, p. 333f). The notion of dialogue partners coming from different perspectives and negotiating from these is an important contribution of dialogic inquiry (Wells, 1999). Another key concept is that of a *shared dynamic dialogic space*, within which knowledge building can take place (Kershner, Mercer, Warwick, & Staarman, 2010). This is similar to the *joint problem space* of (Teasley & Roschelle, 1993), but now developed in an unambiguously post-cognitive manner.

The idea of an interactional *space* for interaction within a small group is central to group-cognition theory (Stahl, 2006) as well. The term *group cognition* was coined to stress the goal of developing a post-cognitive view of cognition as the possible achievement of a small group collaborating so tightly that the process of building knowledge in the group discourse cannot be attributed to any individual or even reduced to a sequence of contributions from individual minds. For instance, the knowledge might emerge through the interaction of linguistic elements, situated within a sequentially unfolding set of constraints defined by the group task, the membership of the group, and other local or cultural influences, as well as due to the mediation of representational artifacts and media used by the group—within a larger horizon of language and history (Gadamer, 1960/1988; Husserl, 1936).

The theory of group cognition absorbs many ideas from the theories discussed above, including that of a shared dynamic dialogical space. Despite some scattered case studies by the authors already mentioned and their colleagues, there is yet not much documentation and analysis of empirical instances of effective group cognition. The analysis of group cognition needs not only specially focused methods to track its occurrence, but even prior to that it needs appropriate collaboration technologies, group methods, pedagogy and guidance to structure and support groups to effectively build knowledge that can be shown to be a group product not reducible to individual mental representations. The virtual math teams project was launched to generate a data corpus that would allow for the analysis of group cognition. This project and some analyses by a number of researchers are documented in (Stahl, 2009). Group-cognition theory focuses on the sequential team interaction within case studies of small-group collaboration. This takes place within an interaction space or a *world* in

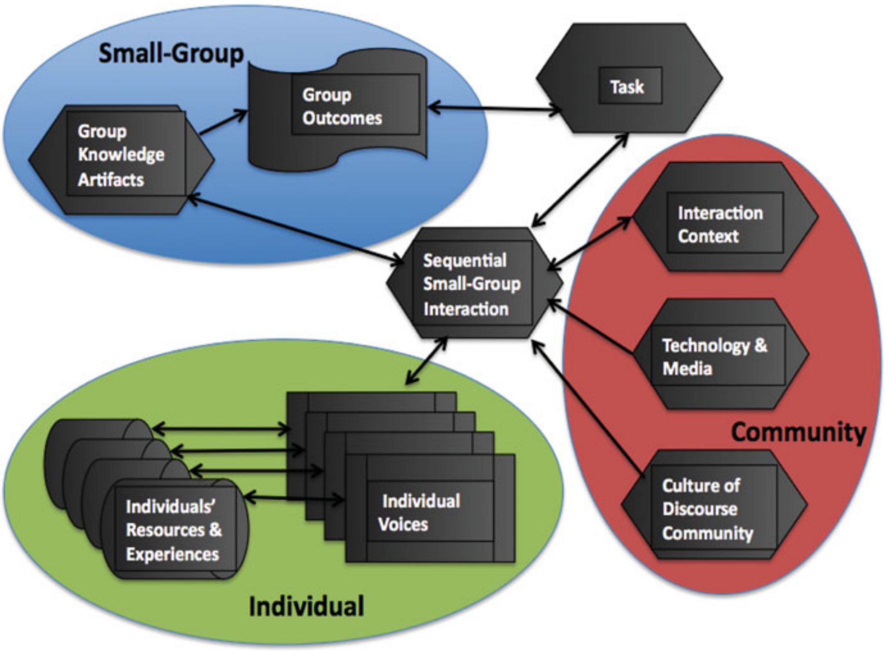

Fig. 3.2 A diagram of constraints on sequential small-group interaction from (Stahl, 2010b, p. 256, Fig. 1)

Heidegger's (1927) sense, which opens up to allow the production of group-cognitive accomplishments. The interaction that takes place within such a world—whether face-to-face or online—is subject to a variety of *constraints*, as pictured in Fig. 3.2.

Note that Fig. 3.2 is not intended to be a model of objects and processes. Rather it tries to present some of the complex constraints on the discourse through which group cognition might be achieved. Neither the physical individuals nor their group are represented here as such; the dialogical voices (Bakhtin, 1986) of the individuals enter into the sequential team interaction and respond to it. Over time, the sequential team interaction forms the central shared dynamic dialogic space within which the group-cognitive constraints interact. Behind the individual voices that enter into this interaction space are not so much minds containing mental representations, as a fluid background of past experiences and developed resources for action, which surface based on relevance to the interaction. The team discourse is situated in the shared dialogical context generated by the on-going interaction itself; the culture and history associated with the group's community-of-practice; and the socio-technical environment including the media of communication. The interaction is goal-oriented toward the task—as given externally but as enacted by the group—and mediated by a variety of kinds of artifacts, including codifications of knowledge products previously generated by the group. These artifacts might end up among the team outcomes, in relation to the guiding task. Of course, other constraints and influences are possible as well, coming for instance from the guidance of a teacher or the motivations of a reward system. The point is that one can picture the whole system producing cognitive accomplishments without having to postulate mental representations in individual minds, let alone to reduce the whole system either to rational mental decisions or to regulation by rules of social institutions.

The term *constraint* in Fig. 3.2 is chosen to be a neutral term, not implicating a notion of mechanistic causality. While it is clear that the traditional conception of causality is inadequate—stemming back to Aristotle and metaphors of physical mechanics from the everyday world—it is less obvious how to think about the working of the constraints upon group cognition. Folk theory adopts a mechanistic worldview, or even an anthropomorphic view of nature combined with a mechanistic view of causality. Observable behavior of people is taken to be the result of rational decision making in the heads of individuals causing the people to behave as a result of the minds acting as the agency for causing words to be produced and limbs to be moved. But the *linguistic turn* of Wittgenstein (1953) and even more so the recent *practice turn* (Schatzki, Knorr Cetina, & Savigny, 2001) have veered radically away from such a view.

Latour (1992) seems to be working toward a post-cognitive notion of causality, perhaps relying heavily on Hegel's notion of mediation. Interestingly, he not only argues against the hegemony of individual minds as agents in the social world, but he also argues against the adequacy of our notion of the *social* (Latour, 2007). History is made neither by rational decisions of individual minds nor by the workings of *society*. Rather, it is the result of a complex network of mediating actors, including all kinds of artifacts as well as human actors. Thus, Latour seems to be advocating an analytic approach that steers clear of both individual minds and social institutions to focus on a middle ground. He selects the term "group" for this middle ground, precisely because it can be used without implying theoretical preconceptions: "The word 'group' is so empty that it sets neither the size nor the content …. This is exactly why I have chosen it" (Latour, 2007, p. 29). Figure 3.2 may illustrate the kind of network that he would endorse for picking apart and then reassembling instances of group cognition.

Such new conceptualizations of cognition, agency and causality may be particularly appropriate for collaborative learning and cooperative work, especially as they are brought together in CSCL at Work. Here, the focus is on interpersonal *communication* and work *practices* of groups. CSCL at Work should adopt these new perspectives for facilitating computer-mediated discourse focused on improving small-group practices.

A Multiplicity of Theories of Cognition

In general, CSCL, CSCW, and CSCL at Work raise many fundamental questions for traditional theories, oriented as they are to small groups and to online interaction. The accustomed characteristics of the physical world, in which colleagues and interlocutors are embodied and visible to each other, are often missing in these virtual settings, and that brings into question numerous assumptions of folk theories and traditional approaches. The group itself has no identity as a physical body and has no brain to possess its knowledge; it relies on external memories, which differ essentially from personal memories (Donald, 1991). The online world—shared dialogical space—has no location or extension. Group members can come from around the world and do not necessarily share local connections and culture. CSCL and CSCW involve students and workers in qualitatively different social relations of production, modes of being in the world or forms of life; even Marx, Heidegger and Wittgenstein's foundational philosophies of post-cognitive theory need to be rethought for virtual groups. Concepts of causality, world, knowledge, cognition, intersubjectivity, interaction, and presence need to be reconceptualized for theories of collaboration.

There are many avenues for developing theories of CSCL at Work, as reviewed in this chapter. Although there are some similarities among these alternatives—often in terms of their critiques of earlier theories—there are strong differences of position and perspective. This is not necessarily a problem. There is a huge assortment of processes taking place in successful collaborative events: at multiple time scales and involving different aspects of interaction. It is possible to raise innumerable research questions, each requiring possibly different methods of investigation at various levels of analysis. It is likely that CSCL at Work requires multiple theories, which are not reducible to one grand unifying theory and that even seem incommensurate with each other. This goes essentially beyond the common notion of *mixed methods*, in which two or more methods of analysis are used to triangulate a single phenomenon from different angles. There are distinct phenomena at different levels of description—and they interact with each other in complex ways in group settings.

CSCL and CSCW study collaboration, from a design perspective. CSCL often involves whole classrooms or schools and widespread educational practices; CSCW often involves large departments or factories and widespread work practices. At the opposite end of the spectrum, much of the actual work comes down to tasks done by individuals. But much of the coordination, decision making, articulation, brainstorming, discovery and knowledge building is accomplished by small groups. Community accomplishments are thereby mediated by small groups, which carry out the necessary activities and involve the individuals. Collaboration involves a tight and complex integration of processes at the individual, small-group, and community levels. Computer support for collaboration must provide supports at each level while also supporting the integration of the activities at all levels. To provide insight for this, CSCL and CSCW research must recognize the levels as distinct and conduct analyses at all levels.

Some time ago when I was a CSCL researcher working in a CSCW research lab, I argued that CSCL and CSCW were closely related in terms of their theoretical foundations, but that they differed in terms of the population on which they focused (Stahl, 2002). CSCL is concerned with students who are learning practices at which they are still novices. In the Vygotskian metaphor, they are experiencing group-cognitive processes that they can subsequently internalize. CSCW is concerned with professionals who are refining their skills as experts. They may be engaged in group-cognitive processes which cannot be internalized by an individual, such as navigating a large naval vessel (Hutchins, 1996). The theme of this book, learning at work, demonstrates that even at the level of concrete learning activities the two often separated research fields have much in common.

In CSCL at Work, there are many phenomena of interest, and they are largely defined by the theories that conceptualize them. So different theories can be talking about quite different phenomena (although they may unfortunately be calling them by the same name). In order to avoid confusion and arguments about pseudo-problems, we need to be clear about the theories behind research questions, assumptions, methodologies, analysis tools, findings, and claims in this research.

This chapter has sketched some of the theoretical landscape underlying CSCL and CSCW research. Progress in further developing theories of CSCL at Work will require careful analysis of case studies—such as those in this volume—and experimental results guided by theoretical perspectives that are clearly enunciated.

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Chapter 4
CSCL@Networking: Regional Learning in Software Industries

Markus Rohde and Volker Wulf

Introduction

Flourishing regional networks and clusters (for example, Silicon Valley IT Cluster, the Japanese Mie Medical Valley (Biotechnology), South Corean's Seoul Digital Media City, etc.) are interesting phenomena. Their existence is an indicator that locality still plays an important role in a globalizing economy. We focus on these forms of regional cooperation between different companies to understand how these companies build strategic alliances, share specific expertise and therefore, learn from each other to strengthen their own market position and to improve regional business conditions. With regard to the activities of regional learning, we do not differentiate between more institutionalized clusters and regional networks.

Regional clusters and networks have become an arena to implement economic policies. While globalization and multilateral agreements seemingly restrict opportunities for policy making on the level of national states, interventions to foster regionally based industrial sectors promise to broaden opportunity. Initiatives to foster regional clusters and networks have been set up by a variety of different national governments such as the USA, Japan, France, Korea, and Germany. In Germany, the different states have implemented additional measures in support of regional learning. Thus, a better understanding of leaning within regional clusters and networks seem to be of high societal relevance.

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In this chapter, we have two goals: (1) to evaluate interventions that stimulate the process of regional learning (learning across the boundaries of organizations) and (2) to better understand the preconditions and obstacles for collaborative learning in regional clusters and networks. We conduct this investigation from the point of view of a regional research university and look into its opportunities to stimulate regional learning in specific industrial sectors. We elaborate on our understanding of “regional learning” by exploring the concepts of social capital and communities of practice. We believe that both of these concepts can add to a CSCL at Work perspective on collaborative learning practice among regional actors. In our research we looked at IT companies in the region of Siegen-Wittgenstein (Germany), how they get to know each other, their respective competencies, services, and products. We work to understand how they set up cooperation projects to learn from each other’s expertise and therefore, strengthen their market position.

Porter (2000), defines regional clusters as a “geographical concentration of interconnected companies, specialized suppliers, firms in related industries, and associated institutions in particular fields that compete but also cooperate” (p. 15). Regional networks are a weaker form of geographical concentration. We define regional networks as those socio-territorial entities that consist of regional firms working in a similar industry but who do not qualify as clusters due to a lower level of concentration or lacking vertical integration. There is only limited understanding of the mechanisms associated with the emergence of a cluster from a regional network, and how to reproduce these sorts of desirable effects (cf. Guiliani, 2005; Lundvall, 1992). Workforce development, including continuing education and learning, are important components in such transformations. Thus, our focus is on the question of how collaborative learning takes place in regional networked companies and institutions. Furthermore, as a regional university, we were interested in creating opportunities for mutual learning, expertise sharing and cooperation structures for IT companies in the German region of Siegen-Wittgenstein. To strive for this goal we first had to understand the mechanisms of IT business networking in our region and how creative learning takes place in regional cooperation.

From the very beginning of the discussion, scholars have been aware of the importance of learning across organizations, so called knowledge “spillovers,” for the flourishing of regional clusters. Marshall (1890) saw such spillovers as the main reason for regional cluster emergence in the physical domain. However, he was already aware of the fact that expertise sharing within a specific industry can be enabled by physical proximity of the actors. Right now economies in the industrialized world are moving from mass production towards flexible specialization as well as from material products towards knowledge-intense services. Under these conditions regional learning in the sense of information passing and expertise sharing becomes an increasingly more important economic factor (cf. Florida, 1995). This fact is also reflected in the cluster related literature (cf. Porter, 1990; Saxenian, 1994). Other studies have supplemented this view by pointing to the importance of cultural factors such as shared values systems and a feeling of reciprocity among regional actors (cf. Becattini, 1990; Lazerson, 1990). Guiliani (2005) explains the development paths of regional clusters primarily from a knowledge perspective.

She argues that the ability of the individual firms to absorb information or expertise from external sources is central to the growth potential of regional clusters. Universities are often seen as important institutional facilitators of technology transfer and the development of regional clusters (cf. Lockemann, 2004; Saxenian, 1994). Our investigation is based on the hypothesis that research universities can also take the role of a facilitator to foster learning in regional networks. We assume that in such a setting mutual learning can take place between regional companies and the university as well. Faculty members and students can learn from companies' practices while company practitioners could learn about academic findings concerning expertise sharing in regional networks.

To ground our investigation theoretically, we draw on the concepts of social capital and communities of practice. Social capital in the sense of sustained mutual relationships is a precondition for expertise sharing among human actors (cf. Ackerman, Pipek, & Wulf, 2003; Cohen & Prusak, 2001; Huysman & Wulf, 2004a, 2004b, 2005). Sociocultural theories of learning hold common practice and mutually defined identities to be central enabling conditions for expertise sharing (Brown & Duguid, 1991; Lave & Wenger, 1991; Wenger, 1998). While these conceptions have not yet been widely applied to the analysis of socio-territorial entities, they provide us with a conceptual framework to conduct interventions and empirical analysis.

The chapter is structured as follows: In the next section, we provide an introduction to the discussion on social capital and present results from sociocultural theories of learning, such as the concepts of network and community of practice. The third section describes the research field and methods. Section four presents the set of different activities that we conducted to foster regional learning. Section five empirically evaluates the outcome of these activities. Finally, we discuss the findings of the study.

Theoretical Framework

To frame regional learning, to ground our interventions and to evaluate their outcomes, we draw conceptually on social capital and sociocultural theories of learning.

The concept of social capital has been tackled from a communitarian perspective (cf. Huysman & Wulf, 2004a). Neglecting its segregating effects, social capital is understood in this discourse as a property of social entities which enables them to function well (e.g., Putnam, 1993, 2000). In this sense many scholars have argued that social capital is essential to information passing and expertise-sharing activities (Cohen & Prusak, 2001; Huysman & Wulf, 2004a, 2004b; Nahapiet & Ghoshal, 1998). So, social capital seems to play a crucial role when understanding and fostering regional learning.

Second, we look into sociocultural theories of learning. Networks and communities of practice are conceptualized as distinct social aggregates sharing a specific communality: a common practice. The homogeneity of practices is seen as the base for their expertise generating capacity (cf. Brown & Duguid, 1991, 2000b; Lave & Wenger, 1991; Wenger, 1998). In this sense, sociocultural theories of learning seem to provide a well-elaborated theoretical basis for understanding and fostering regional learning.

The Communitarian Concept of Social Capital

The term social capital (SC) has been conceptualized heterogeneously with regard to its definition as well as to its epistemological grounding (cf. Huysman & Wulf, 2004a). The basic assumption is that economic interactions are embedded in social relations. Through social exchanges, people build webs of trust, obligation, reputation, expectations, and norms, which influence their economic behavior (Coleman, 1988; Granovetter, 1985). Bourdieu (1985) distinguishes between economic, cultural, and social forms of capital. Economic capital is immediately and directly convertible into money. It may be institutionalized in the forms of property rights. Social capital defines the advantage created by a person's location in a structure of social relationships. Cultural capital defines a person's forms of knowledge, skill, education and the resulting habitus, which gives her a higher status in society.

In American communitarianism SC has been defined as an attribute of a social entity, i.e., community, rather than of individual actors. Communities are seen as voluntaristic social units that promote harmonic development of organizations or society as a whole. Advocates of this point of view protest against the decline of social trust, the loss of civic engagement, and seek to foster the moral, social, and political foundations of society (Etzioni, 1995; Putnam, 2000). Putnam (1993, 2000) equates SC with the level of civil engagement and applies the concept of SC to cities, regions and whole nations. He understands SC as a set of properties, e.g., norms, level of trust or social networks which enables joint activities and cooperation for mutual benefit. Rising SC would therefore, be a major goal in regional development.

Next to civic engagement, SC is perceived to be an important enabling factor for knowledge and expertise intense processes in and between organizations (e.g., Lesser, Fontaine, & Jason, 2000). Focusing on the relational aspects, SC theories have been applied as a conceptual base to knowledge and expertise sharing strategies (Cohen & Prusak, 2001; Huysman & Wulf, 2004a, 2004b; Nahapiet & Ghoshal, 1998). Cohen and Prusak state in this respect:

> Social capital consists of the stock of active connections among people: the trust, mutual understanding and shared values and behavior that bind the members of human networks and communities and make cooperative action possible. Its characteristic elements and indicators include high levels of trust, robust personal networks and vibrant communities, shared understandings, and a sense of equitable participation in a joint enterprise—all things that draw individuals together into a group (Cohen & Prusak, 2001, p. 4).

It is assumed that SC is accumulating when it is used (productively), otherwise it is decreasing. In this sense SC tends to be self-reinforcing and cumulative. People gain connections and trust through successful cooperation, and these achievements of networks and trust support good cooperation in the future.

Sociocultural Theories of Learning

Sociocultural theories of learning and theorists of SC agree with regard to the importance of social networks for expertise sharing and learning. However, sociocultural theories of learning focus on the preconditions for learning. It is assumed that mainly people who are engaged in similar practices are able to share or create knowledge concerning these practices (Brown & Duguid, 1991, 2000b; Lave & Wenger, 1991; Wenger, 1998). So these theories offer an approach to explain the conditions under which social capital can be most efficient for regional learning (cf. Duguid, 2003, 2005).

Practice is basically understood as a recognizable social entity shaped around a set of related activities. Lave and Wenger (1991) and Wenger (1998) define the concept of a community of practice (CoP) as a tightly knit social entity centered on a particular practice. They stress the intertwinedness of practice, identity, and sense making within a CoP. Learning in these communities takes place in the form of enculturation in the community's practice through means of cognitive apprenticeship (Lave & Wenger, 1991). According to the mechanism of "legitimate peripheral participation," a (new) member of a CoP learns by taking part in the collective practice and gets enculturated, moving from the periphery of a CoP toward the core of the community. Within this process, the member learns about aims and goals of the community, about their values and norms, their methods, techniques, and tools. With respect to collective learning Wenger defines CoPs as "shared histories of learning" (Wenger, 1998, p. 86).

Brown and Duguid (2000a) and Duguid (2003) distinguish networks of practice (NoP) from communities of practice (CoP). Within communities of practice, members do not only share a common practice but also work together, and therefore, need to coordinate their activities with each other. The members have, at least implicitly, responsibility for the reproduction of their community and their practice. The creation of new knowledge and expertise is happening mainly inside of CoPs.

Members of a networks of practice (NoP) share practice but do not work together, and therefore, do not need to coordinate their activities. The members of a NoP can be unknown to each other. They often only interact in an indirect manner, i.e., via newsletter or bulletin boards. Within NoPs common practice offers a reference to members for their interaction. Common practice allows them to make sense of it in a relatively effective and coherent way (cf. Duguid, 2003). While new knowledge is mainly created inside CoPs, NoPs are instrumental in passing information among its members. In networks of practice "reflective learning" takes place between different CoPs. To illustrate the concept, Duguid (2005) takes the example of

Knorr-Cetina's (1999) "epistemic culture" of high-energy physicists, which constitutes a global NoP that contains multiple local CoPs.

CoPs and NoPs can be seen as ends in a continuum of social entities defined by similarities in their practice, identity and sense-making. While CoPs will typically have a rather narrowly defined practice and a strong feeling of identity, the shared practice of a NoP will have a wider reach and its identity will be less strongly felt. Therefore, the processes of sense making and learning differ along this continuum.

For the purpose of our investigation into regional learning, we define regional networks of practice (RNoP). RNoPs are understood as NoPs whose members are living and working in the same region and know each other personally. In case of IT companies in the German region of Siegen-Wittgenstein regional learning includes getting to know about the other companies' competencies and expertise, about their products and customers, find out about complementary services, cooperation opportunities, etc. By sharing expertise and establishing strategic alliances and specific cooperation projects, regional companies can learn from each other and strengthen their market position. Dense, well functioning RNoPs are important aspects of a region's SC—in Putnam's sense. Saxenian (1994) showed the importance of RNoP for the development of industrial clusters when investigating the development of the Silicon Valley and the Route 128 region in California.

Field of Application and Research Methods

In this section we describe our research approach. We first describe the regional setting, looking at the software and media industry as well as the university. Second, we introduce the research methods we used to foster regional learning.

The Regional Setting

The region Siegen-Wittgenstein is located in the state of North Rhine Westphalia, almost at the geographical center of the western part of Germany; about 100 km east of Cologne and 125 km north of Frankfurt. Siegen, the region's center, is a city of about 100,000 inhabitants. The University of Siegen is located in one of its suburbs.

During the last 30 years software and media companies have been started within the region. Former students of the university's media science, computer science, and information systems programs created some of the companies. The regional authorities maintain a database in which about 450 small to mid-size software and media companies are registered. These companies employ about 4,500 workers; and are regarded as one out of nine sectors to have regional importance.

The regional council has set up a coordinating unit whose job it is to foster the development of the software and media industries. A particular focus of their activities is fostering the linkage between university and regional industries. For about 5 years, the council was involved in allocating development funds provided by the European Union. These EU funds were allocated for regional development, especially the qualification of employees and the networking of companies. The regional council set up a committee to decide on project applications in which the regional employers' association and trade unions were also represented.

A research group at the University of Siegen's Department of Information Systems, which is headed by the second author, conducted the action research program presented here. The research group works in the field of human centered computing, specifically in the subfields such as Computer Supported Cooperative Work, Participatory Design, End User Development, and Communities and Technologies. Research is organized around specific, typically externally funded projects, and research practice develops within these projects or bundles of related projects (Wulf, Rohde, Pipek, & Stevens, 2011). The second author also headed a research group at Fraunhofer FIT. The Fraunhofer Society is a highly respected chain of German national research centers dedicated to applied science and knowledge transfer into industries. About one-third of its annual research budget is directly paid from industries.

Research Methods

The research group of the University of Siegen started its regional network activities within the local software and media industries in 2002 when the head of the group got a faculty position in the Department of Information Systems. In the beginning, there were mainly three motivations to become engaged in regional activities:

- Access to regional companies was seen as an important element in information systems' education. The authors had gained earlier experiences in integrating student teams into companies' CoPs when pursuing entrepreneurship education at the Computer Science Department of RWTH Aachen and MIT Sloan School (cf. Rohde, Klamma, Jarke, & Wulf, 2007; Rohde, Klamma, & Wulf, 2005).
- Building cooperation between university and local industries was seen by some academic colleagues, especially in the information systems department, the president and the chancellor of the university, as an important aspect of the institution's mission. So these activities could potentially strengthen the group's standing inside the university.
- A part of the German national and European Union's research funding schemes are dedicated towards joint projects between industries and academia. While these schemes typically do not require local partners, it is a clear advantage to establish close cooperation structures and trustful relationships with regional partners.

Action Research

Our investigation of regional learning networks takes an action research perspective. We adopted three of Lewin's (1946) principles of action research:

- Researchers are not just external observers but intervene into the field of application. In our case, we tried to increase the level of social capital in the region and link different communities of practice in the software and media industries.
- Research is a mutual process of learning among the researchers and the practitioners. Action research emphasizes direct researcher–actor collaboration and focuses on group dynamics as the appropriate basis for practical problem-solving. Therefore, it usually combines participative and qualitative methods of analysis, planning, intervention, and evaluation (Lewin, 1946). In our case learning happened in a double sense: we learned together with the practitioners about the effectiveness of our interventions and the different networking activities.

Traditional action research distinguishes three phases of intervention: (a) reflection phase, (b) planning phase, and (c) action and observation phase (e.g., Kemmis & McTaggert, 1988). In contrast, we did not start with on overall phase model or plan for the different interventions. The interventions emerged through a variety of opportunities and context factors. However, they follow the vision of increasing social capital and bridging among different regional CoPs.

We gained an initial understanding of the particularities of the regional industry through informal discussions with senior faculty at the university, the head of the regional authority's support unit, and some company owners. Supported by the regional authorities, we conducted a first networking event, which again led to new insights and contacts. From this starting point, a series of events emerged which are presented later. Courses in practice were an important aspect of the networking process in which students learned through enculturation into regional companies' CoPs.

We conducted a series of semi-structured interviews and additional observational studies. Since the courses in practice were an important research focus, we conducted 25 explorative semi-structured in-depth interviews with students, supervisors from academia and industries and officers of the regional administration. Fourteen students, six company practitioners, three academics, and two officers were interviewed. During the interviews, which lasted between 60 and 180 min, students were first asked about their personal background, their background of education and their motivation for participating in the course. After that, students were questioned on personal impressions and assessments of the course, its components and the technological support by groupware and cooperation platforms. Students were also asked to suggest improvements. Lecturers were asked about their personal background and high emphasis was placed on assessments of the lecture-components held by them. The regional officers were asked about their activities to encourage the competitiveness of the regional software and media industry. We were specifically interested in their experience establishing regional networks and their evaluation of our joint activities in fostering regional networks of practice between local industry and the university Table 4.1.

Table 4.1 Interventions and data collection methods

Topic	Method	Participants
Investigating regional stakeholders, expertise, and networks	Informal talks and discussion	University faculty Regional authorities
	Networking events	Company owners
Establishment and evaluation of courses in practice	Participant observation	14 students 6 company practitioners
	Semi-structured Interviews	3 academic supervisors 2 administration officers
Introduction of expertise finding system	Semi-structured interviews	13 regional IT managers
Regional networking	Participant observation	University faculty Regional authorities
	Networking events	Company practitioners

Furthermore, a second series of 13 semi-structured interviews have been conducted with managers of regional media and IT companies, regarding the introduction of an expertise finding system (Reichling, Moos, Rohde, & Wulf, 2010; Reichling, Wulf, & Moos, 2008). These interviews focused on internal and external cooperation, communication in networks with partner companies and customers as well as IT infrastructure. Additionally, we asked participants about their strategies for finding new partners and for identification of specific interests, expertises and competences sought from internal colleagues, external partners and potential customers.

Each person was interviewed in an individual session. All interviews have been recorded with a DAT recorder and fully transcribed. In the evaluation, the answers were transformed into a table categorizing the role of students, academic and industrial supervisors.

Furthermore, other measures to foster regional networking have been evaluated by participant observation. The observational data was structured around the different events and documented in the form of written notes and minutes. Interviews and observational data have been analyzed descriptively according to our heuristic approach (cf. Kvale, 1996). The process was informed by the experiences gained when carrying out the different measures. In addition, the second author kept a calendar in which he documented his regional networking activities.

Fostering Regional Learning

In the following, we present the selected instruments applied to foster social capital and bridge among CoP in the software and media industries to enable expertise sharing and cooperation projects as opportunities for regional learning.

Learning to Know the Region: Informal Talks and Meetings

Taking an action research perspective means to gain a profound understanding of existent practices in the first stance. As researchers we have to learn about the regional circumstances, the stakeholders and their needs, about the practice of regional IT companies, their products, customers and competencies.

When starting the process, the faculty member did not know the key players in the region's software and media industry. During the course of the first 3 years, a considerable amount of time was spent in informal meetings with a big variety of local actors. Given the general interest of the second author in establishing cooperation with the region's industries, he picked up on opportunities arranged by others. Half a year after taking over the faculty position, the second author was introduced to the head of the region's coordinating unit for the software and media industry. A senior IS faculty member who had a long standing cooperation with the unit had told him about the existence of the unit and suggested he call the head. In the talks it quickly became clear that both sides had a common interest in connecting the IS group with regional industries. For this purpose, the head of the unit offered parts of his network of relationships within the region. He suggested a local company whose owners could be of interest for the IS group and contacted them. He also hinted at specific companies that could be interested in cooperating with the university within the framework of courses in practice (see below). As a result of the resulting talks, the idea for a series of networking event emerged (see below).

In summer 2003, the second author met a consultant whose small company was specialized in setting up EU-funded projects to network small and medium sized enterprises (SMEs). Though the consultant was living in Siegen, his company had not yet been able to get a project in the Siegen region. He hoped to be more successful by involving a faculty member from the local university in his proposal. An acquaintance of both of them facilitated their introduction. The result was a proposal to network and consult with companies from the local software and media industry (see below).

In fall 2003, a journalist from the major local newspaper met with the second author. He was responsible for covering local economics at that newspaper and got interested in the IS group as a result of their local activities. The journalist was interested in learning about the group's research activities and its engagement with local companies. The local newspaper is still a family run business whose main activities are centered in the Siegen region. Beyond journalists' interest, it is safe to assume that the publishing house also has a commercial interest in the flourishing of the local software and media industries. Being by profession well informed about the regions industries, the journalist shared his perspective on important regional actors with the second author. The second author offered to keep him well informed about further initiatives. The meeting contributed to a rather broad and positive coverage of the IS group's activities in the newspaper. This cooperation with regional press helped to increase the IS group's visibility for regional companies. Communicating not only with certain partners but also with the general public is proving to be a crucial success factor for activities aiming at regional development.

Increasing Visibility and Connecting Actors: Networking Events

As a result of the talks with the region's coordinating unit, a concept for a series of networking events was worked out, called, "Lyz Media Breakfast" (according to the location the meetings took place). It tried to reach out towards heads or upper management of regional software and media companies. Following an invited talk in the early morning (starting at 8:30 a.m.), there was a joint breakfast for the participants to network with each other; designed to enable participants to leave by 10 a.m., resulting in minimal disruption to daily work schedules.

These networking events were set up as an enabling structure for mutual exchange and therefore establishing preconditions and opportunities for cooperation and collaborative learning, not only between regional IT companies but between the regional industry and the local university, as well.

At the first of these events, the first author gave an introduction into the work of his group at the University of Siegen. Moreover, a member of his group at Fraunhofer FIT gave a survey on the Usability Lab's services for industry. The coordinating unit had sent invitation letters to the heads of 350 software and media companies stored in its database. The first event had 25 participants and led to discussions and talks among the participants. The first event was viewed as a success, which made the coordinating unit decide to continue organizing further events at a frequency of about four events per year.

Beyond the "Lyz Media Breakfast" series of networking events, specifically designed for the software and media industries, the second author was invited to give talks about the group's work at a variety of other events in the region. The audience included participants ranging from members of a local trade union association to members of the industrial board. These talks helped raise the visibility of the group's work. After each talk there were opportunities to network with the different regional actors.

Bridging Between University and Industry: Courses in Practice

Based on earlier experience in entrepreneurial education, we have developed student courses in practice (CiP), which are a didactical concept that bridges between CoPs of regional software companies and the IS group at the University. Originally, the concept was developed to offer learning opportunities to students by integrating student teams into the CoPs of local IT companies (cf. Rohde et al., 2005, 2007).

The CiP approach works as follows: IT companies define projects close to their core business. The student teams work on these projects inside the companies. When working in industries, the students are additionally coached by members of the IS group at the University. An academic supervisor supports each group. CiPs typically last one academic term (4 months). During this time about five meetings among the students and their academic supervisors take place.

At the end of the term, the students and their company advisors present the results of their projects publicly. The students give a 20 min talk about their results, which is followed by 10 min of advisor comments. Finally, the results are discussed publicly. The event is announced in the region. The participation of the faculty's dean and the engagement of the regional administration guaranteed a certain level of public interest. So, typically some 30 employees of other companies, faculty members, journalists and students join the presentations, which end with a small reception. These events became occasions for further networking among the regional actors as well for engaging with new companies and students.

A groupware tool called Basic Support for Cooperative Work (BSCW) was deployed to all CiP project groups to support their internal cooperation as well as the interaction with the academic supervisors.

The first CiP were held in summer term 2003 at the University of Siegen. After presenting the concept to him, the head of the regional coordination unit pointed us towards two small software companies whose CEOs he knew well and thought would be interested. Following his introduction, we met with each of the CEOs and convinced them to buy into the project. Since 2003, four instances of the CiP have been conducted. Eight student teams, two every year, consisting of 19 students overall were acculturated into the CoPs of four different software companies. Two of the four companies participated more than once in the course: one of them four times, the other company two times.

Our empirical work, focused on an examination of the learning processes taking place within CiPs (Fischer, Rohde, & Wulf, 2007; Rohde et al., 2007), showed that students teams do not just acculturate into the companies' CoPs, but become boundary spanners in the local network. Student learning history at the university and the coaching provided by the IS group while running the projects, enabled students to become boundary spanners between the university and the company's CoPs. This was especially the case for innovative products or processes for which the companies did not have an established set of practices already.

According to the interviews and the observations, the usage of technological cooperation support with BSCW seemed to be ambiguous: While some of the CiP groups used the system regularly and found the support very helpful for their cooperation, other groups did not use the system very much. The findings showed that the usage of cooperation platforms like BSCW depends on several factors, including the number of members in a CiP group, their spatial collocation/distribution, the frequency of their physical meetings, and the usage of other systems (like CVS) in the participating companies. The application of technological cooperation support was more important when the groups met less frequently face to face. The application of BSCW in context of our CiPs could be viewed as an early instance of a CSCL at Work system.

Bridging Among Regional Industries: Funded Networking Project

The European Structural Fund (ESF) provides funds for the industrial development of specific regions under different program lines. In North Rhine Westphalia, the state government decentralized the decision-making for allocation of considerable parts of these funds into the regions. Siegen-Wittgenstein created an advisory board that decided on the different project applications. The advisory board represented enterprise owners, trade unionists, local politicians, and members of the region's administration. A section of the region's business development department was instrumental in preparing the decision making of the advisory board. Since the board did not meet often, the department had a strong influence on the decision process. It provided most of the relevant information towards the members of the board.

Together with the consultant, in September 2003 the second authors set up a meeting with eight CEOs of regional software and media companies. In the meeting we tried to agree with the companies on a joint vision and a work plan for the project, which was fitted to the criteria of the ESF program. In the meeting and the following negotiations, it turned out to be impossible to agree on a work plan. This was due to different interests among the companies, historically grounded animosities and rivalries among certain CEOs, and the requirements that the companies should pay for about one quarter of the projects total costs. Despite these constraints, we did ultimately succeed by developing a proposal with a smaller consortium. This more focused effort was directed towards consulting the participating companies individually and setting up consortia meetings to foster expertise sharing among them. Unfortunately, the regional authorities rejected the proposal. Though the second author intervened strongly with the head of the coordinating unit, he did not get clear feedback on the backgrounds of the decision nor could he revoke it.

Surprisingly, in late November 2004 the regional authorities approached the business consultant and the second author to submit a similar proposal to the one rejected a year prior. Unfortunately the funding conditions had deteriorated, so the companies were expected to cover about half of the costs for the services the project provided. Therefore, we had to find new partners from the local software and media industries and rearrange the project proposal. The project was approved with just four partners—only one of which participated in the original proposal.

The activities of the network-building process covered joint meetings among the CEOs, meetings with the IT departments of strategic clients in the region (e.g., a brewery, a producer of switchboards) and joint public relations. So these joint activities focus around marketing and management practice within software and media companies. Within the process described above and the resulting project, the regional IT companies learned about each other's interests, products, and customers. Furthermore, the participating companies established cooperative structures and shared parts of their expertise to improve their (common) market position in the region.

Finally, the IS research group developed several research proposals together with different member companies from the regional network. Many research programs of the German government and the European Union require participation from industry. Some of them even require explicit SME participation. So, it makes sense for the IS group to include regional companies into their research proposals in case there are matching interests and converging practices. The participating companies were involved in CiP before writing the joint proposal. So the research proposals are grounded on an already rather well established cooperation between university and industry. The opportunity to receive public funding via the university's activities stabilized the regional networks. This collaborative activity of proposal development proved to be an excellent opportunity for mutual learning between regional industry and the university. Academic partners learned about regional industry's needs and competencies, and companies learned about funding opportunities, mechanisms, and programs. Furthermore, the joint activities helped to establish social capital and trustful relationships between regional actors as a precondition for cooperation and mutual exchange of expertise.

Supporting Cooperation: Expertise Finding in Regional Networks

For the media and IT industry in the region of Siegen-Wittgenstein, a company database exists with about 600 different firms. This regional company database only contains the main address data and some keywords regarding the companies' core business. The database is rarely used as regional "yellow pages," and quite often less informative than the companies' Web sites. Therefore, future work will introduce a system for expertise finding to this database. The ExpertFinding framework has been developed at the IS group of Siegen University to foster cooperation between employees in large, distributed organizations.

The system helps to become aware of persons' expertise by making individual knowledge and interests visible. It includes an expertise search engine, which generates individual expertise profiles by using self-assessments and automatically created keyword profiles. Since the self-generated profiles present "yellow page"-like data (contact information, organizational status information, formal qualification, main interests asf.), the automatically created keyword profile is generated by an analysis of documents and folders, which are assigned for this analysis by the individual users. Intelligent search mechanisms allow for the generation of a sorted keyword list, which is ordered by the frequency of the individuals' keyword usage in their documents. That keyword listing can be edited by the individual user and then be published in the system. Therefore, no documents have to be made accessible to others to provide structured data concerning the individual's work practices and expertise. Furthermore, no information is distributed without prior authorization from an individual user (Reichling et al., 2007).

To foster cooperation within the regional media and IT industry in Siegen-Wittgenstein it is planned to introduce the ExpertFinding framework to map the expertise and competencies of companies, instead of individuals. Each regional IT company would be able to create its own "yellow page"-profile and to assign official documents (which might be published already elsewhere or which are not published before) for an automatic keyword analysis. After editing the resulting keyword list, the company can publish the data in the system. Users of the ExpertFinding framework can search for certain keywords and compare their own profiles (the yellow page-profile as well as the keyword-profile) with that of other companies. Intelligent matching algorithms allow users to find companies that are similar to the own company's profile.

According to thirteen interviews with regional IT managers, an improvement of the regional marketing of products and services is expected by some of the interviewees. They consider the ExpertFinding framework a supplement for companies' Web sites, leaflets, and call center activities. Some managers stress the importance of the regional market for their business. They attract their regional customers by maintaining a good reputation and through references communicated mainly in personal networks. Especially very young companies (start-ups) seem to expect improvement by the application of the ExpertFinder. They hope for a quicker and better integration into the regional market.

Other managers stated that their marketing is not focusing on the regional but on national or international markets. These actors expect the main effect of an expertise finding system to be support for regional cooperation with other IT companies. Furthermore, they see advantages of regional cooperation in the reduction of costs (e.g., travelling expenses) and more effective cooperative relations.

However, other interviewees are skeptical with regard to the ExpertFinder. They state that their knowledge of the regional companies and their competencies is quite good, and therefore, they do not need support for regional expertise awareness. Others are rather critical with regard to regional competition. They are worried about giving away information to competitors.

Obstacles to Regional Learning

While the description of the regional networking process has focused so far on the overall achievements, we also encountered considerable problems and setbacks.

In the beginning, it was difficult to identify companies whose practices were related closely enough to the ones of the IS group at the University. Since user orientation does not have a strong tradition in the computer science curriculum at German universities, the importance of this set of practices was not fully understood by some of the regional software companies. As a result, some of them felt little motivation to engage with the IS group. Others did not have fitting expectations for how to match practices. For instance, in the first instance of the CiP one of the companies defined the project tasks in a way that pure implementation work had to be conducted by the student team. The company wanted to realize an awareness feature within an online community system. Though the IS group's research agenda dealt with the design of community ware, the company just asked the student team to implement a specified feature without conducting a requirements analysis or evaluating design alternatives. They seemed to be more interested in cheap student labor than in (mutual) learning at all. Thus, it took time to identify fitting practices within the local software companies and to adapt mutual expectations.

When trying to establish the funded networking projects, we found that the development practices among different regional companies varied considerably. This was due to the fact that many of these companies worked in rather distinct market segments and based their development on different tools and platforms.

To secure shared practices among the CEOs involved, we focused the joint networking activities around management practices in the software industry, which seemed to be more comparable among the different firms.

Even if fitting practices can be identified, the different actors need to accumulate sufficient trust to open up for boundary spanning processes. In the case of CiPs, in two instances companies defined projects that were only peripherally important to their core business. Their engagement in taking care of the students and offering opportunities for enculturation was rather limited in these instances, as well. On the side of the students, such an attitude limited their readiness to engage fully in the project. Moreover, in one of these cases doubts came up whether one of the companies would act fairly towards their students. During a first meeting with the university supervisors, one of the participating students mentioned that the company still owed him money from an earlier student job. Therefore, he clarified in the meeting that he would not participate in the team that was supposed to work in this company. While he participated in the teamwork with another company, his remarks left traces in the other student team's readiness to acculturate into the company's CoP.

Building trust is a crucial activity during the first meetings of a networking project. In a first meeting, the participating CEOs were rather reserved with regard to talk about their problems and issues to be addressed in the project. This attitude changed in the course of the next meetings, however, to different extents among the actors.

During the networking project, we also found that certain companies, while active in the networking process, did not want to be seen as regional players. Two of the larger SMEs delivered software and services to clients all over Germany. They did not want to be perceived as regional players. Therefore, we avoided setting up a Web site for the regional networking process. Thus, it is important to respect the specific identity and self-concept (Tajfel, 1982; Tajfel & Turner, 1986) of the different actors within regional networking processes.

The networking efforts took place in a social world that was shaped by historical processes predating our activities. At different occasions, it turned out that historically caused animosities prevented us from bringing actors together. For instance, when organizing the first ESF consortium among regional software and media companies, two competing Web agencies would not enter the consortium jointly. When investigating this issue, we learned that the CEOs once worked in the same company and separated in a move which was mutually perceived to be hostile. We perceived similar phenomena when setting up another workgroup on HDTV and iTV: The head of the regional economic board was formally member of the group. However, he never showed up due to the fact that he and the local entrepreneur were competing for influence in the region's parliament where they represented different political parties.

The networking activities in the software and media industries were also competing with activities in other industrial sectors. When the first application of the ESF project failed, it became clear that the regional administration had decided in favor of actors from different industrial sectors. Since he was not made aware by the regional authorities with regard to such a potential competition, the second author was strongly disappointed with regard to the application's outcome. Since he felt betrayed to some extent, it paralyzed the networking activities for several months.

The experiences and observations mentioned above show that action research interventions in regional industrial settings have to take into consideration historically evolved structures and relations between different actors. Most of these partly conflicting relations and competitive structures are not known to researchers as new actors in the field nor discussed openly. Speaking in terms of SC, trust-building in regional networks does not starting at point zero but can rely on "bridging" social capital. However, one has to anticipate the negative effects of "bonding" SC, as well (Cohen & Prusak, 2001; Portes, 1998; Putnam, 2000).

Discussion

The aim of the different interventions described in this chapter was to increase the level of social capital between university and regional industries as well as to establish RNoPs amongst regional software and media companies. Given the historically evolved different forms of capital already owned by the companies and actors, it was necessary to invest a significant amount of symbolic, cultural and economic capital as well as communicative resources to trigger and foster the establishment of trustful relationships and the building of networks among the different regional actors (cf. Bourdieu, 1985).

The activities of the Siegen IS group, described in Sect. 4, can be seen as work directed towards the accumulation of capital in the regional setting. In the beginning of the process, none of the members of the research group had lived in the region before or knew any of the important regional actors. Thus, the IS group's activities, especially the ones of the second author, were directed towards raising its social capital in the region. Therefore, other forms of capital needed to be invested to gain and increase social capital.

There were mainly two strategies employed. First, the second author aligned with actors who already owned a considerable level of social capital in the regional software and media industry. The cooperation with the head of the regional coordination unit is the best example of this approach. Secondly, the second author applied symbolic and cultural capital to increase the amount of social capital. In the eyes of regional actors his symbolic capital mainly consisted of (a) being a professor of the university and (b) being additionally aligned to a widely known research organization, the Fraunhofer Society. Symbolic capital played an important role in attracting regional actors to engage with his group. Cultural capital, in the sense of the IS group's expertise, played an important role in maintaining once established relationships with regional actors.

While symbolic, cultural and economic capital can be used for investment to increase social capital, the newly accumulated social capital improved the reputation (symbolic capital) of the university IS group. Since the standing of research groups at residential university is dependent on successful networking with regional actors, trustful relationships and good cooperation with regional industries helps to improve this standing.

However, the regional structure of practices and partly conflicting interests of major actors restricted this approach to expertise sharing. As it was mentioned above, it turned out to be a challenge to identify companies whose practices were closely enough related to each other and to the ones of the IS group to initiate networking in the sense Brown and Duguid (2000a) and Duguid (2003) postulated as crucial for expertise sharing. Some of the involved companies worked in domains that did not focus on human computer interface design and therefore were not interested intrinsically in issues of human centered computing. To find common practices, communication and processes of mutual learning between the university and IT companies were necessary. When building the RNoP secondary business practices (such as marketing and managerial activities) were more likely to offer common ground than the companies' core business practices.

One precondition for expertise sharing within regional networks is mutual awareness of others' expertise. Our investigation into regional cooperation structures led us to the suggestion that this awareness could be supported through technical means. The introduction of an ExpertFinder allows for the generation and matching of companies' competence profiles, which was assessed to be helpful for increasing awareness of regional expertise (Reichling et al., 2010, 2008). Such a system can probably also foster the identification of similar practices and the building of new cooperative structures at the organizational level.

In the near future, the expertise sharing within regional networks will be supported by technical means as well. The introduction of an ExpertFinder to enable the generation and matching of company competence profiles with similar firms was assessed, and shown to be helpful for increasing awareness of regional expertise. Such a system can probably foster the identification of similar practices and the building of new cooperative structures.

Implications for Research

Our work has brought up some wider applicable implications for the action research approach applied in a regional networking context:

- From an action-research perspective interested in regional learning, it is important to deconstruct social systems to understand boundaries, which could act as potential barriers to expertise sharing and the establishment of RNoPs.
- We assume that practice, in the sense of socioculturally embedded bundles of related activities, is an appropriate concept to base analysis and interventions upon. So, CoPs, and RNoPs seem to be appropriate as basic units of analysis, if focusing collaborative learning on regional industry networks.

Starting from these conceptualizations, we assume that interventions should aim at linking existing CoPs by establishing or fostering RNoPs. To encourage regional learning within certain NoPs, these interventions need to increase the level of social capital, in a communitarian sense of that term (Bourdieu, 1985; Coleman, 1988; Granovetter, 1985). The interventions should be aimed at the establishment of social relationships among actors of particular regional CoPs and NoPs.

To gain an appropriate understanding of regional structures and of reproduction these socio-territorial units, the concept of SC can be helpful to analyze a broad variety of social processes:

- These processes of social closure can lead to an extreme emphasis on the regional identity, which makes it quite unlikely that an "outsider," who is a new player in the region, will be accepted by the existing regional communities at all (cf. Cohen & Prusak, 2001; Portes, 1998).
- The accumulation of social capital by a new actor in regional social structures can be analyzed through the investigation of investment in other forms of capital (like symbolic, cultural and economic capital) for trust-building (Bourdieu, 1985). Although the study presented focuses on social capital mainly, the ownership of other forms of capital seemed to be an important facilitator for the accumulation of social capital in the regional networks and communities.
- In the presented case of the fostering of RNoPs, initiated by an academic actor, it was important to refer to SC as an individual resource rather than an collective good, as it is looked upon, e.g., by Putnam or American communitarians. This more individual-centered perspective seems to be more appropriate for the initial phase of social capital building and the personal engagement of certain actors (e.g., the academic researcher or a particular local authority). The more inter individual, collective perspective of the communitarians might be more promising for the analysis of a collective practice than for an existing community.

However, investigation into the processes of regional learning requires other theoretical approaches. Although both theories refer to human actions and the concept of practice, sociocultural theories of learning (esp. Lave and Wenger's concept of CoPs) seem to be more appropriate for understanding the conditions that foster or hinder processes of social learning. The CoP approach refers directly to common practices and shared histories of learning to differentiate between communities. Therefore, for the understanding of collective processes of expertise sharing and the building of RNoPs, the approach of Lave and Wenger (1991) seems more appropriate.

While the successful mutual and collaborative learning of regional industries can be explained better with sociocultural theories of learning and the CoP approach (Lave & Wenger, 1991; Wenger, 1998), the failure of and obstacles faced by regional learning projects might be better understood through the lens of SC; which proved to be helpful with the analysis of social closure and processes of social accentuation between communities. Furthermore, the investigation into the transformation processes of different forms of capital seems to explain the accumulation of social capital as a central precondition for the establishment of regional NoPs. The two sets of theories (SC and the sociocultural inspired CoP approach) were helpful in gaining insights into (1) the successful/non-successful personal impact on building up social capital in regional networks and (2) the collaborative learning of and in regional NoPs. Understanding the involved dynamics and applying the discussed theoretical approaches would help CSCL at Work research to better focus on networking structures in regional industries.

Conclusion

The creation of SC offers opportunities for regional leaning across organizational boundaries. Based on a theoretical understanding of SC and sociocultural theories on learning, the IS group of the University of Siegen attempted to facilitate regional learning in IT industries through interventions such as informal meetings and talks, a series of networking events (Lyz Media Breakfast), the didactic approach of courses in practice (CiP), and conducting an ESF-funded networking project involving several IT companies. Following an action research approach, the empirical evaluation of these measures showed achievements and shortcomings of the attempt.

The close cooperation with local authorities and the collaboration with the respected Fraunhofer research center helped to accumulate social capital within the region and to trigger networking of different IT companies successfully. The CiP approach led to trustful relationships and cooperation between the university IS group, IS students, and several software companies. In an ESF-funded project, four software and media companies did not cooperate with each other with regard to their core businesses but with regard to their marketing and management practices.

On the other hand, the program for facilitation of RNoP faced some obstacles: Certain regional actors were rejected by others when building up network structures. Due to historically evolved, personal animosities and structures of competition, some networking attempts failed. Furthermore, egoistic strategic actions and opaque communication behavior of single actors led to conflicts and set backs in the trust-building process. Since the university started its active role in existing networks in the region for the first time at the start of this project, a reasonable amount of initial investment was required by the university actors to understand the social dynamics and to be accepted by regional IT companies. Differences in practices between IT companies and the IS group hindered learning through enculturation during the CiP program. Limited resources (in terms of economic capital) led to competition among different industrial sectors with regard to publicly funded networking projects.

Summing up our experiences and the empirical findings, theoretical approaches of SC and sociocultural theories of learning offer potential for the analysis and increased understanding of regional social networking and learning processes. The program for the facilitation of regional learning in NoPs of IT companies was motivated by the assumption that expertise sharing between regional software and media companies might lead to advantages for them in competition with other regions' companies, especially with regard to national and global markets (Porter, 2000).

Residential universities are regional actors that could play an important role in the process of regional learning and the building of RNoPs. The experiences of the presented case in the German region of Siegen-Wittgenstein show that regional networking can be an appropriate means for fostering regional learning. Although the Siegen-Wittgenstein region did not offer an interconnected local IT cluster, the interventions by the university's IS group and the regional authorities led to cooperation in which mutual learning between different software companies took place. The technological support of these cooperation structures through the introduction of an ExpertFinding Network is planned and will be evaluated in further research.

The presented case of establishing RNoPs among IT industries describes a university-driven attempt to foster regional exchange of expertise. Due to their particular forms of capital, universities can play an important role in this process. However, processes of networking and enculturation require substantial efforts from regional companies as well as from university actors. Mutual trust between regional companies and academia need to be built over time through cooperation in various regional activities (cf. Fischer et al., 2007).

From an academic point of view, the case indicates that the concept of "regional learning" can contribute to the development of the CSCL at Work discourse. It can be investigated with concepts already key to the CSCL community more broadly construed. Engaging with local industries can help researchers to gain insights into facilitating and hindering conditions for regional learning and foster the development of concepts. Thus, an action research approach may be methodologically fitting to investigate into this specific domain of CSCL at Work.

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Chapter 5
Work Based Learning: A Structure for Learning Through Work

John Mumford

Introduction

Work based learning is a concept that derives from the proposition that the workplace is a place of learning and that this learning has academic validity, but that this validity can only be demonstrated if the learner produces appropriate evidence that learning has occurred. It is an attempt to raise the status and recognise the importance of learning in the workplace by viewing it through the quality control lens of university campus education. It can be regarded as part of a continuum spanning campus based university programmes and employer led workforce development. Importantly, it attempts to make the tacit learning from everyday workplace experience explicit and accessible to both the individual and the organisation.

In this chapter we examine some of the forms of structured learning undertaken by those in high pressure fulltime jobs and review the underlying learning theory. At one extreme we look at the experience of individuals in full-time employment who undertook part-time university degrees in their "spare" time and used their work experience as the subject matter in these part-time degrees. In these cases the university managed the learning and the employer contribution was often minimal. At the other extreme we observe the experience of senior managers going through staff development courses and other developmental interventions in a large multinational company. In this case the employer managed the learning and the university contribution was more peripheral. The common factor in all the cases is that the learners were in full-time employment and the workplace provided the context and motivation for the learning.

But before reviewing these cases we define what we mean by work based learning and discuss why it has emerged as a topic of interest.

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What Is Work Based Learning?

The term "work based learning", as explained by Costley (2001), is part of a cluster of concepts, including "lifelong learning", "employability" and "flexibility". Unwin and Fuller (2003) concentrate on learning in the workplace as opposed to work based learning:

- "The term 'workplace learning' is used to embrace all types of learning which are generated or stimulated by the needs of the workplace including formal on-the-job training, informal learning and work-related off-the-job education and training" (Unwin & Fuller, 2003, p. 7 cited in Evans & Kersh 2006, p. 4).

Boud and Symes (2000, p. 14) (cited in Evans & Kersh, 2006, p. 4), take this further by making a distinction between these two terms:

- "Work based learning needs to be distinguished from workplace learning, that form of learning that occurs on a day-to-day basis at work as employees acquire new skills to develop new approaches to solving problems. No formal education recognition normally accrues to such learning, whether or not it is organised systematically".

The Universities Vocational Award Council attempted to bring clarity about what work based learning involves and the contexts in which it occurs:

- "It is evident there can be no single or simple definition of what work based learning entails beyond the notion that it is about learning (not teaching) and occurs in the workplace (rather than on campus). As such, *work based* learning can, and should be, distinguished from the notion of *work related* learning; the latter, in the form of vocational programmes, is designed to prepare people for employment which often includes employer-determined competencies, e.g. national occupational standards, and does not necessarily require significant areas of the curriculum to be completed in the work place itself. Neither should it be assumed that work based learning in the higher education context is specifically about training; work based learning may take many forms and be undertaken for a number of different purposes; it is not restricted to performance-related learning in a narrow sense. Instead, the emphasis is on identifying and demonstrating learning that has occurred through work based activity, wherever and however this may have been achieved" (UVAC, 2005).

This position is underlined by the Higher Education Academy's guide to learning and employability:

- "It is not necessarily the experience of work itself that is paramount—rather it is the learning that an individual derives from that experience of work and from reflecting upon it. A government-sponsored review recognised that work based learning could take many forms including a full-time undergraduate undertaking a work placement planned as part of the curriculum; a full-time undergraduate doing a part-time job; a full-time employee seeking to explore work focused and work-related issues in the context of the knowledge, skills and values of a higher education institution. The common factor linking these forms was that the individual would be doing a job of work, or would be undertaking a work role" (Little & ESECT, 2004).

Some would claim that work based learning is an emerging discrete university subject which is taught, studied and researched, "a field of study", (Gibbs & Garnett, 2007, cited in Garnett, Costley, & Workman, 2009, p. 3) in its own right. It is not a traditional part-time course undertaken whilst at work but rather "the demonstration of your ability to reflect upon your skills, knowledge and approach to your work, often called your 'professional practice.' In some situations, learners will develop occupational competence *alongside* the WBL programme and this is usually assessed separately by the employer" (Durrant, Rhodes, & Young, 2009, p. 2). This separation of work based learning from occupational competence suggests that it is how you learn rather than what you learn that is the distinguishing feature. The subject matter of the learning is whatever has and can be learnt at work by carrying out the job. In this respect, a job is defined as follows:

- Paid full-time or part-time employment.
- Unpaid work, which could include voluntary work or working for a family member.
- Self-employed work and business ownership.

In short, 'work based learning is for anyone who is regularly engaged in work (or undertakes periods of contractual work sufficiently long enough to complete a programme of study), whatever the nature of that work.' (Durrant et al., 2009, p. 19). However, confusion remains over work based learning terminology for employers and higher education, and as a result it is recognised as essential that a common language is established: "… it is critically important to establish a shared understanding of the particular area of focus from both an academic and employer perspective, irrespective of the terms used" (Nixon, Smith, Stafford, & Camm, 2006).

In this chapter we apply the term to people in full-time employment going through a managed learning process which uses their work environment as the context and motivation for the learning.

Why Is Learning in the Workplace Important?

The rise in interest by UK universities in work based learning over the last decade or so can be seen in the context of the political desire to up skill the country's workforce. The migration of jobs to developing countries is seen as an inevitable consequence of the globalisation in the last quarter of the twentieth century.

A key feature of this globalisation is the growing interdependence of countries world-wide through the increasing volume and variety of cross-border transactions in goods and services, and also through the more rapid and widespread diffusion of technology through the knowledge economy. Towards the end of the twentieth century a belief emerged that economically advanced countries could sustain their superior standards of living only if they focused their economies on the higher valued jobs that could be created in this knowledge economy. Thus, education and workplace skills became seen as a key enabler of economic success. These views were echoed by the Institute of Directors: “Education and skills are crucial ingredients for business success. Businesses need to have an educated and skilled workforce in order to enhance their productivity, quality of service and overall competitiveness. Business success is important because it can result in employment and wealth creation and so contribute towards financing the public services through taxation” (Wilson, 2006).

In 2009 Mandelson, the Secretary of State for Business and Universities reaffirmed these themes: “the modern global economy puts a premium on specialization. It is an economy of supply chains and niches. The sectors in which British firms have potential comparative advantage in the next decade—low carbon, digital communications, life science, the creative industries: these are all absolutely reliant on high levels of knowledge, of skill and innovation. They will also draw heavily on our capacity for research and our ability to commercialise it. So our universities are inescapably central to our economic future” (Mandelson, 2009).

In this setting, learning is seen as an essential, integral and ongoing feature of working (Brennan, 2005). This is reflected in the Department for Education and Employment Green Paper (1999) which highlights the rise of the knowledge economy, or the learning society. Brennan argues, in this version of human capital theory, that intellectual capital has become critical to economic success. This approach focuses on the importance of knowledge creation, and the application and manipulation of “new” knowledge in the workplace. Garnett describes it as follows: “It is intellectual capital that is the true measure of the wealth of an organisation. The importance attached to the concept of intellectual capital is indicative of a revolutionary shift from the company as a place of production to being a ‘place of thinking’. At one level this could be thinking to improve what is it being done or at a deeper level a fundamental change in what is being done” (Garnett, Costley, & Workman, 2009, p. 226).

However, Garnett suggests that knowledge can only have a value to the organisation if it contributes to the aims of the organisation. This “places an emphasis for the organisation on identifying, utilising and measuring the performance of the value of knowledge” (Garnett et al., 2009, p. 228).

Learning in the workplace must therefore accommodate the production and dissemination of new knowledge. The review of training packages in Australia (Australian National Training, 2003) suggests that the production of new knowledge within organisations and enterprises is different from the knowledge outlined in traditional subjects or disciplines, and common in educational and training programmes.

New knowledge is high in use-value for the enterprise or organisation. Its deployment has immediate value but, as it is context specific, its value within the enterprise or organisation may be short-lived. New knowledge is not foundational and cannot be codified into written texts such as competency standard descriptions, procedural manuals or textbooks; rather it is constructed within the context and environment of the immediate workplace. New knowledge is therefore rarely the product of individuals but is constructed through collaborations and networks that exist within specific sites and particular contexts.

Brennan (2005) reasons that this new knowledge is conceptualised as practical, interdisciplinary, informal, applied, and contextual rather than theoretical, disciplinary, formal, foundational and generalisable. Learning in the workplace no longer equates with the "application" of knowledge from outside the work context, but instead, the workplace itself is seen as a site of knowledge production. The application of skills previously learned outside the work context may no longer be sufficient. Thus, work based learning differs from traditional university award courses in that it:

- Does not rely on the intervention of institutionally based teachers or organisationally based workplace trainers.
- Is structured around pre-determined vocational outcomes.
- Is not determined by qualification frameworks and endorsed training packages.
- Is not guided by specific content.
- Is not organised around traditional academic disciplines.

Instead the main characteristics of work based learning, as identified by Brennan (2005), are that it:

- Is context bound, and driven by specific and immediate work requirements.
- Emphasises learning over teaching or training as a defining characteristic.
- Depends on the responsibility for learning being spread between a number of people within the workplace.
- Is consistent with new learning concepts such as learning networks, learning organisation and communities of practice.

These characteristics suggest that work based learning inevitably involves some form of collaboration between employers, employers' organisations, workers, and both further and higher education providers. It resonates with concepts of lifelong learning and the importance of continued training, individual personal and professional development and workforce development.

Relating Collaborative Work Based Learning to the Concept of Organisational Learning

Our understanding of organisational learning is based on a number of tenets.

- An organisation is a group composed of specialists working together on a common task, and its function is to make knowledge productive (Drucker, 1993).

- Behaviour in organisation is based on routines (Cyert & March, 1963). Organisational actions are history dependent (Lindblom, 1959).
- Organisations are target oriented (Simon, 1955).
- Knowledge always stays with the individual and a social process is needed between individuals so they cooperate in making their knowledge explicit (Nonaka & Takeuchi, 1995).

The individual leaving the world of full-time education and entering the world of employment transfers from a context which focuses on the capability of the individual to an environment focused on group performance. The individual becomes a specialist contributing to a group working together on a common task(s), and does so by making his/her knowledge productive for the group as a whole (Drucker, 1993). The individual in this work context, consciously or unconsciously, accumulates personal knowledge because it is of value to the group. Possession of this knowledge also becomes a source of personal competitive advantage (Nonaka & Takeuchi, 1995). Immediately then a tension emerges between the needs of the individual and the group. However, these knowledge workers cannot be forced to share their knowledge (von Krogh, Ichijo, & Nonaka, 2000). Consequently, organisational or group learning requires a process whereby individuals are enticed to share their specialist knowledge.

These organisational learning models characterise organisations as socio-technical systems comprising collective participation by individuals and groups (Argyris, 1992). They presume that stability of shared understanding is important for organisational efficiency and survival (March, 1999). However, organisations compete for survival and this competition manifests itself as a drive for innovation resulting in new products and services. Leaders in organisations are exhorted to have new ideas and induce change; however, most new ideas are bad ones (March). Thus, this form of innovation creates conflict and resistance to change and may itself be caused by conflict (West, 2000).

Theories of organisation emanating from the Tavistock Institute tradition, such as open system theory (Miller, 1993), propose that behaviour within organisations can be interpreted as a manifestation of tensions between groups in a system of interacting groups. Organisations respond to threats by defensive repertoires such as protection of task and technical rationalism (Argyris & Schon, 1978). They create secret knowledge which defines membership of the group and excludes outsiders. Mechanisms predicted by both organisation systems and organisation learning theories for an organisation under stress (Miller, 1993; Schon, 1983), lead to what Argyris and Schon (1978) describe as Model I “behavior where actors have to justify their actions with technical rationality”. Protective mechanisms encourage people to keep their views private (Argyris & Schon, 1978). The expected impact of such behaviour is that ideas which cannot be expressed as logical extensions of existing knowledge are quickly “filtered out”; this phenomenon is often referred to as “institutional lock”. Once decisions are formed they cannot be reconsidered even though new information may challenge the decision (Gregory, 1988).

The legitimate push for rational thinking in an organisation can thus become a major obstacle to creativity and innovation. So the need to constantly justify ones belief in front of others inhibits knowledge creation (von Krogh et al., 2000). In addition, individuals dread incompetence and behave according to organisation defence routines, not as individual personalities (Argyris, 1992). Knowledge creation thus requires an enabling context which overcomes these defence routines. Knowledge creation in the workplace beyond the individual needs a micro-community of knowledge which develops its own rituals, language, norms, and values (von Krogh et al.). This phenomenon is cited in many of the case studies when referring to learning support arrangements where networks and learning communities are highlighted as key components of knowledge exchange.

It is therefore not surprising that the major part of any organisations formal training budget is spent on behavioural alignment and change management. Organisations frequently use their training function as a means of intervening in the learning of their staff in order to break this institutional "lock", introduce and embed change as well as encourage innovation. In addition, there are often company "entry to work" training programmes (e.g. apprenticeships) which teach some basic skills. However, as we shall see in the case study of employer led staff development, for those already in work the interventions tend to be stimulations to learning rather than teaching, in the traditional university sense. They are focussed as much on getting individuals to share their own learning with each other as they are on enabling the individual to acquire new knowledge.

The learner in full-time employment is part of a process designed to promote organisational learning, but may feel blocked from processes that promote individual learning. In the following section we look at case studies where individuals participate in university programmes as an adjunct to their full-time employment. In some cases the employer is very involved in the design of the programme that the learner undertakes and the individual is sent on the programme by the employer as a form of staff development. However, we also see a number of instances where the individual felt their development was "locked" in their workplace and the individual turned to university courses looking for a learning experience that was independent from the employer.

Case Studies Involving University Courses

Roodhouse and Mumford (2010) in *Understanding Work Based Learning* give details of 12 case studies covering the experience of individuals who undertook degree level programmes while working full-time. These were presented as examples of individuals in the knowledge economy seeking higher education as a form of higher level progression.

The case studies were gathered together by approaching universities noted for work based learning and asking them to volunteer students who had completed accredited programmes while working full-time. Not surprisingly the cases clustered around conventional part-time courses, with a combination of classroom and distance learning. These are the longer established forms of work based learning.

Table 5.1 Case characteristics (foundation degree is an award at level 5 introduced by the UK government in 2002 which integrates academic and vocational learning. It equates to two-thirds of an honours degree in terms of credits)

Case	Type of workplace	Workplace role	Course
1	Small business	Managing Director	MBA
2	Police force	Operations Manager	MBA
3	Supermarket chain	Dot-com Training Manager	M Phil
4	Major oil company	Country Vice president	PhD
5	Civil service	Internal Audit Manager	Hons. Degree
6	Regulatory authority	Care Commission Officer	Hons. Degree
7	Training company	Director of Learning	PhD
8	National Health Service	IT Operations Manager	Foundation Degree
9	Local authority	Children's Services Manager	Masters
10	Children's playgroup	Leader	Hons. Degree
11	University	Lecturer and trainer	Masters
12	Restaurant chain	Store Manager	Foundation Degree

Although the learners represented very diverse backgrounds, they all came with significant workplace experience. There were no learners who were new in the world of work. Again this is not surprising. University admission procedures tolerate those without entry qualifications who have deep workplace experience, but are stricter with those who are new to work (an issue for those who are trying to progress through apprenticeships). These cases were characterised as follows (Table 5.1).

In compiling the cases the learners were given free rein to say what they felt and as the case studies demonstrate, to focus on the issues they felt were important. The cases are narratives by learners expressing what it feels like to be working full-time and doing a university degree. However, the volunteers were given some headings to guide them:

- What was the learner situation?
- Why did I decide to do something like this?
- What were the barriers to learning?
- What sort of workplace environment was I coming from?
- What supplements and tools did I use?
- Did capturing workplace experience work?
- Did the assessment method work?
- What was the outcome and what were the benefits?
- How much did it cost and who paid?
- What are the lessons learned?

The full narrative is contained in "understanding work based learning" (Roodhouse & Mumford, 2010) and much of it deals with the effectiveness of the university role. However, the interest here is the nature of the learning and the importance of collaboration in that learning. In this respect there were four different types of learning cohort:

1. A learner working on his/her own under the guidance and support of a university tutor and using his/her workplace colleagues as a source of data for his research, for example case 4.
2. A group of learners from different organisations meeting each other physically every week for seminars at the university and collaborating in the execution of study assignments, for example case 1.
3. A group of learners from the same organisation (but not the same work team) meeting physically each week for seminars at the university and collaborating in the execution of study assignments, for example case 2.
4. A group of learners from the same organisation (all from the same peer group but not necessarily the same work team) meeting at the company's own training centre for week long residential training programmes and collaborating in the execution of study assignments in the interim periods between events at the training centre, for example case 12.

Interestingly there were no examples of a learning cohort which was an existing work team, a situation which contrasts with employer led training programmes, examples of which are discussed later in the chapter. However, it was evident from the learner narratives that the learning cohort had formed itself into collaborative group and was behaving like a work team when conducting assignments. Indeed, there were many examples of the learner cohort taking collective control of the programme and intervening when the university was not delivering to expectations. This was seen as a clear indication that the learner cohort was behaving collaboratively, despite the diversity of background and limited face-to-face contact.

The learning process in all these case studies was highly structured. The process started with all the normal enrolment procedures of a university programme and attendance at an induction event. In nearly all cases the learner became part of a cadre of students doing the same programme simultaneously. In all cases there was an academic tutor appointed to guide the student and in all but one case the academic contact time in the programme took place on university premises. Hence, although the subject matter of the learning was the workplace, the learning was stimulated and managed in an environment separate from the workplace. Importantly the collaborative aspects of the learning were not centred on the people the learner was working with in the workplace (the locus of their workplace experience). The collaboration was taking place with a group of individuals who had stepped away from the workplace environment to do their learning.

This observation might suggest that the learning was not motivated by workplace needs. However, this was not the case. The learners were predominately people looking for progression in their careers. In none of the cases was the learning motivated by a non-work oriented purpose and importantly none of the learners were thinking of changing employer or career. Some were undergoing employer sponsored programmes but the majority were self-motivated and doing something on their own initiative. So people were leaving their own workplace to mix with others from different workplaces and, through reflection and analysis about their own workplace, learn things beneficial to their current jobs. What is more there was strong evidence that the process had delivered these benefits. Universally, the people in the case studies were very pleased they had undertaken the learning and felt they had benefited both in terms of personal esteem and career prospects. Moreover, one of the main areas where people derived value was the interaction with other members of a learning cohort and the interaction with the university tutor. Although people may have been learning in their work environments, it was the structured learning interactions in the university environment that exposed this learning and made it accessible.

However, the quality of this learning management was not universally good. In most of the case studies the facilitating role of the tutor was a powerful enabler of learning but there were other examples of poor support. In some cases the cohort of learners found itself in conflict with the lecturer over what was important, and effectively took over the running of the classes. In others the university kept swapping the lecturers leading the programme and again the learners had to take charge in order to keep the programme running. Mutual support between cohort members at difficult moments also featured strongly. A strong sense of programme ownership by the learners was evident in all the cases.

A key differentiator of this type of learning is that it is drawn to a conclusion after a pre-set period of time with a formal assessment. In a normal work environment one would expect one's competence and achievement to be assessed on the basis of observation of work undertaken for a work purpose. Achievement of the work purpose on time and on budget would be considered the prime evidence in this assessment. Work based learning assessments by universities attempt to emulate this by assessing work done in the context of the learner's own work environment. However, in order to be assessed the learner has to create evidence which would not normally be required in the workplace, be it a reflective essay or an academically structured piece of research. One might have expected people in full-time employment to regard this as an unnecessary imposition. However, this was not the case. Indeed nearly everyone felt that the assessment process was a key part of the learning. The feeling of success on getting through a rigorous assessment had given people confidence in their ability.

However, all commented on the sacrifices that had been necessary in order to go through the university programme. There were stories of getting up at 5 a.m. to do study preparation prior to going to "real" work and then having to participate in seminars or syndicate exercises in the evening after work. Nearly all commented that dealing with university administrative procedures was a source of frustration. There was a sense that university processes are built round the schedules of full-time students and fail to accommodate, or even recognise, the conflicting pressures experienced by those in full-time employment. The capabilities and needs of learners in long-term full-time employment are materially different from the capabilities and needs of conventional full-time students.

One important question for any form of work-based learning is the fit between the workplace needs and the learning process. Traditionally, large organisations managed their employees' learning as if they were cadres on prescribed career paths, and this ensured the learning was aligned with the workplace. The current norm, however, is for employees to take charge of their own career management and, in any event, most work for small organisations that have no capacity to manage careers. So did the case study learners fit this model of self-directed progression and did they direct their learning in a way that aligned with workplace needs? The evidence from the case studies was that workplace alignment depended on the learner making an appropriate choice of project work. Where the employer was not engaged in the choice of project work, there was often conflict between the university programme and the daily workplace demands that the learner had to manage. It was of key importance that the learners continually related what they are doing in the university to their current workplace objectives.

Case Study of Employer Led Staff Development

Over the period 1996–2008 the author participated in a number of company programmes where all managers at a certain level were put through managed courses. The company in question had been through a series of mergers and acquisitions, and there was a desire to homogenise the new management. The style of the company was very open and participative and it wanted processes that engaged rather than directed employees. The structure of the programmes was typically a cascade process where the most senior managers went through the programme first and then acted as coaches for the subordinates when they went through the programme. This process was designed to reinforce the leadership role of senior managers in relation to their juniors. It contrasted with many culture change programmes where junior staff are encouraged to break away from the behavioural norms of the existing senior management.

The programmes that were observed can best be described as interventions that took staff away from their daily job focused routines. The programmes for the most senior managers were often arranged as short sabbaticals at prestigious universities. Top academics, heads of non-governmental organisations and business leaders were used as lecturers in these programmes but the programmes were not accredited. The role of these lecturers was to create a “wow factor” to stimulate the managers’ interest and reflection. The courses for more junior managers tended to be managed in-house and held at hotels. Lecturers on these courses were drawn from company management. The author was involved as a participant in the senior courses and as a leader in the more junior courses. The distinguishing feature of these courses was that they were not necessarily part of an ongoing programme. They were planned as campaigns, each with its own specific learning and organisation development objectives. Some had relatively short lifespans such as just one cycle of delivery achieved in less than a year.

However, there were many other forms of organisational development intervention which had an important learning component. Presentations at routine meetings were frequently used as a way of making employees aware of developments in the company. The format of these was a PowerPoint presentation with accompanying notes.

A manager would give this presentation to his staff at a routine meeting having first heard it at a meeting chaired by his own manager. At each point in the cascade local context was added to increase the relevance for the staff present, and less relevant material was condensed. The effect was not only to inform but also to stimulate discussion about the implications for the local work environment.

Team meetings, which occurred either weekly or monthly, were by their nature managed networking events for a group of individuals with interacting roles. Despite attempts to make these events as informal as possible, team meetings assumed an air of formality where a manager, and other team members, would introduce topics that affected all present. But nothing very controversial was aired. These meetings were supplemented by frequent one-to-one conversations between managers and subordinates to consider performance and progress. These conversations could be much more frank and they covered topics such as work allocation, progression and skills needs.

Together these meetings and conversations formed a company sponsored form of networking between everyone in the organisation. However, it must be recognised that these team meetings were not the predominant form of networking between individuals. Emails and mobile phone calls formed a much greater part of the interaction between those with interacting roles. These interactions appeared to be ad hoc collaboration between those collaborating on a specific work task and not necessarily connected with any managed process. An analysis of the observed interactions suggested there were three categories of managed intervention:

- Those designed to increase the generic skills of individuals.
- Those designed to train individuals in company specific processes.
- Those designed to deploy the individuals to best effect.

Considering some examples of those that appeared to be designed to improve individual's generic skills programmes we see some elements of structure from formal education programmes (shown in Table 5.2). There are lectures in a classroom format and there is an emphasis on inspiring the individuals through exposure to new (to them) information. There is use of team building exercises to embed the learning which resonates with the use of case studies in academic programmes. The role of universities in these interventions is clearly to provide the impact of a prestigious university setting but there is also the introduction of academic content to add to the image that something mysterious and profound underpins what is happening.

However, there is no attempt to actually teach this content. The objective is that the individual broadens his/her outlook on life and uses this broadening to reflect on how they are doing their day job. Interestingly there is scant assessment of the learning achieved. In no instance is there anything that might be considered a programme assessment and in only one case was there an attempt to evaluate changed behaviour, and that was only through the routine staff appraisal system.

This is all the more remarkable when one considers that these were all very expensive programmes, involving high quality residential accommodation and prestigious lecturers. The organisation put all its managers through several programmes

Table 5.2 Programmes designed to improve generic skills (Mumford, 2011)

Manager of the future (externally run by a training company) • Theory lectures in a classroom format • Offline reading and preparation of coursework • Casework on live projects • External mentoring and support	Harvard/Stanford bespoke short programmes • Theory lectures in a classroom format • Inspirational talks from industry leaders • Closed learning community with company senior managers only • Expensive dinners and nice certificate at end
Culture change (internally run with external design and facilitators) • Theory lectures in a classroom format • Alignment workshops and team building exercises • Internal assessment through staff appraisal • Senior staff leading by example	Cambridge bespoke short programme • Theory lectures in a classroom format • Inspirational talks from thought leaders, e.g. the environmental campaigner Jonathan Porrit • Mixed learning community with public and NGO sectors • Company directors actively participating

Table 5.3 Programmes designed to embed organisation specific processes (Mumford, 2011)

Management framework introduction • Training in the new procedures • Alignment workshops • Staff appraisal of implementation in practice • Directors leading by example	Safety process introduction • Training in the new procedures • Mentoring • Staff appraisal of implementation in practice • Directors leading by example

each costing many thousand pounds per head and never measured whether any learning had taken place. Despite the fact some programmes were delivered by top class universities the individuals received no academic credit recognition. However, there is no doubt that the individuals on these courses were rejuvenated by the experience which broadened their understanding of their work. So the company and the individuals both benefitted.

Turning to examples of interventions which appear designed to embed specific training in company process (shown in Table 5.3) one sees that appraisal does come into play, albeit via the staff appraisal system. Here the nature of the learning experience is much more down to earth. The purpose is not to stimulate individuals into new ways of thinking; it is to ensure the company as a whole follows a clearly defined set of behaviours or rules. The idea is that the consequent uniformity of process across the company generates organisation capability. It is if the organisation is being taught to behave as a single individual. Learning outcomes thus become very important because the organisation has to monitor that the required behaviour is achieved. Also it is quite apparent that the training assumes that all individuals have the same learning style.

Whereas the programmes in Table 5.2 appeared to be designed to turn the company into an open network of highly skilled forward thinking individuals, the programmes

Table 5.4 Programmes designed to deploy individuals to best effect (Mumford, 2011)

Staff promotions	Reorganisations
• Assessment as part of placement activity	• Assessment of individual skills and past performance
• Coaching to gain new job skills	• Reassessment of job competency requirements
• Field visits and orientation exercises	• Team building exercises
• Performance reviews in new job	• Task-oriented teamwork

in Table 5.3 appear to be designed to turn the company into a body of conforming foot-soldiers.

Finally the interventions that involve deployment individuals (shown in Table 5.4) must be considered. It might seem odd to consider staff placement as source of organisation development, let alone learning, but actually much of the learning that an individual acquires during their work career comes from experiencing a variety of jobs and situations. Job rotation can be a powerful form of individual and organisation development as individuals gain a rounded understanding of the organisation in all its breadth and are stimulated by the range of experiences. Most of the staff appraisal and development discussions that were observed involved a review of the job change opportunities that might be available and the discussions explored what changes would benefit the individual and the company. Indeed there was a sense that those individuals who were stuck in the same job for many years had reached the zenith of their career and were not worthy of further development.

Reorganisations featured very frequently. Indeed, in some parts of the organisation there were major upheavals every year or two. The philosophy of this type of organisational change is that you unfreeze an organisation by uprooting people and changing job roles. The organisation is then quickly refrozen in a new structure which has improved capability. It is a fast process that, according to some, achieves effective change with minimum loss of productive output. It is in contrast to an approach which relies on the initiative of individuals and the natural flexibility in an organisation to achieve slower incremental change. The organisation in the case study believed that major upheavals were the way to maximise organisation performance. However, many staff came to regard their job roles as very temporary and found the repetitive cycle of threatened redundancies extremely stressful.

Although this type of intervention would not normally be considered as a learning process, many of the features that were observed resonate with learning management. All reorganisations, possibly because of employment law requirements, involved an objective assessment of the competence and capability of the individuals affected. The refreezing of the new organisation did not happen naturally and was nearly always facilitated by training programmes, individual mentoring, and team building events. However, unlike an education process, these processes were not aimed at enabling the individual to achieve their potential. They were aimed at putting individuals in job roles that were most appropriate for the organisation.

The assessment processes were being used as a selection tool not a development tool. The training programmes were aimed at aligning behaviours in the new work teams and embedding any new company procedures that were being introduced as part of the reorganisation.

In summary this case study shows that experiential learning in the workplace is punctuated by management interventions which are motivated by organisational development needs but promote individual learning by creating the opportunity for the individual to step away from the daily routine work tasks and reflect on his/her experience from different perspective.

Linking These Concepts

It is apparent that learning processes in an organisation involve a two-way diffusion of knowledge between the organisation and the individuals. Our interest focuses on structured interventions that stimulate explicit learning and promote diffusion of knowledge between the individual and the organisation. We saw in the case studies examples of processes led by employers and processes led by universities, and it was clear that the processes used by universities were very different to the processes used by employers. Indeed, some see a conflict between business management processes and the process of individual learning and go as far to suggest that organisational development processes suppress individual learning and creativity (Argyris & Schon, 1978; Hatch, 1997).

However, the competitive pressure in the knowledge economy should encourage managers to *promote learning within* their organisations. In our case studies the individuals and the organisations both benefited from the learning. So, perhaps this a sign that our understanding of learning processes in organisations needs further exploration? One common factor in our case studies was that the individuals were stepping away from their daily work tasks in order to reflect on their professional experience. Processes that promote reflection on workplace experience are clearly of value are clearly of value to both the individual and the organisation. Increasing interest in this area has certainly stimulated study and writing particularly about contextual knowledge and transfer (Evans, Guile, & Harris, 2009).

Kolb, Schon, Boud and Eraut are perhaps the key thinkers underpinning of our understanding of learning and knowledge transfer. Kolb developed the Experiential Learning Model composed of four elements:

1. Concrete experience.
2. Observation of and reflection on that experience.
3. Formation of concepts based on reflection.
4. Testing new concepts to create new concrete experience.

These four elements are the essence of a spiral of learning that can begin with any one of the four elements, but typically begins with a concrete experience. His model was developed predominantly for use with adult education, but has found widespread pedagogical implications in higher education.

Schön was largely responsible for introducing reflective practice which is a continuous process and involves the learner considering critical incidents in his or her life's experiences.

As defined by Schön, reflective practice involves thoughtfully considering one's own experiences in applying knowledge to practice while being coached by professionals in the discipline. He additionally argued that organisations and individuals should be flexible and incorporate lessons learned throughout their lifespans, now a well-established discipline in management and business studies, organisational learning.

Boud is interested in how people learn and the fostering of that learning through mechanisms such as problem-based and negotiated learning incorporating reflection and reciprocal peer learning. He has developed models for learning from experience and the role of those who intervene in learning whether or not they are identified as teachers. Problem-based learning (PBL) is a student-centred instructional strategy in which students collaboratively solve problems and reflect on their experiences. The characteristics of PBL are:

- Students work in small collaborative groups.
- Learning is driven by challenging, open-ended problems.
- Teachers take on the role as "facilitators" of learning.

Students are encouraged to take responsibility for their group and organise and direct the learning process with support from a tutor or instructor. How professionals learn in work place settings has been Eraut's focus. He found that most learning occurs informally during normal working processes and that there is considerable scope for recognising and enhancing such learning. As mentioned earlier, the current focus is on developing an epistemology of practice where knowledge is created and used rather "than codified" (Costley & Gibbs, p. 221, cited in Garnett et al., 2009).

One concept that is frequently used in discussions of this type of learning is "flexibility"; all organisations, including higher education are expected to respond flexibly and rapidly to labour market changes. Flexibility may require working in partnership or collaboratively with other organisations in order to achieve desired goals most effectively. With this drive to create flexible organisations has come a corresponding emphasis on flexible learning, within and across organisations, which includes different learning levels, contexts, and modes of delivery and assessment methodologies. As Garrick and Usher (2000) state: "Organizations are expected to respond flexibly and rapidly to market changes and a premium is now placed on the need for flexibility not only within workplaces but also between them. Within this context are located interlinking discourses of flexible organizations, flexible workers and a consequent perceived need amongst managers (at a range of levels) for flexible structures, modes and contents of learning to service these organisations and workers".

The need for this flexibility is reinforced by considering the economic and policy drivers in the workplace. The most significant of these structural changes can be summarised as follows:

- Increased use of collaboration such as outsourcing to manage non-core functions, whereby a number of individual firms collaborate with each other to manage production of an end product or service.
- Flattening of traditional bureaucratic hierarchies, creating fewer layers of management, with the consequence that, in many occupations, workers are required to take on broader responsibilities. In addition to technical tasks, workers then develop a wider range of skills in order to enable them to contribute to the strategic performance of the organisation by engaging in quality management, teamwork, and interpersonal and inter-organisational collaboration.
- Restructuring and downsizing as a strategy for maintaining flexibility in order to respond quickly to changing market requirements.
- A rise in non-standard work as a consequence of restructuring and downsizing as organisations seek to adjust the size and composition of their workforce in response to market requirements.
- Breakdown of traditional occupational demarcations leading to multi-skilling across all major occupations.

Structured support for learning in the workplace therefore focuses on interventions that allow the individual to see how what they are doing "fits" with the activities of others; in other words, culture building. As observed in the case studies, one typically sees:

- Employee orientation courses that teach the social norms of an organisation and explain the overall purpose of a company.
- Team building events where employees learn to interact constructively in challenging settings.
- Feedback processes that expose the employee to the views of peers, bosses, subordinates, clients and so on.
- Away-days where employees can reflect either individually or collectively on the workplace context.
- "Lessons learned" exercises at the end of projects or missions to disseminate experience in a way that is accessible to others.
- Training to ensure that the statutory obligations of the organisation are shared as obligations of the individuals.

These interventions are initiated and managed by employers as part of their human resource development process and respond to perceived business needs or gaps in organisational capability. The decision whether to initiate a specific programme is taken in the context of other business options and competing calls on the company's management resource. It's a business decision taken like any other business decision. The knowledge dealt with in the events listed in the bullet points above is very context specific and often only relevant to those participating in the event itself. They are usually regarded as quite private affairs.

It is clear that work based learning is related closely to organisational learning. Both link the capability of the individual with the organisational learning tenets described by March (1999). They also reflect the ability of the individual to create the

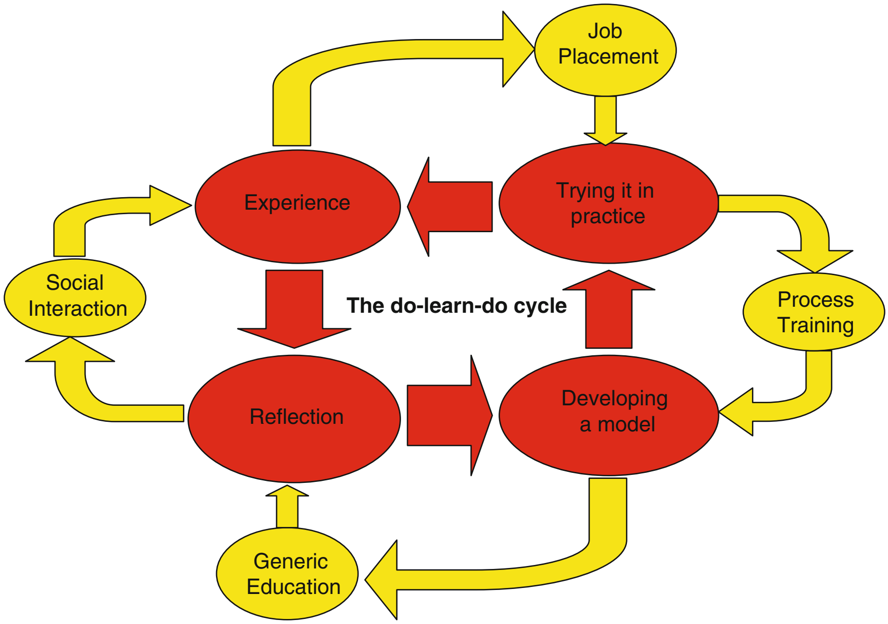

Fig. 5.1 The learning cycle with feedback interventions (Mumford, 2011)

social processes described by Nonaka and Takeuchi (1995). But although management interventions practiced in a work environment do not constitute what a university might consider a learning management, they clearly reinforce experiential learning. The routine management processes can be considered as reinforcing the experiential learning model by stimulating a cycle of trying something in practice, reflecting of the experience, and using that reflection to update ones mental models. For example

- Performance assessments provide a reality check on their current mental models of the work environment and encourage them to reflect.
- Training someone in a new routine procedure forces them to do things in a different way and adapt their mental models to accommodate the new procedure.
- Placing someone in a new job provides them with new things to try and hence broaden their experience.
- Team building and networking events provide a social interaction which allows people to compare experiences and reflect on others' experiences.

One can readily see in Fig. 5.1 how these fit the Kolb cycle, serving as feedback loops to reinforce whichever part of the cycle may be deficient.

However, the situation is less clear when one considers the measurement of learning. The case studies suggested that employees who broke away from the learning environment in the organisation to pursue university led programmes saw great benefit from the rigorous assessment of learning that these programmes entailed. This is reinforced by evidence from the annual HE at Work large company

Table 5.5 Comparing workplace and academic progression (Mumford, 2011)

Workplace progression ladder	Academic progression ladder
Follows laid down procedure with supervision	Works within a routine and defined context
Follows laid down procedure without supervision	Works largely within routine and defined context
Can supervise others following laid down procedure	Begins to work beyond routine and defined context
Can develop new procedures to deal with defined problems	Can apply defined methods to a defined problem
Can engage the organisation in implementing new procedures	Can identify elements of a problem and choose appropriate methods
Can deal with undefined problems and engage the organisation in implementing successful interventions to deal with the problems	Confident and flexible in identifying complex problems and applying appropriate knowledge and skills in solution
Can read complex and ambiguous situations and lead an organisation through the actions needed	Can demonstrate initiative and originality in problem solving, and can act autonomously in complex and unpredictable situations
Can deal with the paradox of power and manage multiple situations with different skills simultaneously	Can act independently with originality in problem solving and is able to lead planning and implementing at professional level

survey which confirms that those in full-time employment want to progress academically (Dunn, Mumford, & Roodhouse, 2008).

However, the evidence is that university assessment of employee skills is not something generally valued by employers. Performance assessment in the workplace is intuitively conducted by work peers and line managers, in a way that is both continuous and involuntary. In the world of employment there is an ongoing need to make a contribution in a work team that is valued by others and this need is central to the learning that takes place. Importantly, the work role automatically creates a social setting and competency framework. Academic learning may not fit this model and hence the assessments associated with academic learning are viewed with suspicion. However, it is interesting to compare the generic descriptors of job requirements in different levels of an organisation with the level descriptors in the Framework for Higher Education (Table 5.5).

In the workplace one progresses from an ability to work at simple defined tasks under supervision, through ability to work autonomously in increasing complex situations, to the ability to manage the paradoxes faced at the top management levels. In the academic framework one progresses from working within well defined routines, through understanding increasingly complex problems, to leading professional research activity. The interesting contrast is that while the workplace framework talks about increasing ability to influence an organisation to make things happen, the academic framework uses language about increasing ability for complex understanding and original thought. One is a doing skill while the other is an understanding skill, but is one any less valid than the other?

The suggestion from the case studies is that both forms of skill are needed in the knowledge economy. That all individuals in the case studies had accumulated experiential learning was not in doubt. However, while in the workplace the individuals were structured as a work group, not a cohort of learners. Regardless of whether individuals were managing their own development or participating in an employer led programme they seemed to need to step away from the work group to reflect. In the case studies at least, it was the interaction with the cohort of learners away from the workplace that made the experiential learning in the workplace accessible. In summary, the key features which promoted learning were:

- The interaction with a cohort of learners committed to going through a shared process, plus
- The challenge to succeed at something which is demonstrably very difficult, plus
- The opportunity to step away from the workplace and reflect on one's experience.

The case studies demonstrate that these features can be supplied by the machinery of a university programme with its system of cohorts, assessments and awards of it can be supplied by the staff development processes of a company with its system of courses, staff appraisals and career promotions. The key is that the individual steps away from the locus of everyday experience and reflects on his/her experience from a different viewpoint. Perhaps the most striking thing about this observation is that it generally reflects the model of the first (medieval) universities. The learners all had a wealth of experience and wanted the university to help them express this learning. Nowadays universities are generally focused on the preparation of individuals for the world of work, which is a pity. They have much to offer those in full-time employment.

Conclusions

In summary this chapter observes how those in full-time employment can engage in personal development as individuals working in collaboration with universities, and in organisational development as employees working in collaboration with their employer. In both instances, the key characteristic of the observed learning process was the use of interventions that enabled the learner to reflect on workplace experience. Those in full-time employment have a wealth of experience to draw on but the demands of their day-jobs often mean there is little time to sit back and reflect. Without this reflection the experience fails to be captured as explicit knowledge and the individual fails to capture deeper understandings that can emerge from reflection. Moreover, the learning is not accessible to the organisation as a whole. Thus, the interventions promote reflection are extremely important to both individual and organisational learning.

The key characteristic of the interventions we observed in the case studies was that they created an ability to step away from the workplace environment and enter a world focussed on learning. A learner cohort, separate from the work-team, played a key role as did the "wow factor" of high profile speakers or the academic paraphernalia of a university. But the key feature was not the transfer of knowledge from others; it was the way the interaction with others stimulated deeper understanding of one's own experience. This contrasts with the development of individuals prior to employment where the transfer of codified knowledge is an important precursor to exposure to real life experience. The acquisition of codified knowledge is of course still important for those in full-time employment when that knowledge relates to formal processes, for example health and safety regulations or financial procedures. However, this type of knowledge relates to compliances with organisational rules. It has little to do with personal development, organisational development, or creative use of knowledge for innovation.

The relevance for CSCL is the role played by the creation of an interactive space for a cohort of learners. In the examples discussed in this chapter computer based interaction plays an important enabling role because it overcomes the time and travel requirements for physical interactions; something which is vital for those in full-time work, who lack the flexibility of full-time students. However, all those who experienced computer based networking stated that the occasional physical meeting was necessary to create the atmosphere for computer based interaction. There is something rather important about the level of "wow factor" associated with physical interaction in a prestigious setting. There is an element of being admitted to a secret society when one enters a very exclusive physical location. Creating a similar sensation when logging on to a web site is the challenge for CSCL.

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Part II
CSCL@Work in Practice: Facilitation and Reflection

This section describes how work practices can lead to CSCL at Work through facilitation and reflection.

Hartswood, Procter, Taylor, Blot, and Anderson (Chap. 6) bridges these two concepts of facilitation and reflection in a study of how experts at reading mammograms use a technology to support review and feedback of novice mammogram reading. The goals of the program are to minimize false-positive readings without causing false-negative readings. Experts are good at making these judgments in hard cases, and it is the hard cases that get focused on.

Prilla, Hermann, and Degeling (Chap. 7) focus on two cases as well, elaborating on how facilitated collaborative reflection on work practices occurs differently, depending on the role and status of members. They describe a framework for supporting workplace reflection and underscore the importance of reflection for CSCL at Work.

Hokstad, Prasolova-Førland, and Fominykh (Chap. 8) present results of designing a reflective community integrated at the workplace. The community offers rapid access to learn how to perform project management and sustainable manufacturing. Using a serious games approach, they design a game on “how to do project management” in SecondLife with the aim of facilitating a *reflective dialogue* in communities to support lifelong workplace learning.

Kienle (Chap. 9) describes two types of CSCL at Work. The first is expert location, which is a long-standing issue in knowledge management. The second is discovering knowledge when the answer is not known, which Fischer (this volume) describes a central concern for CSCL at Work. To address different types of CSCL at Work, she presents a model of facilitated, asynchronous triadic communication. Kienle emphasized that the design for facilitation support should take into consideration the tasks for each member role, technical features, and their potential interference with user activities.

Chapter 6
Technologies of Participation: A Case Study of CSCL@Work in Mammography

Mark Hartswood, Rob Procter, Paul Taylor, Lilian Blot, and Stuart Anderson

Introduction

We report experiences from an ongoing project to develop a computer-supported training environment to facilitate the acquisition of the skills required to interpret breast X-rays (mammograms) in the UK breast screening programme. The aim of the project is to explore ways that computer-support can add value to existing workplace-based training in the development of professional expertise. The breast screening programme's move from film to digital imaging makes an investigation of screening training particularly timely. For example, exploiting the greater mobility of digital images and associated training materials may enhance opportunities for interaction and collaboration between trainees and their mentors, enable new modes of training and allow trainees access to rarer cases than they might ordinarily encounter.

Many of the chapters in this book explore learning in situations where the learning outcome is unclear and where the goal is to solve emergent problems or acquire competencies in novel social contexts. In these cases, the CSCL at Work paradigm is concerned with the creation of new knowledge via collaborative learning practices mediated by information and communication technologies (ICTs). Our chapter

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differs in that the learning outcome is well understood. The learner aims to acquire competencies that others already possess by participating in mature and highly professionalised work practices. What is less well understood is the impact of ICTs on participation. Our case study develops the notion of 'technologies of participation', a deepening of our understanding of how existing collaborative practices underpin the acquisition of professional expertise and an analysis of the interaction between technologies of participation and collaborative practice.

Our project brings together research groups at University College London, Edinburgh and Manchester Universities and radiologists working at two UK NHS breast screening centres (Hartswood et al., 2009). To develop the training environment we followed a user-centred, participative design approach that was built on our previous ethnographic studies of breast screening (Hartswood, Procter, Rouncefield, & Slack, 2002). The training environment consists of two distinct tools, each of which addresses different aspects of mammographic image interpretation. The first tool enables senior radiologists (mentors) to select cases to meet the specific training requirements of trainees. The tool then replicates the conditions of everyday mammography reading practice and provides automated feedback in response to trainees' attempts at interpretation. The second tool, provisionally named 'Lesion Zoo', gives trainees access to a large number of abnormalities and rarer cases that they are unlikely to encounter in everyday reading work (Taylor, Blot, Hartswood, & Procter, 2010).

This chapter documents early trials of a working prototype to explore how users (mentors and trainees) appropriated the environment's emerging affordances to support learning. In particular, we detail the emerging collaborative practices of mentors and trainees engaged in 'mentoring sessions', i.e. sessions where decisions made by the trainee using the training environment are retrospectively reviewed. The 'learning experiences' that arise from these encounters are shown to be collaborative achievements realised as a part of the participants' shared interactional practices. This focus enables us to identify various ways of providing the environment with affordances that enhance collaborative dimensions of its use and thus help address the question posed by Fischer in this volume: 'How can we co-evolve a new understanding of learning, working, and collaborating, new media and new technologies, and new learning organizations?' (Fischer, RQ5)

As the chapter progresses we develop two themes. The first is how our training environment constitutes a 'technology of participation', providing a means for trainees to access materials and practice skills appropriate to their professional development. The second concerns how collaborative learning practices are instrumental in 'relevancing' content and experiences to 'real-world' practice and performance. In particular, we examine:

- The divergent affordances of different 'technologies of participation', and how these shape the sorts and styles of collaboration that are possible.
- How the 'hard' affordances of formalised instruction (e.g. marks, structure, audit) interplay and are reconciled with 'softer' affordances of less formalised collaborative learning (acquiring confidence, maintaining autonomy, professional development).

- How computer-supported learning provides the opportunity for re-envisioning the mammography workplace and, in particular, its boundaries as a 'community of practice'.

We conclude with reflections on lessons learnt for CSCL at Work.

Breast Cancer Screening in the UK

Breast cancer is the most common cancer in women in the UK and the second leading cause of cancer death among women. A screening programme has been in operation in the UK for more than 20 years. The initial screening test is by mammography, where one or more X-ray films (mammograms) are taken of each breast. The usual types of mammogram taken are mediolateral oblique (Oblique) and craniocaudal (CC). Each mammogram is examined for evidence of abnormality by at least one trained reader (typically a radiologist). There is a very large range of normal and abnormal appearances, which result from a range of different types of breast tissue and different pathological processes. Abnormalities can be very subtle and interpretation can be extremely difficult. Indicators of malignancy include the following:

- Micro-calcification clusters are small deposits of calcium salts visible as bright specks.
- Ill-defined lesions are areas of radiographically dense tissue appearing as a bright patch that might indicate a developing tumour.
- Stellate lesions are visible as a radiating structure with ill-defined borders. Architectural distortion may be visible when tissue around the site of a developing tumour contracts.
- Asymmetry between left and right mammograms may be the only visible sign of some lesions.

The practice of breast screening calls for readers to exercise a combination of perceptual skills—to find what may be faint and small features in a complex visual field—and interpretative skills to classify them appropriately, i.e. as benign or suspicious. Two reader performance parameters are particularly important: specificity and sensitivity. A high specificity (high true positive rate) means that few healthy women will be recalled for further tests; a high sensitivity (low false negative rate) means that few cancers will be missed. Achieving high specificity and high sensitivity is difficult.

Relatively few existing teaching aids have attempted to provide a richly interactive educational resource that is grounded in an understanding of how radiology is actually taught and how trainees learn. Those that do (Azevedo & Lajoie, 1998; Sharples et al., 2000) have focused narrowly on the formal instructive content of didactic encounters and neglect how these are parts of broader process of learning that links acquiring professional competencies with an engagement in the cultural, professional and historical regimes in which those competencies are applied (Lave & Wenger, 1991). Our own studies of reading work (Hartswood et al., 2002) point to how reading mammograms is observably not an isolated cognitive act, but an active social process since it is lodged within and orientating to a specific community of practice to which its members are accountable, an accountability that can be likened to Goodwin's concept of professional vision (Goodwin, 1994, 2000a, 2000b).

A particular focus for the project has been to redress this omission by asking how one might design a training environment that draws upon understandings both of the perceptual skills demanded and of contextualised professional conduct (Hartswood et al., 2002). To understand the implications of this for training, we turn to the concepts of 'situated learning' and 'technologies of participation'.

Situated Learning

Lave and Wenger (1991) developed the concept of situated learning from the observation that, in a range of situations, apprentices apparently progress towards competency without a well-defined programme of formal instruction (i.e. lessons, examinations, etc.). Two key claims underpin the idea of situated learning. The first is that learning is not dependant on teaching, but rather is a constituent part of our participating in the social world:

> Indeed, this viewpoint makes a fundamental distinction between learning and intentional instruction. Such decoupling does not deny that learning can take place where there is teaching, but does not take intentional instruction as the cause or source of learning, and thus does not blunt the claim that what gets learned is problematic with respect to what is taught (op. cit. p. 40–41).

Problematising the relation between 'intentional instruction' and learning has significant implications for those designing instructional programmes, especially where these are designed as proxies or replacements for on-the-job training. If instruction is not seen as the cause of learning, then one has basic difficulties in setting about creating resources or practices with the aim of inculcating skill or expertise. A number of authors have attempted to reconcile pedagogy with situated learning. One approach introduces the concept of 'stolen knowledge'—i.e. by providing a resource of sufficient richness the learner is able to appropriate what they need from the learning encounter (Brown & Duguid, 1996). Another describes how teaching math in a way that reflects mathematicians' representational and problem-solving strategies allows students to learn by engaging (by proxy) with the community practices of mathematicians (Brown, Collins, & Duguid, 1996). In our study, we see both the pedagogical intent in the shaping of the training environment and instructional content *and* the various unplanned, informal and situated methods the learner and the mentor employ to realise the trainee's use of the environment as a 'learning experience'. One key aspect of the latter concerns how the trainee and the mentor, working collaboratively, relevance their experiences using the environment to 'real-world' practice.

Lave and Wenger's second claim is that learning is not limited to technical know-how, but rather that learning in the greater part involves becoming conversant with the sociocultural history and organisation of the workplace. Taken together, these two claims form the basis for what Lave and Wenger refer to as *legitimate peripheral participation* in *communities of practice*, where *legitimate peripheral participation* describes the conditions for situated learning to be effective, and *communities of practice* encompass the shared sociocultural traditions of practitioners. Becoming a member of a community of practice is not simply about acquiring the appropriate technical competencies, but about acquiring an identity as a practitioner.

Legitimate Peripheral Participation

The phrase 'legitimate peripheral participation' expresses the idea that the trajectory from apprentice or trainee to full participant involves the trainee's engagement in the work setting so that they have access to a series of loosely structured 'learning experiences'. Most obviously, legitimation points to trainees' right to engage with the setting.

> Master tailors must sponsor apprentices before the latter can have legitimate access to participation in the community's productive activities. In short, the form in which such legitimate access is secured for apprentices depends upon the characteristics of the division of labor in the social milieu in which the community of practice is located (Lave & Wenger, 1991, p. 92).

In professional settings such as medicine, learners have additional entitlements over and above legitimate access to the work setting. Access itself is on a footing commensurate with junior medics' status as learners, whereby they are not burdened with the 'full workload' expected of skilled staff. Other entitlements include access to learning experiences (as per the example above) and having time to engage in 'non-productive' activities, such as attending college, time to reflect, undertaking 'learning' tasks that involve some element of practice, or acquiring theoretical underpinnings. Aspects of legitimation in professional settings like medicine also have a significant formal component, such as attaining certain qualifications or membership of professional organisations.

Peripherality relates to the mode of the novice's engagement with the setting:

> To begin with, newcomers' legitimate peripherality provides them with more than just an "observational" lookout post: It crucially involves *participation* as a way of learning—of both absorbing and being absorbed in—the "culture of practice." … From a broadly peripheral perspective, apprentices gradually assemble a general idea of what constitutes the practice of the community. This uneven sketch of the enterprise … might include who is involved; what they do; what everyday life is like; how masters talk, walk, work, and generally conduct their lives; what people who are other learners are doing; and what learners need to learn to become full practitioners (Lave & Wenger, 1991, p. 95).

Participation is peripheral in the sense that novices have limited responsibilities and undertake non-critical tasks, rather because they are at a distance from the action. On the contrary, their involvement enables them to observe 'old hands' at work, to gain familiarity with craft materials and practices, to access expertise, get a feel for the routines and rhythms of the work and, by moving between tasks, get an overview of how different component activities of the enterprise mesh together. This point is further developed by Fuller, Hodkinson, Hodkinson and Unwin (2005) and Fuller and Unwin (2003) who point out that modern enterprises comprise multiple, overlapping communities of practice and that acquiring competence in each, and understanding how they articulate together, is an important part of becoming a full participant.

The medical apprenticeship has many of the features described above. Progression initially involves academic training, which in later years is coupled with placements, followed by on-the-job training rotations and specialisation. As part of this trajectory we see increased competence coupled with increased status, responsibility and autonomy. Until the very final stages of specialisation, there is a rotation though different clinical areas, providing trainees with an overview of the medical enterprise as a whole, and an appreciation of each of its components and how they interrelate.

Novice medics are regulated in the degree to which they can independently undertake clinical tasks both to protect patients and the medics themselves from being burdened with responsibilities that they are incapable of discharging. It is necessary to ensure the integrity of practice so that decision-making and procedure in breast screening remain of a standard that will guarantee the safety of women using the service. Later in the chapter we will see how a trainee film reader's participation is carefully managed to ensure their safe involvement.

Technologies of Participation

In an exploration of how computer-supported learning can be informed by the concept of situated learning, McLellan (1996) highlights the role that technology can play in enhancing access to craft materials and demonstrations of expertise:

> Technology is another central consideration in the situated learning model because technology expands the power and flexibility of the resources that can be deployed to support the various components of situated learning. For example, reflection is enhanced by the use of the various techniques for reproducing or "replaying" the performances of both expert and novice for comparison (McLellan, 1996, p. 12).

While technology can mobilise workplace learning resources and improve their 'power and flexibility' (op. cit., situated learning is as much about enculturation as it is about acquisition of narrowly defined technical skills. So, although replaying the 'performance' of an expert might allow physical moves to be examined and practiced with much greater ease, this type of presentation may do less well at conveying the ethical considerations in making certain moves at certain times. In the domain of surgery, Kneebone, Scott, Darzi and Horrocks (2004) describe how it is increasingly unacceptable for junior surgeons to undertake procedures on real patients, and how improvements in the fidelity of simulators provide an alternative, but argue that simulation 'must be used alongside clinical practice and closely linked with it' (op. cit.) for precisely these reasons.

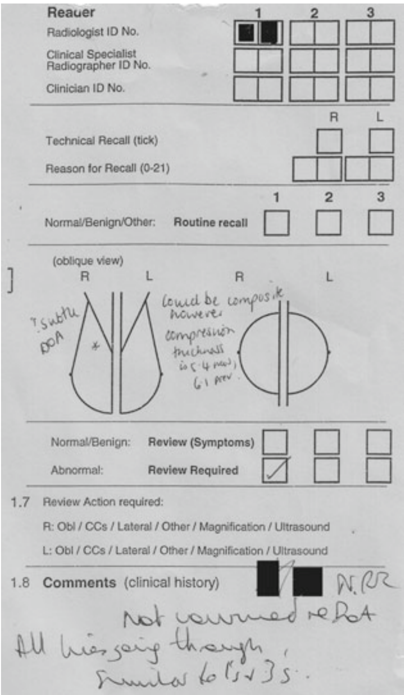
Use of simulators (surgical, or our training environment) can be thought of as proxies for 'authentic' workplace experiences. Such proxies offer new affordances with the potential to enhance learning in the ways that McLellan suggests, but, at the same time, they can displace direct access to workplace activity with the risk of impoverishing the overall learning experience, a danger that Kneebone et al. acknowledge and seek to guard against. In Lave and Wenger's terms, use of proxy learning experiences can deny access to relevant 'arenas of activity', limiting the novice's ability to acquire their identity as a practitioner. The importance of this is highlighted by Fuller et al.'s identification of 'restrictive' apprenticeships where the novice's experiences of the workplace are narrowly constrained to a particular task or location, resulting in poorer motivation and a lower likelihood of career progression. We argue that the CSCL at Work concept helps us here by maintaining a focus on collaboration as an activity of key importance to learning, and on the workplace as a place for learning. We argue that the design of computer-supported learning environments has to attend to building in affordances for collaborative practices that help relevance their use to broader workplace concerns.

This chapter develops the idea of 'technologies of participation' to capture the different ways in which technologies mediate access to all the various aspects of practice, including to craft materials, expertise and work settings or arenas. Put another way, we are interested in how technologies aimed at supporting learning impact on a novice's status or effectiveness as a legitimate peripheral participant. The literature outlined above provides us with some starting reference points, and as the chapter develops we explore in greater detail the interplay between participation in the sense of gaining access to craft materials and expertise, and participation in the sense of being able to engage informally and collaboratively with practitioners.

Technologies of Participation in Breast Cancer Screening

Much training in mammography is conducted at work: an experienced mentor guides a trainee's interpretation of actual screening cases. There is a formal requirement for trainee film readers to read at least 400 screening cases every month for a year. The trainee reads 'live' screening cases and makes a decision on each, but not one that influences the outcome—the cases are still read in the usual way by qualified readers. In this way, trainees can participate safely in a real setting where they have access to experienced practitioners, can see them at work and examine their opinions and contrast them with their own. Their participation gives them access to the breast screening clinic as an 'arena of practice'—they are in a position to observe others at work, to consult with 'old hands' and develop a deep familiarity with the work of breast screening in the round. Some of this interaction is mediated by the dedicated paperwork on which the trainee records their decision, and upon which, at a later time, a qualified film reader will give their view of the trainee's interpretation.

The trainee's 'screening slip' (Fig. 6.1) can be taken as a very simple technology of participation in that it provides a means for the trainee to safely participate in



Reader | 1 | 2 | 3
Radiologist ID No. [redacted]
Clinical Specialist Radiographer ID No.
Clinician ID No.

R | L
Technical Recall (tick)
Reason for Recall (0-21)

1 | 2 | 3
Normal/Benign/Other: Routine recall

(oblique view)
R L R L
? subtle DOA
could be composite however compression thickness is 5.4 now, 6.1 prev.

Normal/Benign: Review (Symptoms)
Abnormal: Review Required ✓

1.7 Review Action required:
R: Obl / CCs / Lateral / Other / Magnification / Ultrasound
L: Obl / CCs / Lateral / Other / Magnification / Ultrasound

1.8 Comments (clinical history) [redacted] N.RR
Not convinced re DOA
All lines going through,
similar to 3's.

The trainee has written: "? Subtle DOA. Could be composite, however compression thickness is 5.4 now, 6.1 prev?" and has ticked the 'Review required' box.

DOA stands for: Distortion of Architecture. The trainee wonders if what she is seeing is 'composite', i.e. due to a confluence of normal breast tissue, but notes the breast is compressed less in this image than in that taken at the earlier visit, which presumably has a bearing on whether composite structures might appear.

The 'reply' by the senior radiologist in the 'Comments' box starts out by indicating the decision of the two expert readers of the case, both identified by a number "xx/yy NRR". (Normal Routine Recall.) "Not convinced of DOA. All lines going through, similar to 3's". So the expert is not convinced that there might be a DOA, saying that "All lines going through" – lines radiating from a point indicate malignancy, but if radiating lines can be 'traced through' they are probably normal breast tissue. Also the expert makes reference to films "3's"-from the third screening round where there are similar sorts of appearances.

Fig. 6.1 Example of a training screening slip. The top of the form containing the patient identifier has been removed. The slip actually is a fragment of the form used for 'actual' reading by already qualified staff. There are three columns for the film reader's decision: 'routine recall', 'Normal (but) Review (symptoms)' and 'Abnormal Review Required'. This clinic operates a system of arbitration, whereby if there is a disagreement between the first and second reader, then a third reader has a casting vote (hence the three columns)

reading actual screening cases ('live' paperwork and decision-making is largely undisturbed) in an authentic setting—using equipment, and the physical organisation of materials is used in 'actual' screening, and at the same time affording asynchronous access to radiological expertise.

Training screening slips get passed back to the trainee after the cases have been read by senior radiologists, with comments where the trainee's opinion differs from the final decision. Also marked is the final decision and how it was arrived at, i.e. whether there was a consensus between the two readers, or whether the case went to arbitration.

Sara, the specialist registrar (SPR)[1] trainee taking part in our study, further improvised use of the training screening slip, writing on the patient's CHI number[2]

[1]An SPR is a doctor undergoing final training before becoming a consultant in a specialist area of medicine.

[2]The CHI number is a unique numeric identifier, allocated to each patient on first registration with the healthcare system in Scotland.

so that she could retrieve cases after the slip had been returned to her, allowing her to review the films in light of the other readers' comments. She also started keeping a record of the returned slips to self-audit the cases she had read in order to gauge her own progress, as well as developing a strategy of recalling cases as a means of eliciting feedback (a practice she carried over to her use of the digital training environment)[3]:

> Sara: So I know it's specifically at the moment I'm overcalling almost intentionally
>
> Mark: Yeah
>
> Sara: whereas I think if I was actually in a exam situation and being forced to come down the fence I would probably gone for normal … [on the training screening slips] I'll say I've seen these little opacities, these are the reasons I think they don't need recalled. They've either been there before or
>
> Mark: ah ha
>
> Sara: they look benign or they erm or I think they are com- they're technical.
>
> Mark: Yes, ok
>
> Sara: So I qualify the decision that I make but I kind of know that—for every—you can basically guarantee that every single one that I've put a little slip on in this situation I'd be flagging it as recalls so I got some feedback on it.
>
> Mark: Ok.
>
> Sara: It's my way of making sure I get feedback because otherwise there's no way of learning.

The trainee also indicated that the larger part of the feedback she received is via the use of the training screening slips, rather than talking directly to other readers. Although senior readers would be more than happy to give guidance on request, the trainee's reading sessions do not always overlap with those of other readers.

In this sketch of the training screening slip as a technology of participation various issues come to the fore. It evidently performs well at supporting decision-making in an authentic environment, and provides a means of accessing expertise in circumstances where co-location on a regular basis would be difficult to arrange. The trainee uses the system instrumentally to gain access to expertise by overcalling. Training slips make the trainee's performance partially visible to the senior readers, who will see the decision made by the trainee on cases they themselves are reading. They perform less well at providing a record of the trainee's performance; audit functions are improvised by the trainee but, by the same token, the trainee maintains ownership of their own audit.

Later, we will contrast the affordances of the training screening slip and our training environment to demonstrate how they function in subtly different ways as technologies of participation. This analysis allows us to see areas where computerisation impacts upon the trainee's status as a legitimate peripheral participant and how collaborative affordances can be designed to compensate in cases where the impact is negative.

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[3] In the extract, Mark is the software developer.

Development and Use of the Training Environment

As Goggins and Jahnke note in their introduction to this volume, designing for collaborative learning is inherently socio-technical. Taking this seriously calls for following a user-participative, co-production or 'co-realisation' approach to the design and development of technical innovations (see Hartswood, Procter, Rouncefield, Slack, & Voss, 2008).

In this project, design and development work was initiated through with a series of meetings involving designers, potential users and domain experts where ideas and subsequently prototypes were iteratively worked up to a point where it was agreed that they were mature enough to be used by trainees. As we have described, training in mammography has an established repertoire of technologies and practices. Not surprisingly, therefore, the training screening slip—which itself is a replica of the normal reporting paperwork—was adopted as the initial template for the new training environment. Subsequently, the design of environment was iteratively evaluated and refined as we describe below. In its current version, the environment allows trainees to mark a case in a number of ways (Fig. 6.2). They can make one or more annotations, make a comment on a case, make a recall decision or flag the case as one that they wish to discuss.

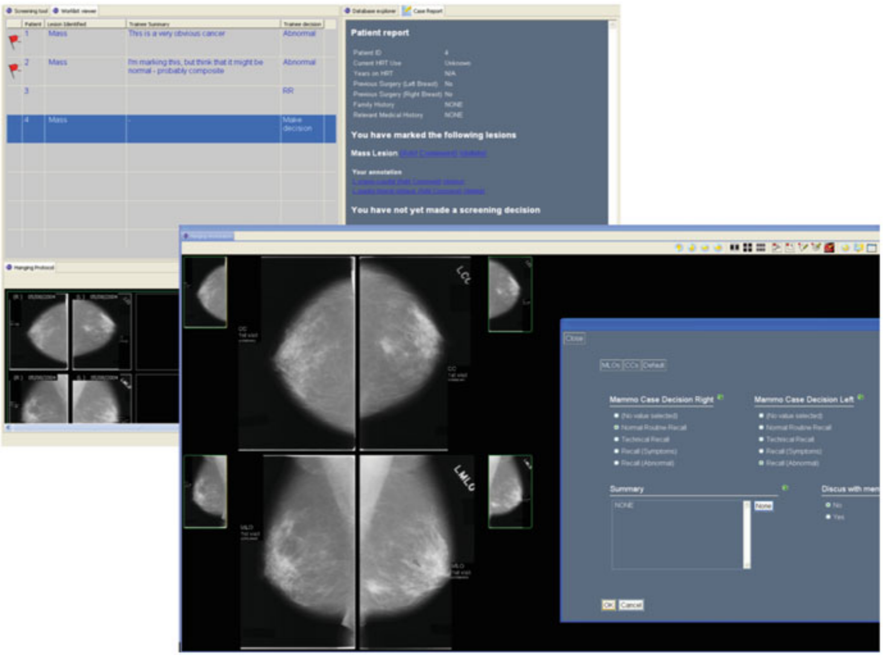

Fig. 6.2 The training environment user interface. The interface enables browsing cases (*rearmost panel*), displaying the mammograms and making a decision (*frontmost panel*)

Two expert radiologists compiled a training set by selecting cases from an archive. In subsequent evaluation sessions two trainees used the training environment to work through the set's 91 cases, 30 demonstrating an abnormality and 61 'time proven normals'. At intervals of 20 cases the environment gave the trainee the option of reviewing their decisions, and provided them with automated feedback based on prior expert annotation. While trainees can, in principle, use the training environment to learn independently, we were keen to explore how its use could be integrated with existing mentoring arrangements. Our trainees were given the opportunity to review cases they had read with their mentor. Both trainees found that reading roughly 20 cases using the environment in each session provided a reasonable trade-off between comfort and making progress and both read all 91 cases during the course of four sessions using the environment. Our first trainee, a radiographer training to be a film reader,[4] opted to have mentoring sessions for each batch of cases she completed, so she had four mentoring sessions in total. Our second trainee, an SPR, opted to complete all four sessions with the environment before having a single mentoring session.

Development and evaluation were closely coupled throughout each of the above activities, which meant that trainees experienced different configurations of the environment as their sessions progressed. Some functionality accumulated during the course of the evaluation, for example, facilities to flag cases for discussion were available to the second trainee but not the first. On other occasions functionality was refined, for example, the way that the trainee's score was calculated and presented was revised a number of times over the course of the evaluation period.

Findings from Evaluation and Use

Each of the design, evaluation, training and mentoring sessions were video recorded and transcripts produced for subsequent analysis. Below, using extracts from these sessions, we provide some examples of the issues that arose. Some of these issues—which, broadly speaking, map to dimensions within clusters A (human and organisational constraints) and B (socio-technical design) in the conceptual framework outlined by Goggins and Jahnke in their introduction—help give shape to an analysis of the training environment as a technology of participation. Others, particularly those taken from the mentoring sessions, help us to envisage collaborative affordances that can enhance trainees' legitimate peripheral participation.

The first two fieldwork extracts concern aspects of how pedagogical intent is embedded in the training environment, and how it is recognised and managed by the trainee engaging with intentional instruction.

[4] Radiographers' more usual responsibilities concern the production rather than the interpretation of screening images. It has become increasingly common and acceptable to train radiographers to read films as a means of addressing shortages of radiologists.

Selection of Training Materials

In this first fieldwork extract radiologists Jane, Mary and Ann are looking through the archive of abnormal cases and choosing cases appropriate for two training sets they are compiling. Jane and Mary are radiologists who deliver training, and Ann is a radiographer who helped compile the case archive from which our training cases are drawn.[5] Mary had left the room, but returns halfway through the extract.

> Jane: Yep. Erm. No, I mean we've got a fibroadenoma [Ann: hmmm] there. Oh. [Ann: That's interesting]. Oh, right, there's one up there.
>
> Mark: Yeah there's two—there's two bits to it.
>
> Jane: I thought it was two together, like a dumbbell shape that thing at the bottom but there's obviously one up there as well. Might—sbit confusing. It's like a lymph node.
>
> Ann: Well that's something in its self that (u …?) (laughs)
>
> Jane: I wonder if I made a new (… … …?)
>
> Mark: Er. Two fibroadenomas. Learning points, one lesion only seen in one view.
>
> Jane: CC.
>
> (Mary: returns)
>
> Jane: One of them is way up in the top there and we never saw it [Jane: yeah] and it isn't on the CC.
>
> Mary: Yeah, no I don't think that's [Jane: That's too confusing, it's a bit] very good.
>
> Jane: No, we won't have that one then. Right. Ok.

Fibroadenomas are breast lesions that are not in themselves cancerous, but are potentially the site of cancer formation. They can be very subtle and are similar in appearance to 'architectural distortions', which do signify cancer. Fibroadenomas therefore represent an interesting exception to the basic pattern of breast cancer presentations and so are useful cases to include in a training package. In the extract above the radiologists are trying to make sense of the case with two lesions that Jane had initially thought were adjacent, but which turn out to be in quite separate parts of the breast. One of the fibroadenomas deviates from its archetypal appearance, and because of this, and its location, its presentation is confusingly similar to that of a lymph node. In the rejection of this case as 'too confusing' we can see the 'guiding pedagogical hand' at work filtering and sifting the case archive, tailoring it to meet the pedagogical intentions of its authors. In this example the set is shaped by rejecting a case that is too ambiguous or too complex; the fieldwork also included examples of rejecting or including cases on the basis of achieving a balanced mix of presentations, and rejecting cases that were considered to be too easy.

[5] As before, Mark is the software developer.

Formal Instruction and Actual Practice

The 'guiding pedagogical hand' is also highly visible in the next fieldwork extract, where the trainee (Sara) comments upon the 'rapid reporting' component of the radiology exam:

> Sara: It's like exams we do for our radiology final exam we do a rapid reporting thing an it's basically A&E type films, hands, fingers, chests, abdomens. Bits of people. And, you've got to report in thirteen—how long—how many films do you get? Is it thirty films in half an hour? … And you have to decide [Mark: that's one a minute] if it's abnormal or normal—yeah that's why it's called rapid reporting. Abnormal or normal and if it's abnormal you have to correctly identify the abnormality and people say oh no it's not—I think it does sharpen you up—it really does make you focus in on what's relevant.

Like most exercises created with pedagogy or assessment in mind, the rapid reporting exam is easily distinguishable from real-life film reading. Pedagogical intent is highly visible in the ways that such exercises variously identify and focus on component skills, distort frequency and mix of presentations and disconnect the learner from resources normally available in practice (consulting with colleagues, taking time to reflect, ordering further tests, consulting with the patient and so on). What is evident in the extract is the need for the artificiality of the exercise to be explicitly managed by the trainee in order for its relevance to be clear to them.[6] The trainee orients to this when she says '[rapid reporting] *does sharpen you up … make you focus on what is relevant* [in a radiological image]'. Such relevancies might not necessarily be found, as the trainee refers to other students with a different impression: '… *people say oh no it's not*—[a realist test of radiological skill]'.

Collaboration between the trainee and mentor to find relevance in the trainees' experiences of using the environment is a recurring theme in the fieldwork, which brings us to the issue of *learning transfer*. Learning transfer concerns how learning experiences in one context are able to improve performance in another and has been an important phenomenon for learning theories to account for, particularly those factors that might inhibit or enhance transfer (Subedi, 2004). In so far as transfer depends upon discovering the relevance *of*, and relevancies *in* an instructional encounter, our studies reveal it to be a practical accomplishment residing within the interactional practices of the participants. Although appreciating relevance and finding relevancies might not always depend on explicit collaboration, we find relevancing work to be a highly visible and significant part of mentoring sessions, and argue that support for collaborative relevancing work should have a prominent place within the CSCL at Work concept. The remaining fieldwork examples explore in greater detail the different aspects of relevancing work undertaken by the mentor and the trainee.

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[6]Pedagogy serves more than one purpose and trainees are aware of this. It is open for them to suspect that a given exercise may serve institutional or professional objectives rather than strictly educational ones.

Situating Computer-Supported Training Within the Trainees' Broader Learning Experience

Because trainees continued with their normal training at the same time as evaluating the training environment, they often accrued significant additional experience in between evaluation sessions. The discussion between the trainee and the mentor often referred to the trainee's progression over these periods as shown in the following extracts (Sara is the trainee and Jane the mentor):

> Sara: Show my [annotation]—I think it was this. And, yeah, it was this area here. [The trainee had annotated one area, but the lesion was in another] Again, I think now …
>
> Jane: Having a second look you might feel
>
> Sara: having—well just having done a lot more mammos.
>
> Jane: (emphatically) Yes.
>
> Sara: And have been to a lot more clinics.
>
> Jane: So this one of the earlier ones that you did when you hadn't done an awful lot.
>
> …
>
> Sara: I would have pointed that—it's interesting actually now to go back through this again [Jane: Hmmm] with a bit more under your belt [Jane: HmmmMmm]
>
> …
>
> Sara: but I do actually think that it is useful now going back through the cases and seeing how with some time [Jane: How you've changed yeah]

Here we can see the mentor and the trainee situating the performance captured by the training environment as belonging to specific moment in the trainee's learning career. This was one of a number of cases where an incorrect decision had been made, but where it was agreed that the trainee would be unlikely to make a similar mistake now, in light of her additional experience. Use of the environment provides a snapshot of the trainee's performance. It freezes a moment in time that can be revisited and re-examined from the perspective of greater maturity, an affordance the mentor exploits to build the trainee's confidence.

Note how the mentor and trainee reflect on use of the training environment in light of their other training- and practice-based experiences in ways that are mutually illuminating. This seems to be part and parcel of working out what sort of learning experience the training environment provides and how it is relevant to and articulates with other learning- and practice-based experiences. The training environment's ability to take snapshots of performance emerges as a key affordance in making progress perspicuous to both trainee and mentor.

Interpretative Privilege

A further interesting aspect of the trainees' work of reviewing their prior decisions was that of 'interpretative privilege'. Trainees, on occasion, provided an interpretative context against which their scores or marks should be judged, rather than expecting that these should be taken at ‘face value’ as somehow directly representing the trainee’s performance. For one trainee, Tina, this was often the performance of the system itself (because flaws were ironed out and features were added to the system as the training progressed).

> Tina: And not having that facility, I think, just having the … the enlarge facility [the ‘magnifying glass’ enabling portions of the image to be seen in close-up, which did not function correctly during early training sessions with Tina] probably made me think that there was something—It does look like something on the CC.

For a second trainee, Sara, it was that she often made recalls to elicit feedback, rather than because she ‘really’ wanted to recall the case.

> Sara: I would have gone … I knew I’d consciously did overcall on some things in this just to have them … just to have them flagged up.

On the one hand, these can be seen to be entirely reasonable considerations. For example, although it is possible to flag a case or a lesion without recalling it, it is entirely likely that the second trainee only gradually became aware of these possible modes of using the training environment as the sessions progressed. Similarly, for the first trainee, improvements were made to image presentation and quality over the course of her sessions. On the other hand, though, these sorts of comments signal how trainees sought to:

1. Maintain control over how their score should be properly interpreted.
2. Create a ‘distance’ between recorded decisions and how far those decisions can be read as indicative of their performance.

We might see this as an important aspect of presenting evidence relating to trainee performance. Since the general idea is for trainees to progress, it is important for the trainee not to feel that they are ‘saddled’ with a particular score or mark, or to have a representation of decisions made seen to be definitive of their ‘actual ability’. Any such point is always something that trainees need to be able to move on from as their skill and expertise mature. Trainees’ orienting to marks as transitional has similarities with fieldwork in the previous section where some sorts of erroneous decisions lose their relevance as the trainee grows in competence. This seems to be characteristic of a more general phenomenon whereby the trainee’s accumulated learning experiences are woven together to create an overall ‘narrative of progress’, a topic we return to in the conclusions.

Scores or marks are summative accounts of performance that do not convey the circumstances in which they were acquired. Trainees seek to supply elided contextual particulars, highlighting the constraints on their performance at the time the marks were achieved in order to create a preferred frame for their interpretation. In a digital training environment, where decisions are persistent and marks perhaps available to others, having control over their interpretation assumes greater significance.

Attending to Errors

Where a trainee has made a mistake, the discussion with the mentor was found often to be diagnostic, and typically involved reconstructing a plausible account of how or why the trainee might have missed or misinterpreted something, and in doing so drawing their attention to broader classes of problems or pitfalls associated with reading.

> Jane: I think because she's—I wonder … Is it because you are thinking there is asymmetry and there's much more stuff going on here? So you've concentrated on that side? And maybe not looked …

Often the mentor would also subtly point out or emphasise evidence that the trainee might have missed or weighed insufficiently, such as comparisons between views, or the possibility of teasing the lesion apart into its constituent (normal) components.

> Jane: Opacity. Not clear on oblique. So you saw something on the CC, so you mean that thing on the top there? … Hmmm. Just an asymmetric patch of breast tissue, isn't it? … I mean there's no distortion there's nothing particularly suspicious there I suppose I (…?) it does stand out if you're looking at it from here.

It was typical also for the mentor to treat the trainee's decisions as generally credible and give the trainee room to 'argue' or 'hold out' for favoured interpretations, as the mentor apparently endeavoured to balance influencing the trainees' approach by allowing them flex their muscles as independent decision-makers.

> Jane: Well, yeah, I mean the reason you want to call it presumably is because it is sticking out of the back of the breast disk to some extent on the CC. Isn't it? [Sara: yeah] away, in a way. Yeah, no, that's a fair cop. (laughs) I can, I can understand you would (do that?) [Sara: I can talk you into that one] Yeah, yeah, no I'm not unhappy with that one.

There are a number of interesting aspects to these encounters. The first concerns the, often, ambiguous character of breast lesions, which means that film readers need to set a threshold for what counts as recallable or 'suspicious'. The mentor, in the comments above, is helping the trainee to establish a sense of where this threshold should lie. The second is that by engaging with the mentor in these discussions, the trainee is also engaging with the film readers' wider community practices, since this sort of mutual calibration and informal review is an important component of normal screening work. The discussions between the mentor and trainee can be seen as an extension of these practices, rather than as a detached episode concerned solely with 'knowledge transfer'. Use of the training environment supports participation by providing opportunities to have one's own decisions questioned, and to question the decisions of others and, importantly, to see how this questioning is done—how decisions should properly be accounted for, what sorts of etiquettes should be observed, when to hold out, when to give ground and so on. Thirdly, because the mentor orients to the trainee as a practice member, for example, by treating their decisions as generally credible, the trainee can feel a degree of community acceptance that again helps marks progress towards full membership. This aspect can be seen in the way that the mentor takes care to build the trainee's confidence by careful choice of feedback, for example:

> Jane: No, you you've got two [i.e. found two lesions in the image] and the expert's only got one. For calcification lesion. So you've marked both the areas and the the so the expert hasn't seen the other one maybe … Yes, you're the smart one you see.

The 'expert' referred to is the experienced film reader who originally annotated the abnormality in the film. As far as the training environment is concerned the trainee's second annotation is in error because it does not correspond to a region marked as abnormal by the expert. However, the mentor and trainee are both convinced that the second lesion marked by the trainee is also clinically significant. The mentor is able to emphasise the trainee's own developing expertise by pointing out how it compares favourably against that of an 'expert'.

In comparison with the nuanced accounts of the trainee's performance provided by the mentor, the training environment's own feedback often fared badly. Both trainees and mentors disliked our early attempts at automated marking, which consisted of simple metrics describing how often the trainee had agreed or disagreed with the 'expert' opinion. The main complaint was that the marks did not distinguish sufficiently between more and less clinically important mistakes and painted an overly negative picture of the trainee's ability, which the trainees found to be both unpleasant and discouraging. Although we refined the marking system so that it could distinguish between different classes of error, and can imagine refining it further, the degree of nuance available from mentoring sessions will always surpass capabilities of the automated system. An obvious example is that the automated system would never be able to work out that the trainee had found an unmarked lesion as the mentor did in fieldwork extract above.

One issue evident in these extracts is the richness and contextualised character of the discussion between mentor and trainee, and how proxies are inevitably viewed as a consolation rather than a proper replacement. Even the training screening slip, while supporting better contextualised expert feedback than the training environment's automated provision, was still seen as 'second best' by Sara, who described it as 'having a conversation with a piece of paper'. One important reason for this is that the rich learning opportunities afforded by conversing with a mentor arise not because a trainee straightforwardly has access to their knowledge, but because those discussions are actually constitutive of participating in a community of practice. This is perhaps also indicative of the general sorts of struggles apprentices have in accessing appropriate learning opportunities against the backdrop of competing demands on the 'masters' time. There is a legitimate balance to be struck between regulating learners' access to organisational resources and the provision of rich learning experiences, with important questions arising for CSCL at Work as to the opportunities technology provides both for holding learners at arm's length and for drawing them in.

The Training Environment as a Technology of Participation

In this section we compare and contrast use of the mammography training environment with current workplace-based training to show how each mediates access to craft materials, expertise and arenas of practice in very different ways. We are not presuming that our training environment could replace current training practices in the near future, or that this would necessarily be the most effective mode of use. Rather, the comparison aims to illuminate the differing affordances of the two approaches. That said, with breast screening centres in the UK poised to adopt digital mammography, it is not implausible to think that training provision will follow suit in time. Our comparison also presumes that the computer-supported training environment is used as an independent learning resource—that is, used without explicit collaborative activities involving other learners, or mentors. Again, this is not a realistic assumption, but examining how delivery of a vanilla computer-based training programme stacks up against current training practice gives us purchase for identifying collaborative affordances that could be usefully built into the computerised tools. The dimensions of comparison are summarised in Table 6.1.

Curation

In the conventional approach to training, craft materials (images, cases) are used naturalistically; but in the computer-supported training environment they have to be curated. That is, cases have to be selected for inclusion in the training archive and case materials then need to be marked-up or annotated with meta-data—i.e. the 'ground truth' (diagnostic information where available) and information that afford subsequent case discovery, selection and reuse for training purposes. Importantly, much of this curation work must typically be repeated on a regular basis if the contents of the archive are to remain 'fit for purpose' over time.

Table 6.1 Comparison of computer-supported training with conventional, 'on-the-job' training

	Computer-supported training	Current training
Curation	Cases have to be selected for archiving and case materials have to be annotated	No preselection of cases—trainees see everything
Case mix	Possibility of broadening access to cases from other centres	Case mix limited to what is available at the individual centre
Location	Potential to be inclusive of participants at a distance	Benefits of co-location—access to context
Expertise	Access to codified expertise	Access to actual experts
Realism	Relations to 'real practice' have to be explicitly attended to	Realism can be taken for granted
Tracking progress	Records kept of trainees' decisions	Trainees' decisions ephemeral

Table 6.2 Relation between locality and training approach

		Locality	
		Within clinic	Beyond clinic boundaries
Training approach	Conventional training	Good access to practice arenas	N/A
		Not able to see full spectrum of abnormalities	
	Computer-supported training	Good access to practice arenas	Limited access to practice arenas
		Access to a very broad spectrum of abnormalities	Access to a very broad spectrum of abnormalities

Case Mix

In current training, what trainees see is limited to cases available within the individual centre and does not exhaust all abnormal presentations. The mobility of digital data means that the digital training environment has the potential to provide access to cases sourced from different clinics, and so affords trainees' exposure to a broader range of abnormal presentations and training materials.

In this sense, the use of digital content may be seen as expanding the horizons of the trainee beyond the boundaries of the physical workplace. However, this may not be so straightforward as it might seem. Coopmans (2006) has challenged assumptions that mobility of data is afforded by digitisation alone, lending weight to claims that data is not so easily disentangled from—and hence used beyond—the context of its production (Carlson & Anderson, 2007). 'An understanding of mobility […] draws attention to the craft like nature of that achievement: the artful connecting of time, space, material and immaterial elements into a "mobility effect"' (Coopmans, 2006, p. 7). This view is corroborated by our own findings, which we report in more detail elsewhere (Hartswood et al., 2012).

Location

Using the training environment a trainee would be able to access craft materials in a location-independent way making participation more convenient. Moreover, because digital training cases are anonymised, and can be accessed without attending a live clinical setting, various ethical barriers to participation are removed. Therefore, a training environment, such as the one we have developed, has the potential to be more inclusive of a broader range of trainees. In contrast, co-location in conventional training provides a potentially richer learning experience because trainees have direct access to the work setting. The different permutations of locality and training approach are illustrated in Table 6.2.

Keeping computer-supported training within the clinic was the solution offered by Kneebone et al. for surgery simulators (op. cit.), and while this, in some ways, offers the best of both worlds, once established, remote training is likely to open up possibilities that are equally attractive, such as increasing the size of training cohorts. When training is delivered outside of the clinical setting then one needs to consider how access to practice arenas can be otherwise mediated.

Access to Expertise

When used as a resource for independent learning the training environment provides access to codified expertise in the form of annotations delineating the location of lesions, an expert opinion of the case and a 'learning point' (both consisting of a short passage of free text). Much richer access is available in scheduled mentoring sessions, or informally as part of on-the-job training or asynchronously (in writing) via the training screening slip. It is notable from the fieldwork extracts that encounters with experts during mentoring sessions are unstructured, serendipitous, shift between different topics and are highly contextualised. Experts not only provide 'expertise', but they also provide reassurance, help to build the trainee's confidence and expose trainees to community practices associated with interpreting mammographic images.

Realism

Trainees understand that they are engaging with an environment that has components that are more or less artificial or intentionally fashioned. In on-the-job training trainees get to see everything and anything, whereas in a computer-supported training environment, trainees only see a pre-compiled set, put together with a particular purpose in mind. One question that arises is that of validity of the learning experience in relation to the 'real' task. While realism in conventional practice can more or less be taken for granted, realism in the training environment is something that always has to be attended to.

Tracking Progress

In current mammography training, training screening slips are thrown away. They are ephemeral. Outcomes of decisions in the training environments have a much more permanent character. In some of the fieldwork extracts we saw how the trainee managed this formal aspect of computer-supported training. On occasion, retrospective examination of errors provided trainees with a sense of how they had progressed between sessions using the training environment.

Discussion and Implications for CSCL at Work

We have seen above how the computer-supported training environment provides potentially significant benefits over current mammography training practice. However, it also raises a number of issues whose resolution we argue has broader relevance for CSCL at Work.

Collaborative Approaches to Curation and Case Mix

Our experience in this project is that exploiting digital archives—selecting training cases, creating and renewing training content—is a time-consuming task heavily constrained by the availability of expertise. The 'handcrafted' approach to producing training materials that we have relied on to date does not scale well. One alternative lies in the exploitation of 'social media' approaches, which have demonstrated that the markup of shared content can be distributed effectively between community members, a practice often referred to as 'social curation' (De Roure et al., 2010).

It would be important to explore, for example, how, by harvesting information generated as a by-product of the use of the training archive, social curation could be used to add value incrementally to it and thereby shift the burden of preparing and curating training materials from a small number of experts to the wider community of mentors and trainees. The adoption of social curation techniques may also provide a solution to the challenges of making case materials usable for training beyond the context in which they have been produced.

Collaborative Approaches to Problems of Location and Access to Expertise

Counter-intuitively, it is likely that trainees evaluating the training environment had more dependable access to expertise than they would in conventional training because of the mentoring sessions explicitly scheduled as part of the evaluation process. If deployed 'for real' it is likely that use of the environment would be more along the lines of an independent learning resource. The question arises then of what collaborative affordances might we use to ease access to expertise for users of the environment? This question is especially pertinent when training is remotely delivered to trainees, whose access to the clinical as an arena of practice will be greatly curtailed.

One approach would be to provide a digital version of the training screening slip with supporting experts' comments on trainee decisions for cases that the trainee flags as significant. In a digital version, the expert's comment could then be shared with *any* trainee who makes a similar decision. Thus, decisions and comments made by individual trainees and mentors could be exploited to benefit the wider learning community. Another approach would be to capture trainee reading or mentoring sessions on video and sharing these with other trainees to support 'vicarious learning' (Lee, 2006).

Collaborative Approaches to Problems of Realism

One important aspect of the mentoring sessions was the work done to relevance the trainees' experiences of using the environment to their 'real-world' practice. Many of the suggested collaborative affordances in this section support relevancing work of one form or another. It is worth pointing out, however, that it is hard for someone to engage in helping you find relevance in your use of the training materials unless they have some understanding of your accomplishments and requirements as a learner. This perhaps suggests the importance of supporting a relationship with a *single* mentor over the course of an apprenticeship. However, communities could play a significant role here too—communities of learners in particular (which our research did not explicitly examine), who presumably also engage in collaborative relevancing work which could be amplified with appropriate computer-based tools.

Collaborative Approaches to Problems of Tracking Progress

An important aspect of providing collaborative affordances based on traces of the trainees' work concerns confidentiality and control. Trainees sought to maintain interpretative privilege over their performance as recorded by the environment, and a permanent record of trainee performance opens up the possibility of its appropriation for audit purposes in ways that might be controversial. For this reason, questions have to be explicitly addressed concerning who has access to the trainees' record on the training environment and under what circumstances.

There are a number of ways in which CSCL at Work could provide 'biographical support' to assist trainees measure their progress over time. Most obviously, perhaps, are basic numerical scores detailing correct and incorrect decisions that can be compared if this or other sets are (re)taken on a future date. The sorts of occasions detailed above, however, provide additional opportunities for richer measures of progress. For example, identifying cases that remain hard for the trainee to interpret accurately provides a convenient way of indexing cases that require further review and reflection, which might then be reinserted into future training rounds (comparison with other trainees' performance on those same cases would help to establish if they are intrinsically hard). As the trainee accrues still more experience they will presumably struggle with fewer of these cases, demonstrating how and where they are making progress, and where the trainee still struggles with certain types of interpretative task then training exercises can be tailored to address these specific weaknesses. If it is possible to establish the lessons represented by each case, then it would also be possible to present trainees with biographical account of what they have learnt.

Concluding Remarks

In this chapter, we have attempted to address the question of how one might evolve CSCL at Work to take advantage of the opportunities afforded by digital media to enhance mammography training.

Medical training is complex: it is multifaceted and is layered over several years. The impact of any one element of training may be hard to gauge, yet somehow each contributes something to the trainee's growing technical and professional competence. If we consider the impact of a training environment such as this one from the perspective of the totality of the trainee's education then its overall impact is likely to be small. Also, we can see that it depends on aspects of that wider training for its own effectiveness, both in terms of the prior learning needed to be able to draw lessons from using the environment and subsequent learning where those lessons become a resource in further assimilation.

In the fieldwork we could see how trainees and mentors relevanced their experiences by linking them into a broader narrative of the trainee's progress and professional development. Each trainee's narrative orders and makes sense of a diverse array of individual experiences while at the same time having a common overall shape for all trainees, that is, one defined by specific passage points (passing a radiology exam), fixed durations (the length of a rotation), expected outcomes (a professionally capable individual) and so on. Much of this relevancing work and narrative construction turned out to have significant collaborative dimensions, visible, for example, in the way that the mentor demonstrated the trainee's progress by contrasting prior mistakes with current abilities. Identifying these allowed us to focus on ways of enhancing and extending collaborative relevancing work, including tools that more effectively provide 'biographical support' for individuals to better gauge their own progress, and tools enabling aspects of individuals' learning experiences to be shared with the wider learning community.

During the development and evaluation activities outlined above many possibilities emerged for enhancing computer-support for training in mammography that we have yet to fully explore. Among these include capturing a richer account of the context in which trainees made their decisions. This could involve using audio capture, capture of training environment use (e.g. mouse and keystroke events), capture by video of gestures, eye movement tracking and so on. While (as we saw above) there are cases for which there would be little interest in forensically reconstituting trainees' reading, in others it might be highly productive and generative of opportunities for additional learning.

The development and evaluation of the mammography training environment have entailed exploring how a CSCL at Work intervention can be made ‘at home’ in the context of a sophisticated and mature regime of training delivered in a complex, professional workplace setting. While evidently capable of generating rich opportunities for interaction between trainee and mentor, as highlighted in the sections above, use of the training environment also challenged mentors to develop new competencies and rethink the role and character of training delivery for different groups of trainees. While computer-supported training offers flexible and configurable modes of delivery, by the same token it raises questions as to which modes and configurations best suit which training circumstances. The ability to tailor content is a significant benefit of computer-supported training, but it also places additional demands on content creators, who have to acquire skills in set creation and invest considerable effort in curating training cases. Our experiences in this project show that a traditional, linear curation process has significant bottlenecks that inhibit large-scale mobilisation of digital resources, and we have suggested social curation, where reliance is placed on harvesting community rather than individual expertise, as an alternative.

CSCL at Work provides the opportunity for re-envisioning the breast screening workplace and, in particular, its boundaries as a community of practice. Conventional film-based training is necessarily rooted in a very clearly bounded locality: the breast screening centre that provides a ‘home’ for the trainee and is the source of both mentoring expertise and craft materials. The move to digital images, with their presumed mobility, opens up the prospect of creating a much larger, federated resource of training cases accessible beyond the physical walls of the individual breast screening centre. Delivering mammography training outside breast screening centres may offer a number of advantages, not least of which would be increasing trainee numbers, but comes at the cost of limiting access to arenas of practice. Creating rich and portable representations of practice and expert engagement that can be shared and elaborated by other community members is perhaps one way of allowing community practices to be remotely accessible alongside training materials.

Finally, the presumed mobility of digital content is a key enabler of the possibilities outlined above. However, we suggest that making digital content reusable beyond the immediate context in which it has been produced is a major challenge and makes it unclear to what extent mammography training might take advantage of the opportunities offered by CSCL at Work. On that specific issue, social curation is one possible way forward, but much remains to be learnt about how to exploit this in practice. If social curation turns out to be a viable and effective technique for resolving problems of reusing digital content in mammography training, then we would expect it would have much wider significance for CSCL at Work.

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Chapter 7
Collaborative Reflection for Learning at the Healthcare Workplace

Michael Prilla, Thomas Herrmann, and Martin Degeling

Introduction

As we know from practical experience as well as from the literature (e.g., Carell & Nolte, 2010), human work has two main characteristics. On the one hand, it contributes to the completion of a concrete task and creates a value. On the other hand, every process of work has its history (Engeström, 2000). Therefore the same task is rarely conducted in the same way by the same group of people and the completion of a task leads to a process of adaptation through which the work environment, tools, information basis, etc. are continuously altered. Workers improve their status through training and enhance their competence. Subsequently, learning at the job takes place. This kind of learning is considered as informal learning (cf. Eraut, 2004). Learning on the job is a multifaceted phenomenon, which combines the learning of facts (learning what) and methods (learning how), the construction of new knowledge, and the moving from the fringes of an expert community to its center (Lave & Wenger, 1991). By contrast, formal learning takes place at occasions which are planned and scheduled in advance and within special behavior settings that are explicitly dedicated to learning as it is the case with classical trainings or courses (e.g., for using a computer software), symposia of experts, etc. Other cases, like job rotation, are in between formal and informal learning. The opportunity for learning is formally organized but the process of learning happens in relation to the work itself.

While CSCL-research has been primarily focused on supporting collaboration for preplanned courses and classes there is little attention for the question of *how informal collaborative learning can be integrated into the everyday work processes*.

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Therefore we argue that new ways of CSCL, as they are relevant in the context of work, are facing their strongest challenge with respect to informal learning.

Learning takes place when the learner reflects on what s/he is or was doing and draws conclusions from this by contrasting his/her experiences and knowledge with the experiences of others (Daudelin, 1996; Murray & Kujundzic, 2005; Schön, 1983). We examine integration between informal learning (in daily work settings) and (critical) reflection (Prilla, Knipfer, Degeling, Cress, & Herrmann, 2011) about events during work to enhance problem solving and discovery of opportunities for organizational improvement.

Reflection is a cognitive process, which becomes apparent and observable for others when it takes place collaboratively during articulation work (Schmidt & Bannon, 1992). We use the term "collaborative reflection" to describe reflection that is accompanied and enabled by communication between people who can contribute to it on the basis of their own experience. This collaboration can emerge spontaneously and does not require the context of an established group. Consequently, questions and results produced by reflection are shared with others. During collaborative reflection, existing knowledge contributed by others will be combined with the construction of new knowledge that emerges during the communication about work practices and the accompanying challenges. Therefore, we consider collaborative reflection as an important foundation for CSCL at Work.

From this perspective one of the key questions to be asked is about how individual reflection and learning on the job can be intertwined with collaborative reflection, and how to provide appropriate technical support for collaborative reflection. Work-related reflection, whether individual or collaborative, is a constructive activity when:

(a) Incompatibilities occur or exist between (1) the procedure of task completions and (2) the workers' experience, expectations, or competences, e.g., with respect to facts or to methods.
(b) Diverging opinions, experiences, or beliefs exist as they are expressed during communication with colleagues (Stahl, 2000).

CSCL at Work faces the challenge of supporting workers in both conditions where reflection is called for. Workplace triggers for reflection are different than what are found in more typical CSCL scenarios, like the university-oriented one depicted in Fig. 7.1.

It helps to explain the differences between informal and prepared learning opportunities at schools or universities. At work, there is no teacher who prepares material or tasks. The material is generated by the workers' activities. CSCL, however, can help to capture this material and make it a location for learning. In the workplace, "teaching" is supplanted by initiating, coaching, or facilitating activity focused on collaborative reflection. Feedback regarding the success of learning will not be provided by a teacher, but partially by the work situation itself or by other people in the worker's organization who are interested in the outcome of his/her work, not necessarily in the progress of his/her learning.

This chapter presents an analysis of the prerequisites for CSCL at Work with respect to the situations, roles, and material helping to initiate and to promote

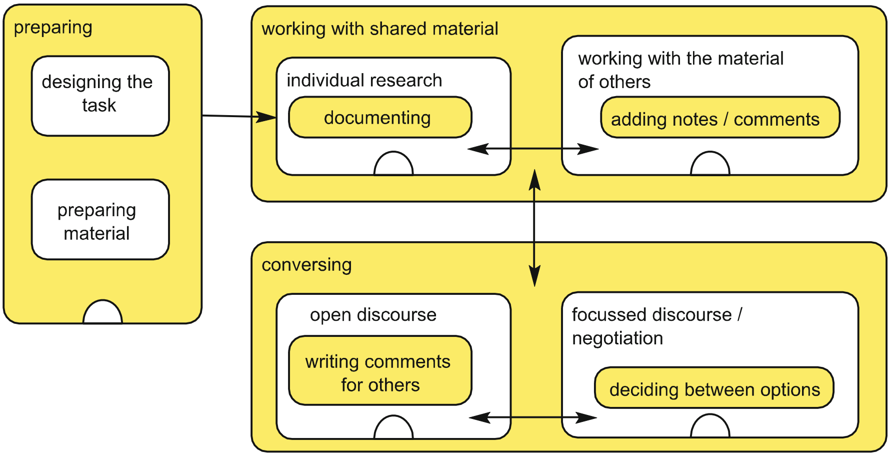

Fig. 7.1 Typical schema of course-based CSCL

learning by collaborative reflection at work. Therefore, we present the result of two case studies that analyzed the extent to which reflection at work already takes place and possible ways to enhance workplace reflection in support of CSCL at Work.

Sociotechnical support for collaborative reflection and learning has to consider several questions which arise in each case:

- How can different processes of reflection—e.g., planned and unplanned—be supported?
- Where does reflection start, individually or collaboratively (what is the topic, individual work or group work)?
- How much time, material, and support should be available (few minutes or several hours; strict guidance or just orientation)?
- Which roles are relevant to support collaborative reflection?

These questions are closely related to those raised by Fischer (Chap. 2), related to the role of media in facilitating discussion and dialogue for reflective communities. When designing sociotechnical systems for learning situations in which the answer to a question is not known, modes of reflection including the differentiation of roles (e.g., participant and helper/facilitator; see, e.g., Table 7.4) as well as opportunities for reflection at the workplace need to be considered.

Collaborative Reflection at Work: Background and Open Issues

Here, we present models of work and their relation to learning.

Figure 7.2 differentiates two perspectives on work and will be used to explain their relation to reflection and informal learning in the following. As shown in the figure, human work usually combines manual and cognitive work, as well as work in solitude with communication and collaboration. Human work becomes more

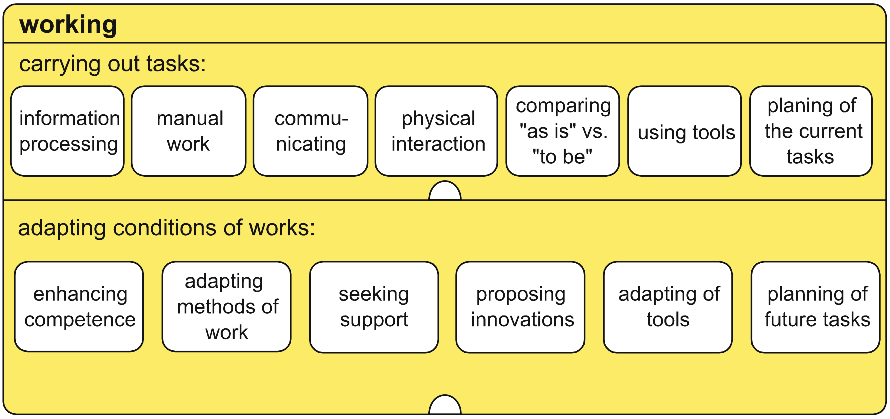

Fig. 7.2 Work task adoption

complex and interesting for the workforce as needs for planning and coordination increase—this is typical for distributed work. Planning is triggered by a comparison between the projected goal and the current status of task completion. Subsequently, these comparisons can reveal that the workers have to adapt their strategies and work conditions. This leads to a higher level of work, during which learning takes place, methods are altered, support is sought, tools are appropriated differently, and other forms of adaptation occur. These indicators are accompanied and supported by a kind of implicit reflection that is—if it takes place—inseparably combined with the daily work. There is a possible fluent transition to explicit reflection, which leaves traces in documents or becomes articulated if it takes place during communication with others. Figure 7.2 expresses that *carrying out tasks* can, but does not need to, be combined with the reflection and *adapting of work conditions* and behavior during work. There are cognitive and communicative activities which are mainly focused on completing the task, but not on learning how future work can be carried out more efficiently, less stressfully, more satisfying, etc.

Reflection as a Decisive Mechanism of Learning at the Workplace

Learning at the workplace, when done informally, means learning from experiences rather than learning from cases presented by a teacher or a facilitator (cf. Eraut, 2004). In this context, reflection is viewed as a decisive mechanism for learning and for learning at work (cf. Argyris & Schön, 1996; Boud, Keogh, & Walker, 1985; Kolb & Fry, 1975). Such reflective practice can lead to a deeper understanding and enables the learner to advance her thinking beyond reproduction of what, e.g., a teacher has said.

Reflection can be defined as going back to (past) experiences, reevaluating them, and drawing conclusions for current or future behavior from those reflections

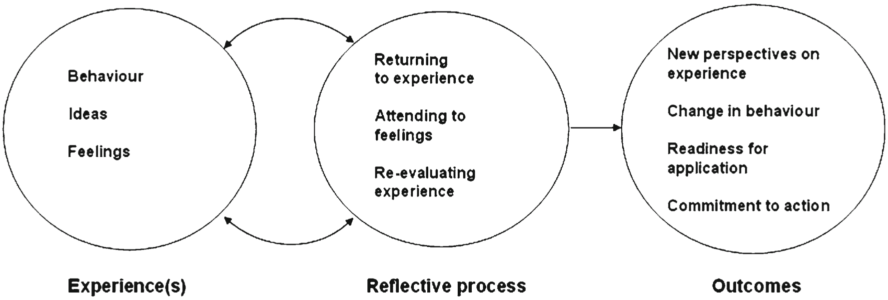

Fig. 7.3 Reflection model by Boud et al. (1985)

(cf. Boud et al., 1985). Reevaluating experiences can then lead to a different or a better understanding of practice and thus enable learning about it, potentially leading to changes in future behavior (cf. Järvinen & Poikela, 2001; Moon, 1999). Learning by reflection has to be seen as closely related to other types such as problem-based learning (cf. Schön, 1983)—learning from problem solving requires reflection on past problem-solving experiences, particularly in those cases where problems may be solved by reflecting on the occurrences in practice.

According to Boud et al. (1985), experience consists of past behavior, ideas, and feelings towards these (see Fig. 7.3). Reflection requires the person to mentally return to past experiences and feelings to reevaluate them. What differentiates the reflective process from mere ruminating is that reflection has an outcome. Boud's model shows that this outcome includes new perspectives on one's own experience and either changes in behavior or at least knowledge and readiness for changing it. It is at this point when learning occurs through reflection. The model in Fig. 7.3 also indicates that reflection can occur multiple times during a workday. Thus, reflection should not be thought of as a restricted, episodic process, but as one that is frequent and ongoing.

Returning to one's own experiences is central to reflection. Individual memory is however limited. Memories fade and can be hard to return to without recorded data or prompts from others. Groups of people working together can help to trigger memory. Individuals can support their own reflection through personal journals (e.g., Loo & Thorpe, 2002), personal learning environments, (e-) portfolios (e.g., Scott, 2010), or pictures (Fleck & Fitzpatrick, 2006). In addition, data produced during everyday work, along with artifacts produced in work, can support reflection (Knipfer, Prilla, Cress, & Herrmann, 2011).

Most models and approaches to explaining or supporting reflection are focused on individual reflection and the individual process of learning. As a consequence, individual reflection processes are well understood (cf. Boud et al., 1985; Schön, 1983). Collaborative reflection, in contrast, is a more social process that is less examined in current literature. Collaborative reflection and collaborative learning by reflection are the focus of our work, and explained in the next section.

Collaborative Reflection

Informal learning is a primary means for learning in the workplace (Eraut, 2004) and learning through collaborative reflection is potentially an important contribution to CSCL at Work (e.g., Dyke, 2006; Hoyrup, 2004; van Woerkom & Croon, 2008). The understanding of reflection as an essential part of workplace learning, however, needs further research (cf. Knipfer et al., 2011).

The difference between collaborative and individual processes of reflection is where the reflection is focused. In individual reflection, the focus is on individual cognition, while collaborative reflection requires communication and coordination between participants. Collaborative reflection processes can be thought of as "people engaged in finding common meanings and making sense of the collective work they do" (Hoyrup, 2004) or as "tool(s) for explicating and making implicit knowledge embedded in contexts" (Järvinen & Poikela, 2001). For collaborative reflection to occur, people must share their experiences and communicate about them. This leads to shared meaning making (cf. Daudelin, 1996; Forneris & Peden-McAlpine, 2006; Scott, 2010). Learning by collaborative reflection may then occur when an individual links her knowledge to the experience of others (Daudelin, 1996) or when a group combines different viewpoints stemming from its members' experience and reflects on them collaboratively (Hoyrup, 2004). Therefore, supporting collaborative reflection requires support for the communicative interaction and experience of people reflecting together.

Collaborative reflection is often focused on specific situations, such as debriefing sessions and project review meetings (e.g., Boud et al., 1985) or regarded as an activity initiated by an individual seeking help for her/his own reflection (e.g., Yip, 2006). However, there are also voices claiming that collaborative reflection can happen along a spectrum ranging from informal talks to scheduled meetings (cf. Daudelin, 1996; Dyke, 2006). Research focused on how commonalities or differences in such settings contribute to collaborative reflection is limited. To support learning from collaborative reflection, it is therefore necessary to explore the characteristics of effective collaborative reflection in practice and to differentiate between various settings in which it occurs.

Understanding whether or not collaborative reflection is occurring is difficult. Not all discursive interaction or collaborative problem-solving situations can be considered as collaborative reflection. Observing and analyzing situations of reflective learning and not conflating them with other learning processes are, therefore, critical. One key perspective on collaborative reflection in practice can be found in the work of van Woerkom and Croon (2008). They explain typical indicators for reflection such as "critical opinion sharing" during discourse, not sticking to agreed-upon opinions and standards, "challenging groupthink", "asking for feedback" on one's own actions, "experimenting with alternatives" when solving issues, and "openness about mistakes" during daily working situations are vital components of collaborative reflection. Errors are not mishaps, but opportunities for learning. Using these indicators facilitates recognition of reflection in practice. Moreover, observing collaborative reflection in practice can both reveal additional indicators and help to differentiate the existing set.

Open Issues: Research Questions for Case Studies

Existing work on collaborative reflection provides information on its contexts, advantages, and problems as well as on its occurrence in practice. However, it is not sufficient to base the design and implementation of IT support for learning from collaborative reflection on insights from existing work (cf. Knipfer et al., 2011). Therefore, further work is needed to better understand the nature of collaborative reflection. In the next sections, we present an approach that builds on existing theory, and is guided by the following research questions:

Question 1 (*RQ* 1): Which processes of collaborative reflection are relevant in practice? What are their characteristics and what is their outcome?
Question 2 (*RQ* 2): How do communication structures and material influence learning by collaborative reflection in practice and how can these influences be used and supported?
Question 3 (*RQ* 3): Which roles and actors (the whole company or just special people) are present in collaborative reflection and what is their influence on learning in practice?

Since different scopes, participants, and ways of collaborative reflection result in different requirements, support for collaborative reflection through technology is better understood through an examination of these questions. To address them, we developed differentiation criteria for collaborative reflection in order to formalize the problem space of reflection support. This differentiation is presented in the next section and was used to inform the case studies presented in the section after that.

A Differentiation of Collaborative Reflection: Outcome, Processes, and Roles

Investigating collaborative reflection as a learning mechanism for CSCL at Work requires an understanding and differentiation of processes and characteristics used for such reflection. As described in the section on "Collaborative Reflection" (see above), one important differentiation is that between individual and collaborative reflection. Our focus is on collaborative reflection. In this section we elaborate on this and propose additional dimensions for differentiating collaborative reflection. These include the consequences of individual and collaborative reflection on the outcome of reflection, in general, and its dissemination. Moreover, to identify the inherent structure of collaborative reflection and possibilities to support it, we will focus on the connections between different processes, roles, and outcomes in collaborative reflection and elaborate on these facets.

Table 7.1 Reflection as a separate activity vs. reflection in parallel to work reflected on

Reflection occurrence	Example	Process
(Pre-)scheduled	Team and project meetings, handover sessions	Facilitated, planned, separated from other work
Concurrent/accompanying	E-mail-exchange on issues, iterative reflection on cases	Recurring, irregularly, in parallel to the actual task, when failures occur or opportunities become apparent

Table 7.2 Reflection by process (kind of reflection) and scope (kind of reflected work)

Kind of reflection/kind of reflected work	Individual reflection	Collaborative reflection
Individual	Reflection on own work; based on own experiences	Reflection on own work; complemented by experiences of others
Collaborative	Reflection of group work; needs *additional data* describing the work of others	Reflection on group work by sharing experiences and communication

Processes: Scheduled and Concurrent Reflection Occurrences

Processes of reflection take place in different settings and work processes, as Table 7.1 illustrates.

Scheduled reflection occurs in (regular) meetings and is present in nearly every organization—reflection can therefore be the main goal of the meeting or occur as one aspect of the meeting. In such settings, reflection is usually facilitated, well planned (e.g., triggered and constrained by an agenda), and separated from the work reflected about. In contrast, concurrent spontaneous reflection is done irregularly and during or in parallel to the work reflected about. It may take forms such as e-mail-exchange about work tasks or continuous reflection on cases like projects or, as in the case of healthcare, patients.

This differentiation implies that there is no single best way to support reflection, but there is a need to adapt support to the different forms collaborative reflection can take in practice. We view this as a continuum, rather than two distinctive categories, and this has to be exploited and complemented in further work.

Scope: Individual and Group Work as the Topic for Reflection

There is a distinction between individual and collaborative reflection. Besides the level of communication and coordination present in collaborative reflection, these levels can also be differentiated by the kind of work reflected about, as Table 7.2 shows.

Individual reflection is a suitable mechanism for learning about individual (own) work. As Table 7.2 shows, individual reflection can also be applied to collaborative work, but is not a good choice for it, especially if aspects of work done together are the subject of reflection. As noted above, thinking about group work

Table 7.3 Reflection by process (kind of reflection) and kind of knowledge as outcome

Kind of reflection/kind of outcome	Collaborative reflection	Individual reflection
Individual knowledge	Knowledge about own behavior from discussion with others	Knowledge about own behavior
Shared knowledge	Knowledge on group behavior, already shared among participants	Not applicable

Table 7.4 Roles being active in collaborative reflection

Role	Task in reflection	Member of reflection group
Reflection initiator	Bringing up reflection topic(s)	Yes
Reflection participant	Adding experience in reflection, sharing context with initiator	Yes
Reflection helper (facilitator, coach, etc.)	Facilitating/supporting reflection process	No

requires sharing of experiences and perspectives. Such shared experience is, of course, not present in individual reflection. Thus, if individual reflection is to be applied to group work, it needs to be supported by additional data representing these perspectives. In contrast, collaborative reflection can be about individual work when one worker articulates a problem and others share their experiences with her. This is a kind of collaborative work, as others can articulate their perspectives and experiences. This differentiation illustrates how collaborative reflection can be used as a learning mechanism.

Outcome: Individual and Collaborative Learning by Collaborative Reflection

One difference between individual and collaborative reflection can also be found in the quality or type of knowledge that is the outcome of learning by reflection. As Table 7.3 shows, individual reflection can only create individual knowledge (directly): the process of individual reflection cannot produce shared knowledge, as knowledge stemming from it will necessarily be bound to the individual in the first place. In contrast, both individual and shared knowledge might stem from collaborative reflection.

Table 7.3 shows that collaborative reflection can lead to both individual and shared knowledge. A reflection participant may acquire individual knowledge and competences (see Table 7.4 for a description of roles in reflection) when she learns about her work during reflection on similar work with colleagues. Shared knowledge can be acquired by the participants when they understand aspects of their cooperation better by reflecting on it and implement changes. In contrast to that, individual reflection can only lead to knowledge of the reflecting individual, who might share it with others. This differentiation also shows the value of collaborative reflection as a learning mechanism.

Roles: Actors in the Context of Collaborative Reflection

The support of collaborative learning requires an understanding of the different roles which are part of the learning process (e.g., Herrmann, Jahnke, & Loser, 2004) in order to understand the interaction processes, how it takes place, and the information flow demands of collaborative reflection processes and the support needs for each role participating in the process. Our initial differentiation of roles included three roles in collaborative reflection, which are shown in Table 7.4.

In our conceptualization of collaborative reflection, topics are brought in by a role we called "reflection initiator." This role is taken either by an actor who perceives a discrepancy or opportunity as described above or by an actor who is responsible for triggering reflection, for example, in meetings. Once reflection has started, "reflection participants" start to engage in collaborative reflection, sharing their experiences and perspectives with others in the context of the issue reflected about. As a third role, "reflection helpers" can be present. These helpers may facilitate the reflection process or support it in any other way. From this description it is evident that one person may take all of these roles in one or more different reflection sessions and that the person may change roles during a session.

It is important to notice that these roles can be differentiated not only by their tasks in collaborative reflection but also by their membership in what we called "reflection group." This group comprises those roles being active in reflection, which share (parts of) the context of the issue reflected with those who are capable of actively adding experiences to reflection. Obviously, initiators and participants belong to this group, while helpers are only present to support the communication and interaction during reflection, but do not add to it in any other way. Therefore, an individual being coached in her reflection and her coach cannot be considered as a reflection group doing collaborative reflection. However, roles are not static and one actor may take different roles in the same reflection process. Further investigations as described below are needed to better describe the dynamics and impact of different roles in collaborative reflection.

Exploring Collaborative Reflection in Healthcare: Two Case Studies

Based on our insights from the literature (see section "Collaborative Reflection") and to find answers for the questions described above, we conducted two empirical case studies exploring the characteristics of collaborative reflection in healthcare practice. For this, we chose two organizations from Germany and the United Kingdom (both in healthcare services), which, aside from the obvious cultural differences, had similarities and differences that enabled broader insight into the practice of collaborative reflection in healthcare.

Our case study work was aimed at gaining an understanding of collaborative reflective learning for the purpose of developing tools to support such processes in practice. Our work in the two organizations was exploratory and focused on gathering case study data. Next, we briefly describe the methodology and how it was applied in our two cases.

Methodology

The gap in understanding of the practice of collaborative reflection led us to conduct exploratory studies. We performed interviews and observations at two different healthcare sites, analyzed the transcripts and notes, and subsumed our findings for each site. For analysis, we used a process aligned with Grounded Theory (cf. Strauss & Corbin, 1998).

Interviews were mainly used to clarify rationales, needs, and wishes of certain people within the environment studied. We explored reflection needs and possibilities in depth. We initially pursued a set of questions concerning the work conducted by the employees at each site, including its special characteristics, aspects of learning and motivation in daily work, communication and collaboration during the day, as well as existing and envisioned practice of individual and collaborative reflection. Examples of questions posed are “When and how do you communicate with others about your work?” or “Please give an example of when a colleague talked to you about his work-related experience.” Interviews lasted between 45 and 90 min. Each interview was audiotaped and later transcribed literally. For analysis, we used a coding scheme containing indicators for collaborative reflection developed by van Woerkom and Croon (2008), described earlier. For example, *asking for feedback* is an indicator of reflection occurring when one person asks others to give feedback on her work from others’ experience. In our analysis, for example, we coded a situation in which nurses asked each other to assess and validate the treatment given to a patient during the day (see the description of case 1 below for details).

Observation was employed to understand what people in the test beds do all day. For example, when do they have time to communicate, what do they do in meetings, or where do they gather for informal conversation? The observation methodology was adapted to the different settings at each site, as described in detail below. In general the observation documentation was based on a scheme developed to contain all relevant aspects we wanted to observe at the partner organizations. This included occurrences of reflection and their detailed description, data and artifacts used by people during the day, IT support for work, and interaction among people. During the observation, each situation was written down with context data such as time, place, and participants. These notes were then transcribed and coded with the categories

Table 7.5 Hospital staff interviewed and observed in case 1

Participant	Profession/position	Age	Observation	Professional experience
P1.1	Nurse	41	–	8 years in case 1/25 in total
P1.2	Nurse	27	2 days	5 years in case 1/10 in total
P1.3	Physician	29	2 days	2.5 months in case 1/2 in total
P1.4	Therapist	25	–	3.5 years in case 1/same in total

from the observation scheme and the scheme used for the interviews. To include different perspectives in observations and to avoid a bias, we always had two researchers doing observations in parallel, working with different subjects. In the studies, we observed two people for 2 days in case 1 and several meetings of caregivers in a timespan of 3 days in case 2 (see the details in the case descriptions).

In the analysis of the studies, we used interviews and observation to complement each other. In interviews there is a risk that outcomes are based on particular episodes and incidents not typical for everyday work; observation allows for insights into daily work to overcome some limitations of interviews. Moreover, reflection can happen unconsciously and tacitly. Thus, interviewees might not be able to sufficiently describe their practice of reflection and the value of interviews is limited. Observations can then help to recognize reflective behavior of workers and make it explicit. On the other hand, a few days of observation cannot result in an overview of all aspects relevant for workers. To fill this gap we triangulated interview data with observations, and asked informants to provide an overview of their work as part of the interview process.

Cases

Our case studies were done in two healthcare organizations. One was a neurological hospital from Germany (case 1). The other was a home care association for dementia patients from the United Kingdom (case 2). These cases share some characteristics, but also differ from each other in order to allow for more solid and general results of our studies.

The target group we interviewed and observed for case 1 consisted of physicians and nurses serving in a hospital stroke ward (cf. Table 7.5). All of the employees in the ward were highly trained and educated to provide care to stroke patients and increase patient's well-being, leading them to be eager to continuously learn about their work and patients. However, time pressure is a barrier to informal learning and in the ward, there is hardly any IT support for nurses, though physicians have access to computers and the Internet. In case 1, we observed the work of physicians and nurses for 2 days each by accompanying them throughout their workday. This, as described above, included coordination and communication of people in the ward (both within professional groups and between nurses and physicians), data being used and produced during work, as well as occurrences of collaborative reflection during the day. Since both professional groups work in shifts, we included handover

Table 7.6 Caregivers interviewed and observed in case 2

Participant	Profession/position	Occupation	Age	Professional experience
P2.1	Senior caregiver	Home 1	48	20 years
P2.2	Caregiver	Home 1	49	3 years
P2.3	Senior caregiver	Home 1	39	3.5 years/6 years in total
P2.4	(Junior) caregiver	Home 1	19	1 year

meetings in the observations as well. In addition, we interviewed the physicians and nurses being observed and conducted three additional interviews with nurses in order to gain broader insights into the work in case 1 (see Table 7.5 for details).

In case 2, the target group consists of the so-called caregivers, who are responsible for the daily care of residents in care homes (cf. Table 7.6). This includes all but medical help during the day (medical help is provided by the home's nurse, who is a superior to the caregivers) such as washing residents, serving them food, and keeping them entertained during the day. In contrast to case 1 and according to the care home management, caregivers in case 2 are usually not well educated and even literacy may be a problem. For example, one caregiver we interviewed was 19 years old and had been a kitchen helper before working as a caregiver. Caregivers, like their higher status counterparts in case 1, were highly motivated and willing to learn how to improve their care for people. One mitigating factor in case 2 is the high turnover rate in care homes. In the home, there is no IT support except a care management system in which caregivers document their work. In our study in case 2, we were able to observe several meetings of caregivers in a period of 3 days, which included both regular meetings and handover sessions between shifts. In addition, we conducted four interviews with care staff with different levels of professional experience, ranging from the 19-year-old beginner to senior caregivers doing their job for over 20 years (see Table 7.6 for details).

As can be seen from the description above, besides similar domains, the cases share certain characteristics such as care for people being the main work done, little IT support, and constant time pressure. On the other hand there are differences in country and thus working culture, in education of employees, and in the tasks done (medial and care vs. only care). As a result, the level of knowledge relevant for learning differs between the caregivers in case 2 and the nurses or physicians in case 1. These similarities and differences show that our cases reflect different perspectives on healthcare workplaces and thus provide a helpful contrast, presented in the results.

Collaborative Reflection in the Healthcare Workplace: Results from the Case Studies

The analysis of both cases led to detailed insights into processes and other structures influencing collaborative reflection at work. In the following sections, we present the most significant findings corresponding to our research questions, described above. In particular, we will refer to the characteristics of reflection in and outside meetings, to opportunities and constraints of collaborative reflection at the health-care workplace, and to the roles and actors engaging in the collaborative reflection processes.

Reflection in Meetings

During our studies of both cases, we observed several occasions in which collaborative reflection happened during meetings. Due to the characteristics of the healthcare workplace such as working in shifts and patients being the center of work, there are daily meetings for handovers between shifts and fewer organizational level meetings. Less frequent meetings can be held regularly (e.g., monthly ward meetings in case 1) or sporadically (e.g., spontaneous "reflective meetings" triggered by current issues in case 2).

We observed handover sessions between different shifts in both cases and daily ward rounds comprising physicians and nurses in case 2. In case 1, handover sessions were run by a nurse, who summarized the shift for her colleagues and informed them of the most relevant issues to be taken care of. In case 2, these meetings are not run by a caregiver, but by the home's nurse. In both cases, there are also handover talks between individual caregivers or nurses responsible for the same resident or patient, respectively. In handover meetings, staff collaboratively reflect by asking each other for feedback on care given to a resident during the day (case 2) or by making proposal for interaction with patients based on experiences with similar or the same patients (case 1). In daily ward rounds, reflection is done across hierarchies between physicians and nurses when physicians ask about patients' well-being to understand how their treatment worked: "I just ask: What happened? What's up? She [the nurse] tells me what happened yesterday or during the night and I reflect" (physician from case 1).

During meetings held biweekly or once per month, we observed reflection to be more structured, yet also more difficult with respect to creating a shared context. In both cases, such meetings were managed exclusively by senior staff such as senior physicians or head nurses (case 1) and managers or senior caregivers (case 2). In case 2, we observed the so-called "reflective meetings," in which a senior caregiver gathered other caregivers between shifts and triggered reflection by asking them to comment on some issues she had collected. In addition, caregivers were allowed to raise additional issues to be reflected about. As an example of topics discussed, we observed a meeting in which the senior caregiver told her colleagues that there was a problem in the on time supply for sanitary pads and asked everybody to comment how this affects their work and how they would change the situation. Reflection was done similarly in case 1, except for the additional component of a public agenda sheet where staff wrote down issues to be discussed. For example, the head nurse proposed to change the way breaks are taken in the morning because, on some days, these break times caused difficulty in the operation of the ward. After that, a critical exchange of opinions and experiences started on the topic. In both cases, follow-up tasks from collaborative reflection, such as dealing with open issues and implementing or propagating decisions, are left to the superiors who run the meetings. Returning to the example of the sanitary pads, during the reflection several alternatives and proposals were brought up, but the final decision of what to do was taken by the senior caregiver.

Informal Reflection Outside Meetings

Besides reflection as a part of meetings, we also came across occasions of reflection during the day. Although these occasions are harder to recognize both for our interviewees and the observers, our analysis shows that there are plenty of such situations and that they may play an important role in the support of collaborative reflection. Typical occasions of reflection outside meetings are breaks, working together on the same task or patient (resident), and spontaneous encounters on the hallway.

Most often, reflection outside meetings is done apart from the work to be reflected on. Such reflection then occurs when staff talks about problems in daily work during regular occasions such as breaks: "we […] do it on breaks really. We can sort of reflect on, if someone needs help or, if like we're doing well" (caregiver in case 2). Additionally, there are implicit routines asking each other for help with specific issues when sitting together during breaks: "Are there—any problems or something like that. Every problem we talk about together" (nurse from case 2).

Collaborative reflection oftentimes happens when, e.g., nurses or caregivers meet in the hallway and start a brief talk or when caregivers in case 2 intentionally approach colleagues perceived as knowledgeable partners on a certain topic: "Well, the seniors are always there, so mostly the girls go up to the senior and say 'Oh I've got a problem' or 'Come and discuss this.' And so we'll take them aside and discuss it and hopefully deal with it" (caregiver in case 2). Such occasions of reflection are usually related to special situations, such as incidents happening during the day or with emotionally positive and negative experiences. In case 1 nurses also intentionally involve other nurses in their work to ensure that their treatment of patients is correct and to explore ways to improve it. As an example of this, we observed groups of nurses iteratively going through the treatment documentation of patients during their shift and talking about similar cases they had been involved in.

Opportunities for Reflection

In both cases we observed, interaction with patients (or residents, respectively) and incidents of them were perceived as the dominant opportunities for collaborative reflection. Other opportunities, such as coordination and organizational issue meetings, were less prominent. For example, the majority of staff from case 2 reported that reflection was usually triggered by problems or interesting interactions with residents. One caregiver told us that a resident had aggressively attacked him and that he later reflected on his behavior before this attack with a colleague. Likewise, collaborative reflection occurred in case 1 in situations when an individual lacked understanding of a patient's situation or treatment and asked others to reflect on this situation together: "When I hand over the patient and something has happened during the day which I did not understand, I ask [a colleague]. Then I am on the safe side" (nurse from case 1). In addition, this also shows that reflection can serve the purpose of reassurance if its result is that everything was done properly.

In addition to the motivation of treating patients (residents) better, we found the healthcare staff from case 1 and 2 to frequently reflect for the purpose of preserving the well-being of nurses (caregivers) themselves. This became obvious both in situations in which nurses from case 1 approached other nurses to ask them what had happened because they perceived them to be emotionally affected or when caregivers from case 2 told us that they actively communicate emotional states to others in order to receive support or feedback: "if you come into work feeling low or something" (caregiver from case 2). Actively caring for others was especially present with more senior staff—for example, in case 2 a senior caregiver told us she felt a responsibility to add to the emotional stability of her younger colleagues.

In both cases, we stumbled upon situations where using artifacts together turned out to be an opportunity for collaborative reflection. In interviews with caregivers from case 2, for example, we were told that they often go back to notes they made during their work on previous days to find out more about the behavior of a resident. In addition, we observed a handover meeting in case 2 in which the caregivers talked about a resident's state and went back to older documents in order to see what had happened some days before. In case 1, we found reflection during the day to be partially guided by the documentation nurses and physicians made for each patient. Many times we saw two or more nurses gathering around this documentation and reflecting on treatment given to a resident. Both of these examples show that artifacts can guide and support the process of collaborative reflection, giving it one or more anchors to be discussed. It also suggests that closely binding the outcomes of collaborative reflection to existing documentation and other data is somewhat natural.

Constraints for Learning by Collaborative Reflection

Besides these opportunities, our studies also revealed some blind spots and more difficult areas for learning by reflection. We found a difference between junior and senior staff for both case 1 and 2 in their willingness and ability to adapt work or behavior as a result of reflection. For example, senior care staff in case 2 told us that they do not like to compare themselves to others, as they had found their way of working and thus, differences to others' ways were not relevant for them. This, of course, may constrain learning from other experiences.

In addition, we found staff to be aware of reflection on organizational and coordination issues only for a short time. Coming back to the break example from case 1, we observed that nurses often reflect on how to deal with an issue for a short time and then turn to other tasks. In this way, the outcomes from their reflection are less persistent because they are not articulated or made explicit in any other way. It was mentioned that these constraints on learning from collaborative reflection are not results of intentionally neglecting these issues. In contrast, they show that making nurses more aware of certain topics and supporting the sustainability of these topics create opportunities for extending reflection at the healthcare workplace.

Group Dynamics and Preferences in Collaborative Reflection

Our description of the planned and unplanned occurrences of collaborative reflection provides insight into the dynamics of reflection groups, including responsibilities for following up on reflection outcomes and the deliberate selection of collaborative reflection partners. In addition to that, we made observations which contribute to an understanding of who is chosen to be a reflection participant and when these participants are chosen.

First, in case 2 we noticed preferences in the choice of an adequate reflection partner. When asked, caregivers often reported that they had a preference to reflect with more experienced staff. Some caregivers also told us that they used issues and other occasions deliberately to ask for feedback on care for residents or to ask a more experienced caregiver to provide feedback on performance. There were a small number of instances when caregivers expressed a preference for reflection with individuals who have a similar experience level. Such preferences, however, were not present in case 1, where nurses and physicians told us that they mainly reflect with colleagues from their professional group, but indicated no particular preferences for reflection partners. This suggests that for less educated staff, experience delivered by seniors is more highly valued in collaborative reflection than it is for highly trained professionals.

Second, in both cases, when different *professional* groups were involved in work on the ward, we observed that only people from the same professional group reflected together. While this observation is easy to explain—staff from the same profession work more closely together and thus have more opportunities to reflect—it identifies possible future opportunities for learning from other professions in collaborative reflection. Furthermore, this observation reveals the importance of bringing together the right people in a reflection group, and it becomes apparent that there is space for improvement for reflection between less experienced caregivers. In addition, support by facilitation and guidance by more experienced employees can positively influence reflection between professional groups.

Results

In summary, we observed several occasions in which collaborative reflection took place. These occasions included meetings explicitly organized for reflection, reflection during regular meetings such as shift handovers as well as less formal situations of reflection, e.g., during breaks and when something unusual had happened. Reflection in both cases was mostly related to patients and their well-being as raising this is the primary motivation for caregivers as well as nurses. Less effort was therefore spent on reflection about organizational issues less often articulated and sustained by writing them down and coming back to them. Besides material to return to, the appropriate reflection partner(s) was reported to be another important factor for starting a collaborative reflection. Especially more experienced staff members or those with the same professional background were consulted for collaborative reflection.

The insights from our case studies as described above allow for a deeper understanding of collaborative reflection processes and learning in these processes in the healthcare environment. In particular, it helps to answer the research questions described above, which we strive to do in this section.

Question 1: Processes of Collaborative Reflection in Practice

Our initial understanding of different modes of collaborative reflection as described above included a differentiation of scheduled and concurrent occurrences of collaborative reflection. While in general this can be held up, our data shows that there is a need for a more detailed differentiation. As a consequence, we derived a two-dimensional scheme to describe modes of reflection along an axis between planned and spontaneous reflection and another axis representing reflection on past work events and reflection occurring during work. Table 7.7 shows the resulting matrix and gives examples for *situations* in which collaborative reflection happens according to this differentiation.

Table 7.7 shows that there are regular (scheduled) occasions, in which reflection can happen as part of the agenda or just spontaneously: While in meetings we oftentimes observe that reflection was triggered by explicitly asking for comments or feedback and was thus planned to happen; we also observed many situations in which it just occurred, e.g., during breaks by chance. In addition, a closer look at reflection during the work to be reflected about showed that this can also be bound to meetings being part of daily work such as handover sessions or ward rounds and that it oftentimes occurs spontaneously, meaning that a topic is pursued by a group of, e.g., nurses reflecting a patient's case over a period of some days, but that they do not explicitly arrange situation in which this reflection happens.

This differentiation shows that support for collaborative reflection depends on the mode of reflection to be supported. While more traditional methods such as facilitation and agendas were still applicable in many meeting-like situations such

Table 7.7 Occurrences of reflection (planned, spontaneous) and relation to work reflected about (separated, concurrent)

Type of occurrence/relation to reflected work	Planned	Spontaneous
Reflection on past work events/with a distance to work reflected about	Scheduled meetings in which reflection is the main task or may occur	Breaks, talks between tasks or at the beginning and end of work
Reflection occurring during work: integrated reflection	Handover sessions as part of daily work, in which reflection may occur	Continuous experience exchange on a patient while caring for her

as handover sessions and staff meetings, for spontaneous reflection the foremost need seems to be maintaining a shared context, as reflection in this case cannot be built on a well-defined description of the issues to be reflected about. Additionally, there is a need for short-time preparation of agendas in planned situations during work such as handover meetings. A challenge remains regarding the best way to support sustained collaborative reflection. While in meetings minutes might be created, this is less likely for breaks and not applicable for brief talks on the hallway. This does not necessarily influence the process of collaborative reflection itself, but the sustainment of its results, the possibility to share them with others, and their influence on future behavior (cf. Kimmerle, Cress, & Held, 2010 for the influence of externalizing knowledge on behavior). In addition, outcomes from one reflection session may be valuable for the next: for example, results from a reflection session during a break might be interesting for a weekly meeting but might be forgotten if not documented. Further research will need to shed light on such issues if collaborative reflection is to be supported adequately in healthcare workplaces.

Question 2: The Role of Communication and Material for Reflective Learning

Communication in collaborative reflection observed was oftentimes related to artifacts representing data and information on work. In case 1, nurses regularly revisited the folder with patients' data together with other nurses to rethink whether the treatment given was suitable for the situation. In case 2, handover meetings were supported by sheets showing a list of patients and a summary of important information to review, including the most recent events and plans for the upcoming shift. We have a few observations about the relationship between modes and context of communication and artifacts around which communication is centered:

- In spontaneous reflection there is a need for rapid context rebuilding, which is normally done verbally, for example, by telling stories about special events or explaining the excitement of the group. The relation of communication to artifacts is only present implicitly, e.g., when caregivers in case 2 refer to the information they got from the care sheets at handovers during reflection.

- In reflection occurring during work, artifacts are used more often and relations between them and communication are explicated. For example, during the reflection about a patient's case in case 1, nurses and physicians stand in front of the patient's folder and point to X-ray pictures and entries, using this data to reflect about the case.
- In planned meetings, artifacts are sometimes directly referenced. These artifacts are altered, e.g., by adding a comment expressing similar experiences and are used to structure the explication of reflection outcomes. For example, in case 1 during daily ward rounds physicians look at every patient's curve folder—the patients' health record at the bedside—review the data, and discuss possible treatments. Results of those discussions are directly noted down in the folder to guide treatment during the day.

As our observation indicates, the process of collaborative reflection and the dissemination of its results can benefit from verbal articulation, which keeps topics and results alive in the communication between workers. In addition, the act of formalizing communication by, e.g., writing it down can be understood as an initial process of individual reflection. Moreover, written artifacts such as minutes of meetings and other documentation can make experiences from communicative interaction available to a broader audience than direct communication, which can only be perceived by witnesses. We therefore propose to weaken the conceptual differentiation between what is regarded as data or material and what is seen as a result of articulation. For example, some entries into the curve folder by a nurse, such as a statement on a patient's progress during the day, can be seen as documented data on the patient *or* as articulations of the nurse's experiences with the patient—in the former sense, it is used as the mandatory documentation and in the latter sense, it becomes a useful communication statement for others working with the curve folder. The same applies for notes written into the daily care sheet by caregivers at a care home. Thus, while not every entry or note is related to reflection or becomes important for later reflection, understanding this dual character of documentation—work-related annotations and articulations of experiences—can be beneficial for conceptualizing the usage of data for collaborative reflection.

This usage of artifacts is related to the need of context reconstruction we observed at the beginning of reflection sessions, especially in scheduled and concurrent situations and when there are several people and perspectives included. Rebuilding is then done by telling stories or through existing, aggregated information. We observed different facets of this in each case: For example, when the break problem was reflected about in case 1, nurses needed to reconstruct occurrences of this problem by stories from the last weeks. In case 2, when the senior caregiver talked about the ordering of sanitary pads, participants of the corresponding meeting needed to tell stories about their work in order to illustrate this topic. Supporting this contextualization by documented stories might speed up the process of context reconstruction and thus leave more time to reflect on these topics.

Table 7.8 Detailed differentiation of roles in collaborative reflection

Role	Relation to old role	Task in reflection	Reflection group
Topic owner	Part of reflection initiator	Being interested in reflecting about an issue and responsible for triggering reflection	Yes/no
Reflection initiator	Part of reflection initiator	Becoming aware of topic to be reflected about and telling it to others/facilitator	Yes
Reflection sparring partner	Temporary reflection participant	Supporting a topic owner in (short-time) collaborative reflection without following up	Yes, temporary
Topic aggregator	Part of reflection helper	Collecting bits and pieces of issues to be reflected about and connecting them to topics	No
Session preparer	Part of reflection helper	Preparing an agenda and underpinning topics with tangible background (stories, etc.)	No
Reflection executive	–	Making decisions based on collaborative reflection results or following up on results	Yes/no

Question 3: Roles and Actors in Collaborative Reflection

The *roles* we identified from theory as described in Table 7.8 help to increase understanding about the tasks done during collaborative reflection and to elicit needs stemming from them. These may include initiating topics and communicating them to potential reflection participants, either in meetings or less formal, spontaneous collaborative reflection sessions. However, underpinning our assumption that this initial categorization was too coarse-grained, the analysis of our observation revealed additional types, which are shown in Table 7.8. This also shows another dimension of how our studies extend the understanding of collaborative reflection as a mechanism for learning at work.

Table 7.8 shows six additional (and preliminary) roles we were able to derive from our studies. Four of these roles are specializations of the roles presented earlier, another is a special instance of one of the earlier roles, and we also identified an entirely new role.

For the specialization of roles, we found that there is a need to differentiate between what we called a "topic owner" and a "reflection initiator." This differentiation stems from our observations described in the last section, in which we found that in meetings in case 1, some issues were brought into the meeting by a facilitator after she had been told about it by a coworker, while others were explained directly by meeting participants. Therefore, we decided to differentiate between the role perceiving a need for reflection (the reflection initiator) and another role actually triggering reflection and being responsible for the topic (the topic owner). This refers to observations in both of our cases, in which the person perceiving the need to reflect sometimes took charge of the topic in a meeting and sometimes handed over the charge for the topic to another person, who then brought it up. In support for collaborative reflection, our differentiation of these roles will allow a person to decide herself whether she just wants to communicate an issue or whether she wants to be the one standing in for it.

Another differentiation we found to be necessary are the roles of a "topic aggregator" and "session preparer." The topic aggregator collects statements made by coworkers and identifies a comprehensive reflection topic from them. The "session preparer" is responsible for providing the foundation for collaborative reflection, including a collection of stories to illustrate the practical impacts of certain topics. Although in practice this role is sometimes taken by the same person, this differentiation is necessary: As described in the results of our studies, we observed some situations in which a facilitator had brought up a topic, but the reconstruction of its context needed support by some other participants, as they were the ones who have experienced the situation to be reflected about. For the support of collaborative reflection this means that a topic aggregator should be able to involve session preparers actively into a topic.

We also found that there is a subtype of a reflection participant, which we called "reflection sparring partner" and who is involved in spontaneous occurrences of concurrent reflection. For example and as described above, in case 1 we often observed situations in which one nurse asked another to reflect with her the treatment given to a patient. These situations can be seen as short-term collaborative reflection, as one nurse asks the other for feedback and the other nurse contributes her experiences to the assessment of the treatment given. However, the other nurse afterwards goes on in her work, while the continuous reflection of the case (the patient) is centered on the nurse triggering the reflection. For the support of collaborative reflection, this means that there should be a possibility to temporarily involve others in spontaneous reflection processes.

There is also a new role in our concept of roles in collaborative reflection: The "reflection executive" stems from observations of meetings in which many people engaged in reflection, but decisions and follow-ups on reflection results were done by one (or a few) person(s). This was common across both cases and thus led to the new role. For applications supporting collaborative reflection, this means on the one hand that there is a need to determine one or more people being responsible for following up on results and implementing them. On the other hand, it also suggests implementing mechanisms for increased transparency on what happens after meetings with the results of reflection.

Our extension of the roles described in Table 7.8 can inform the creation of applications for collaborative reflection support. However, despite the level of details we were able to derive from our studies, we expect further explorations of collaborative reflection in practice—in healthcare contexts or elsewhere—to further extend the work we have done.

In addition to the focus on roles described above, our observation—that different professional groups reflect primarily within their group and that younger caregivers preferring seniors for reflection—points to the notion that the composition of the reflection group may be decisive for successful learning from collaborative reflection: If group composition influences reflection and its outcomes, then the characteristics of people, who were part of a group and make a difference in collaborative reflection (e.g., in comparison to other groups with different people), help to understand success factors and barriers to collaborative reflection in general. More practically, incorporating the composition of groups into a theory of collaborative reflection supports the preparation of scheduled reflection. However, to our knowledge there are no insights in effects of group composition of collaborative reflection available.

Conclusion and Perspectives for Support of Collaborative Reflection

Figure 7.4 summarizes the most important activities occurring in the course of collaborative reflection. The differentiation of roles as shown in Table 7.8 has been transformed into the corresponding activities. The numbers in Fig. 7.4 represent anchor points for technical support.

Figure 7.4 displays a process model of how reflection is interrelated to the work on actual tasks. It indicates where technical features and reflective communication

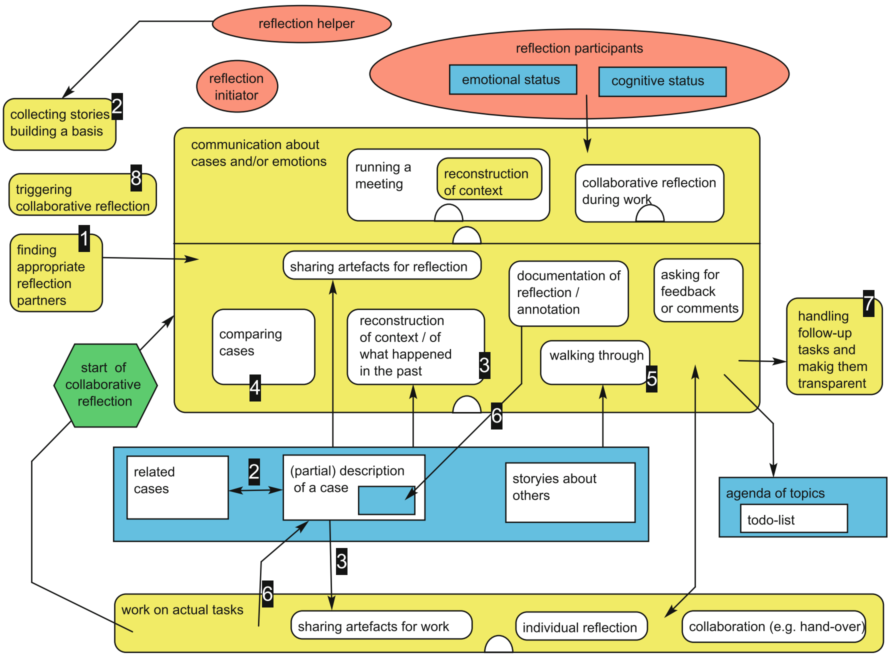

Fig. 7.4 Process of collaborative reflection and work

can be integrated into a sociotechnical solution (Herrmann, 2009). The figure depicts the central characteristics and preconditions of collaborative reflection on the job. The following details suggest potentials of integrating technical support into the process of collaborative reflection as they can be derived from our work described above. They can also be considered a contribution to the question of *how media can facilitate the dialogue within communities or organizations*.

We see possibilities to support the composition of reflection groups and bringing together the right participants for reflection sessions. This is a question of the role a person has and might play in a reflection session as described above. A technical system could make proposals which help identify appropriate reflection partners (Fig. 7.4, #1) based on user profiles and matching similar to online communities. Based on the users' preferences it could propose a close colleague with a similar background and level of experience or a person from another profession which could provide an external view on a situation.

In reflection sessions we see a need for computer support when working with material (Fig. 7.4, #2) as this helps building a large picture and reconstruct the context (Fig. 7.4, #3). This could be done by semi-automated comparison or aggregation of cases as input for reflection (Fig. 7.4, #4) or by support for working with material during reflection session. Especially a walkthrough (Fig. 7.4, #5) should be supported for searching and sorting the right material, linking cases, trimming information to the right level, annotating with text, images, or sketches, sharing and comparing of documentation and articulation, etc.

The source material which could be used either already exists or should be collected during regular work. As time is a huge constraint in most businesses, additional documentation should not take large additional effort. Note taking and articulation should be made as easy as possible with stand-alone applications and integrated into applications like handbooks and manuals to allow articulations whenever possible (Fig. 7.4, #6). Articulation in these cases should not be restricted to written text but could also include audio recordings as well as sketches or pictures.

Additional data, helpful for later reflection, could also be captured automatically by sensors. This kind of data collection implies flexible adaptation to the privacy requirements of the workers as well as to clients or customers. To be able to use all the material during reflection sessions, computer support should enable walking through the data on different paths and offer visualization tools to view and surf through the data like hypertexts (Fig. 7.4, #5).

Reflection support tools should also enable participants to sustain the outcomes of reflection sessions (Fig. 7.4, #7), e.g., in the form of todo-lists, to track planned changes in behavior. The visualizing of the outcomes and plans for future activities could serve as a basis of motivation for future reflection sessions.

The sociotechnical solution is intended to integrate reflection seamlessly into the work on the actual task as expressed by Fig. 7.4, and to support reflection which takes place during occasions being separated from the actual tasks. Separated reflection may be planned or spontaneous. The advantage of planned reflection is that there is more time available, it is easier to bring relevant people together, and the distance from everyday stress promotes a good opportunity for in-depth reflection on what has happened. The disadvantage of planned reflection is de-contextualization: aspects of real work life might be neglected and documents must build a bridge to what has really happened during work.

Therefore, spontaneous reflection and reflection during work have the advantage that details are present and can be taken into consideration. However, the workload and pressing tasks might prevent extensive reflection in such situations. In addition, relevant people are often not available at the moment when the reflection is most appropriate. Consequently, it is a technological challenge to support lightweight, short-term reflection which is smoothly integrated into the carrying out of tasks. Technical means may help to interrupt reflection and to resume it easily when possible. The same requirements have to be taken into consideration with respect to user-driven gathering of data that aims to support reflection: The data capturing has to be smoothly integrated into the documentation taking place anyway as a part of daily work and should be as simple and non-obtrusive as possible. For this purpose, people must be able to employ those means of documentation they are used to.

Since employees may be prevented from reflection by their actual task it is sensible to provide help which triggers reflection (Fig. 7.4, #8): from a technical point of view, reminders can be provided giving hints on aspects that should be subjects of reflection. Such reminders need to be based on models of the users and their situation.

From a more general point we can aggregate our observations and conclusions by suggesting that a sociotechnical solution for supporting learning-oriented reflection at work has to build bridges

- Between actual work and reflection occasions
- Between several short-term reflection events on the same topic
- Between work and experience as well as their context on the one hand and phases of separated reflection of this work on the other hand
- Between people who have similar experiences, problems, or occasions for improving their work situation

This kind of reflection support is highly relevant in situations where knowledge and competences have to be acquired for solving those problems where the answer of how to do it is not known by a trainer, consultant, or supervisor. Reflection is one important element to support critical thinking and to help workers in new situations where innovative behavior is needed.

The technical features described above and the basics of a sociotechnical solution have to be spelled out more concretely, evaluated in experiments, sorted out, and completed by further features which aim on active structuring and promoting of communicative reflection and on building synergies between the various perspectives of the collaborators. This completion requires research by conducting several design cycles in which prototypes are employed in real test beds and feedback is produced to trigger the improvement of the sociotechnical solution. Initial work for such design and prototyping in healthcare has already been done in the context of case 1 as described above (Prilla, Degeling, & Herrmann, 2012).

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Chapter 8
Collaborative Virtual Environments for Reflective Community Building at Work: The Case of TARGET

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Introduction

TARGET is a large university and industry project, involving 17 European countries, focused on the creation of a serious game for competence development in the areas of project management and sustainable manufacturing (www.reachyourtarget.org).

In this article, we describe and discuss in detail the merits and results of using the TARGET International Summer School as a means to create a community in the workplace. In addition, we discuss initial results of a community seeding methodology, outlined in the TARGET community framework. We conducted a study in the virtual world of Second Life involving students, partners, and international visitors. The Summer School acted as a forum for the presentation of innovative approaches, developments, and outcomes of research projects in the areas of technology-enhanced learning, serious games, and collaborative technologies, facilitating the exchange of ideas between students, researchers, and practitioners.

Background

The TARGET project has emerged out of a realization of the need for continuous learning, continuous adaption to changing market needs, and the development of new skills and practices. Innovation and organizational development are perceived as intrinsically connected to the ability of an organization to learn. In turn, learning is seen as a collaborative endeavor that needs to transcend or extend the individual aspects of learning. The transfer aspect of learning is seen as limiting, and learning

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is in this perspective seen as directly connected to the workplace and the challenges and affordances in the working context.

The challenges identified in the TARGET consortium may be identified as gravitating around the following:

1. The in-demand nature of needed knowledge for innovation and development
2. The need to develop knowledge on a collaborative, organizational, and not solely individual basis
3. The need to develop in situ knowledge, that is, knowledge that emerges from local needs and depends on the solution of the available local resources (i.e., time, human power)
4. The need to develop networks and pathways between clusters of knowledge in ever-changing organizations
5. Developing the “lived curriculum” as a basis for learning
6. Providing mechanisms and affordances for the dissemination of knowledge through reflective practices, and securing means for the flow of knowledge across the organization

The learning efforts thus are related to both the dissemination of existing knowledge and developing pathways for knowledge dissemination to parts of the organization where there has been little or no exchange of knowledge. In addition, learning across organizational boundaries and across disciplines is perceived as necessary for the development of new services and products.

The TARGET consortium also sees the need for developing methodologies and practices for developing knowledge that not yet exist in the organization. As such the knowledge perspective adopted here rests on what Gibbons et al. have termed Mode 2 knowledge (Gibbons et al., 1994). Gibbons et al. distinguish between Mode 1 and Mode 2 knowledge production. Whereas Mode 1 represents traditional knowledge, reflecting the classic academic hierarchies, Mode 2 knowledge is developed in an interaction between different actors from science and industry. Typically, this kind of knowledge is developed out of a defined problem or a given context, and is consequently interdisciplinary and rests on both theoretical and practical input. Mode 2 knowledge is also connected to its immediate application, and the interplay between development and application. In a very real sense, learning is not separated from the development of knowledge and its application. Although the individual and social aspects are present in all types of learning and knowledge production, to Gibbons et al. the individual drive is seen as the dominant in Mode 1 knowledge production, and the social or collective drive is seen as dominant in Mode 2 knowledge production (Gibbons et al. 1994). The topics chosen in the TARGET game scenarios, i.e., topics from project management negotiation and sustainability, all have the characteristics of being situated in the organizational context.

To the present context, the most important components of the TARGET project draws upon the following perspectives:

- Threshold concepts
- Learning communities
- Serious games and 3D collaborative virtual environments (CVEs)

These are discussed in more detail below.

Threshold Concepts

The emerging and promising framework of "threshold concepts" is applied as a means of organizing learning content within knowledge ecosystems across corporate and educational environments (Meyer, Land, & Baillie, 2009; Meyer, Land, & Smith, 2008).[1] To be brief, threshold concepts are components of the learning content that address the difficulties and challenges from the perspective of the learner, and focuses upon the relation between the learner and the content of learning. Threshold concepts have the following characteristics:

- Transformative—it means changing the way the learner thinks about a given subject
- Irreversible—it means once learnt it cannot be "unlearnt" or forgotten
- Integrative—it means previously hidden interrelations are exposed to the learner

At the same time, threshold concepts represent aspects of knowledge that are troublesome, and may initially be perceived as counterintuitive. Coming to terms with threshold concepts frequently position the learner in a state of liminality or unrest, during which the learner will oscillate between a previous understanding and an emerging, but not yet fully appreciated, understanding. The period is characterized by unrest and frustration for most learners, and may be referred as a troublesome or painful rite of passage. The nature of a threshold concept is frequently connected to tacit knowledge, and threshold concepts are embedded in the relations between participants and practitioners in communities. Consequently, they are hard to pinpoint for the newcomer, and the participation in a game with supportive community tools may facilitate and ease the transition into this knowledge landscape.

In cross- and interdisciplinary work, threshold concepts are likely to occur to the learners, because they are constantly exposed to and expected to transcend the limits of their own discipline. The desired outcome of the learning process is that new knowledge or new combinations of knowledge from various sources, theoretical or practical, is developed.

Examples of threshold concepts identified in the TARGET consortium, relevant for project management, are connected to negotiation, stakeholder analysis, and sustainability.

Learning Communities: The Community Landscape

Establishing and nurturing vibrant learning communities is seen as a highly complex process (Wenger, McDermott, & Snyder, 2002; Wenger, White, & Smith, 2009).

[1] The authors would like to recommend Dr. Michael Thomas Flanagan's Webpage for an update on the activities and research connected to threshold concepts: http://www.ee.ucl.ac.uk/~mflanaga/thresholds.html.

Yet, at the same time, such communities are seen as highly important in developing and spreading new skills, insight, and innovation (Johnson, 2010). To the TARGET project, developing a methodology for practical guidelines for the creation of a variety of possible communities is an essential part of the work. Traditionally, communities of practice (CoPs) have been the most common form of community. Today, a gamut of community realizations may be identified and described. At the opposite ends of the gamut, the affiliation centers on the metaphors of "belonging" and of "connecting" respectively. Whereas CoPs emphasize the static state of belonging and homogeneity, newer collaborative entities are characterized by their emphasis on connections, networks, and heterogeneity. To the latter category Engeström contributes with the notion of mycorrhizae, a biological metaphor for networks that interact with their surroundings (Engeström, 2007). Perceiving the collaborative grouping as an interacting and interdependent entity, Engström describes such structures as "both a mental landscape and a material infrastructure" for the participants (Engeström).

Drawing upon work by Hughes, Jewson and Unwin, Fuller and Engström, one may suggest that the typology above rests on a historical and evolutionary understanding of collaboration patterns (Engeström, 2007; Fuller, 2007; Huges, Jewson, & Unwin, 2007). Each type or realization is situated in a specific historical context, and reflects that context. Yet, rather than representing sharply distinguished types, each type tends to stretch into the next historical period, thereby constituting a continuum of development. Hence, the notion of a community of interest (CoI), as introduced by Fischer et al., seems to incorporate the variety and dynamism that is a typical feature of a modern workplace (Fischer, Rohde, & Wulf, 2007).

Describing CoIs, Fischer et al. state that "CoIs bring together stakeholders … and are defined by their collective concern with the resolution of a particular problem" (Fischer et al., 2007). CoIs can be thought of as "communities of communities" (Brown & Duguid, 1991) or a community of representatives of communities. CoIs are also defined by their shared interest in framing and resolution of a (design) problem, are more temporary than CoPs, come together in the context of a specific project, and dissolve after the project has ended. According to Fischer (2005) and Fischer et al. (2007), CoIs have potential to be more innovative and transforming than a single CoP if they can exploit "the symmetry of ignorance" for social creativity.

Stakeholders within CoIs, as in the TARGET consortium, are considered as informed participants (Brown, Duguid, & Haviland, 1994; Fischer et al., 2007), being neither experts nor novices, but both. They are experts in their own domains when they communicate their knowledge and understanding to others. At the same time, they are novices and apprentices when they learn from others' areas of expertise. Therefore, the major strength of CoIs is their potential for creativity (Fischer, 2000; Rittel, 1984). CoIs have great potential to be more innovative and more transforming than a single CoP (Fischer, 2001, 2005; Fischer et al., 2007). In the TARGET context, this implies the utilization of the potential in the juxtaposition of different competences to facilitate innovation, and to develop new "across-line-of-service" products and services.

Overcoming distances in social creativity and supporting learning in CoIs require externalizations (Bruner, 1996; Papert & Harel, 1991a, 1991b) in the form of boundary objects (Star, 1989) that have meaning across the boundaries of the individual knowledge systems, subcommunities, or different CoPs that join together in a CoI for some purpose (Fischer, 2001).

Boundary objects serve these different systems or communities in situations where each of them has only partial knowledge (based on the symmetry of ignorance) and partial control over the interpretation of the boundary object (Arias & Fischer, 2000; Fischer, 2001; Star, 1989). In this way, boundary objects allow different knowledge systems and communities to interact by providing a shared reference that is meaningful within both parts. Such objects perform a brokering role involving "translation, coordination, and alignment among the perspectives of different CoPs" (Fischer). Boundary objects are typically negotiated and dynamic and have emergent characteristics. Boundary objects, because of their emergent character, are also central in the development of a culture of reflective dialogue. In the TARGET context, based on the material from the industry partners, one example of a boundary object in project management would be "living with uncertainty" (Karlsen, 2011). As a concept in project management, this comes across as a counterintuitive and troublesome part of the tacit nature of knowledge in this domain, where new or less experienced learners would look for methods that give predictability, checklists for actions, and the like.

Central in this perspective upon community and the learning attempted in these environments is that boundaries between disciplines and knowledge domains are constantly reexamined, broken down, negotiated, and rebuilt. The boundaries between the disciplines and domains thus may be seen as *trading zones* for interdisciplinary activities (Klein, 1996). Consequently, learning depends on collaboration and co-construction in a continuous interplay amongst the participants. These zones are where innovation and development may occur, but simultaneously these zones are difficult to access and grasp.

Since the joint construction of shared knowledge occurs in knowledge domains partly unknown to the participants, a transdisciplinary approach will involve threshold concepts, since the boundary objects typically are troublesome, sometimes counterintuitive, yet they integrate a certain set of beliefs, theories, and concepts.

Collaborative Virtual Environments and Serious Games

Recently, there has been a growing interest in innovative forms of collaborative learning, such as serious games, that may be suited to provide memorable and transformational experiences in the workplace. Serious games are digital games that are driven by learning objectives. Such games can be deployed as test beds for experience management that are—so is the assumption—highly motivating and emotionally engaging, causing high and long knowledge retention.

Based on several sources (Bell, 2008; de Freitas, 2008), 3D CVEs can be defined as three dimensional, multiuser, synchronous, persistent environments, facilitated by networked computers. Second Life is one of the most successful

CVEs at the moment (www.secondlife.com). This virtual world remains one of the most stable, developed, and populated, though there are without doubt certain limitations. CVEs have promising potential for supporting learning communities because of their capability to provide a social arena where students, teachers, and other stakeholders can meet and interact overcoming distances and different time zones (Chou, 2009; Helmer, 2007). On the longer term, the CVE becomes a container of artifacts used by the users for their daily social and educational activities, and traces left by community members as a result of their participation. These traces become a part of the shared repertoire of the community through the process of reification (Wenger, 1998).

Establishing and supporting learning communities are additionally supported in CVEs by an enhanced sense of presence (Bronack et al., 2008; Park, Hwang, & Choi, 2009) and a possibility for collaborative work with various types of content (Atkins, 2009; van Nederveen, 2007).

The TARGET Platform: Learning at Work

The components of the TARGET platform consist of a 3D CVE focused on a serious game application where learners may interact and discuss amongst themselves through their avatars, supported by dedicated Web 2.0 tools, leading to the maturing of the associated knowledge ecosystem of the organization(s).

The center of the platform is an engaging story where each learner has their personal experience based on their unique decisions, thereby affecting the situated context where their avatar is immersed. Plans of personalized learning are construed from tailor-made stories that address the particular needs of the individuals, leveraging the narrative building blocks imbued with the corporate experience of industry such as Siemens and Nokia.

Game scenarios that are being developed are related to stakeholder management, negotiation scenarios, and cases involving sustainability issues. All scenarios are based on empirical material developed in the project consortium together with industry partners.

The purpose of the TARGET project as a whole is to account for and incorporate in the in-service training programs the knowledge in a company that is crucial to the operation of the business, but which at the same time is difficult to capture and to disseminate throughout generations of employees. In this project, learning at the workplace means to activate the "tacit knowledge" of different employees and stakeholders about "project management" (e.g., how to organize, coordinate projects).

The data collected from industry partners Siemens and Nokia and university partner Norwegian University of Science and Technology gave the background material for what kinds of scenarios the consortium wanted to develop. In these organizations, project management courses have been offered for a long time, and evaluation material from the courses was made available to the consortium.

The material was analyzed within the threshold concept framework to deduct the most difficult concepts in the development of competence in project management. In turn, these concepts were used to design the game scenarios, and incorporate the accumulated experience in the kind of situations and challenges that the player shall experience. The main point here is that the content and game design are deeply rooted in the experience of the organizations that partake in the consortium. Furthermore, the game will be deployed in the very same organizations as a part of the ordinary in-service training programs and teaching. In a very real sense, this is knowledge stemming from the workplace, developed and deployed in the workplace.

TARGET International Summer School

The TARGET International Summer School in Second Life acted as a forum for the presentation of innovative approaches, developments, and outcomes of research projects in the areas of technology-enhanced and workplace learning, serious games, and collaborative technologies, facilitating the exchange of ideas between students, researchers, and practitioners. The design of the Summer School activities is intended to suggest possibilities as to facilitate *reflective dialogue* in communities.

The virtual format of the Summer School demonstrated the possibilities of modern educational technologies for working and learning. Participants were able to unleash their creativity and express their ideas in a new way, demonstrating research projects to peers, experts, and other visitors as well as getting feedbacks. Second Life was chosen as preliminary environment to demonstrate and try out different ideas and concepts within the TARGET framework. It was also used as a "proof of concept" in order to test out community seeding methodology proposed by the authors in the context of organizational learning in a highly diverse consortium. The diversity of this consortium that consisted of several partners from both industry and academia provided yet another motivation for the organization of the Summer School, i.e., creating bridges between these different communities and, correspondingly, different approaches to learning.

During the Summer School, we conducted a number of events and activities, both in a virtual environment and in real life. Virtual Campus of Norwegian University of Science and Technology (NTNU) in Second Life provided a venue for the virtual world part of the Summer School and a number of tools to support all the associated events.

A central part of Summer School has been a student project competition that focused on creating visualizations of research projects and presenting them to the audience through role plays. The goal of these activities has been to explore innovative aspects of the CVE technology, focusing on community building and collaborative construction, and sharing of knowledge. This method is based on "constructionism" (Papert & Harel, 1991a, 1991b)—an educational philosophy that implies that learning can happen most effectively through the design and building of personally meaningful artifacts (Papert, 1986; Papert & Harel, 1991a, 1991b).

Fig. 8.1 Role-playing presentation of a student project

These projects were performed in cooperation with a cooperation technology course at NTNU. The participants of the student project competition included 25 students in seven groups, 2–4 students in each, both regular NTNU students (master and PhD level) and international students, participating in the NTNU International Master program. The total building period was 5 weeks. During the final session, the students presented their projects in the form of role plays (Fig. 8.1). They also evaluated each other's constructions and received evaluations and feedbacks from the international visitors. In addition, two seminars were conducted: "Using Virtual Worlds to Improve Business Presentation Skills" by Judith Molka Danielsen and "TARGET EEU (Extended EU)—A step toward new e-learning technologies" by Albena Antonova and Ekaterina Prasolova-Førland.

After the competition, the students delivered a group essay where they reflected on their experience. The students discussed potential use of their constructions, different aspects of collaborative work, role play, 3D visualization, and learning in CVEs.

The Summer School was conducted in conjunction with the Norwegian Science Fair, which is a part of an annual festival Norwegian Science Week. The goal of this event is to present science projects to the public. In Trondheim, which is recognized as a "student city" and a "technological capital," the festival is organized in pavilions at the central city square. In the Virtual Campus of NTNU, a Virtual Science Fair was erected in Second Life to mirror and enhance the one in reality. One of the major city landmarks—King Olav Tower—was reconstructed in the virtual science fair at the virtual "central square," in same place where the fair was organized in reality (Fig. 8.2).

Virtual Science Fair was designed based on the principles of the Virtual Research Arena (VRA)—a framework for creating awareness about educational and research activities, promoting cross-fertilization between different environments and engaging

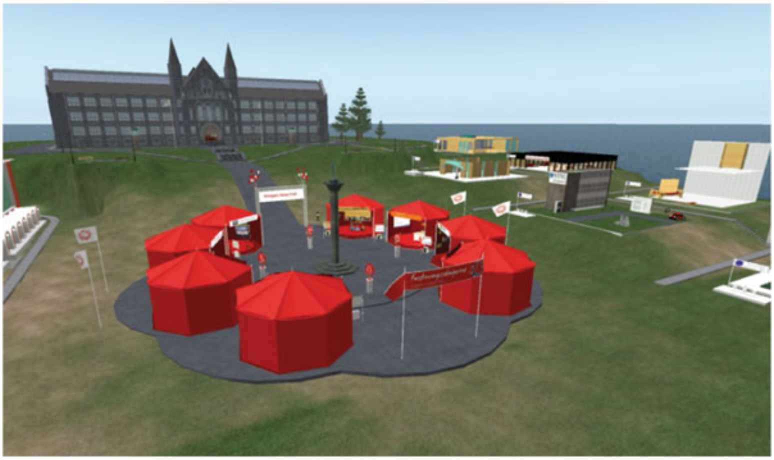

Fig. 8.2 Virtual Science Fair in the Virtual Campus of NTNU

Fig. 8.3 TARGET pavilion at the Virtual Science Fair

general public (Fominykh & Prasolova-Førland, 2011). The Fair consisted of eight pavilions and, together with the Summer School constructions, formed a common environment in the Virtual Campus (Fig. 8.2). Each pavilion presents a research project from different NTNU departments and other research environments (Fig. 8.3). Examples of the projects presented (in addition to presentation of the TARGET project itself) included:

1. "Virtual Eidsvoll"—a historical reconstruction project in Second Life for studying Norwegian history
2. "Multi-lingual text annotator Typecraft"—a free online tool for language experts and anthropologists

Fig. 8.4 Virtual Science Fair is demonstrated to the visitors of the "real-life" Science Fair

3. "Digital style"—a project advertising social networking and mobile technologies
4. "vAcademia"—an educational virtual world

The VRA in this case served as a metaphor and realization of TARGET's ideas of technology transfer between diverse communities and establishing connections between different disciplines and practices, involving representatives from universities, research institutions, businesses, and the general public. It can also be thought as a virtual workplace where learning can take place in many forms as elaborated in the next section.

The potential and usefulness of the VRA were evaluated by the students participating in the Summer School in their essays. There has been some criticism since there was no actual support for doing research, but just for presenting results. Positive feedbacks were related to conceptual opportunities of the VRA.

The Virtual Science Fair was presented at the fair in real life as one of the projects. The visitors in the real life could come to the physical pavilion and immerse themselves into the virtual extension of the fair, exploring a number of projects (Fig. 8.4).

Lessons Learnt for CSCL at Work

In the following, we will discuss how we followed some recommendations based on literature review aligned with input from the consortium, and how this was implemented in the TARGET summer school. In addition, we will suggest implications for the learning processes that may be deducted from the cases. We will also suggest possible future work.

In the TARGET learning environment, collaborative learning has been designed as a reflective learning community at the workplace. TARGET will be a reflective community platform for learners who need to have rapid access to develop competencies in the domain of project management using a serious games approach. The game simulates the activities associated with "planning and executing a project." Through play, participants develop competencies and expertise in project management.

The first TARGET International Summer School in Second Life proved useful insight in terms of testing out community seeding methodology introduced earlier (Prasolova-Førland & Hokstad, 2009), including the new focus on CoIs, social creativity, and community evolution approach; see, e.g., Fischer (2001) and Fischer and Ostwald (2002).

In the following, we will discuss how Summer School functioned as an example of community seeding in a serious game within the TARGET context. Using the community framework and a set of recommendations for community seeding and sustaining we have introduced earlier (Prasolova-Førland & Hokstad, 2009), the process is elaborated and illustrated along the dimensions of domain, community/network, and practice.

Domain

Recommendation. It is necessary to define the domain and engaging issues: issues important to the organization, aspects that are important and motivating for people and can bring in new members. This also includes identifying the ideas, insights, and practices that are to be shared in the community at the early phase (Kaulback & Bergtholdt, 2008; Wenger et al., 2002).

Realization in the Summer School. In the Summer School, the focus was on the topics central for the project domain: exploration of the potentials of role plays and simulations in a business/scientific context, alternative means of project presentations. Project visualizations at the VRA have been extensively used for educational purposes in accordance with the constructionist approach (Papert & Harel, 1991a, 1991b). At the same time, they have been used as a means of knowledge sharing across different CoIs, in this way supporting social creativity (Fischer, 2005). For example, according to one of the student essays, "The Virtual Research Arena could be quite useful for presenting things like: … enable idea gathering in a more interactive intuitive setting … make visualization extensions for information sources like Wikipedia, where visitors can see things in an interactive 3D setting."

In this way, the VRA and its pavilions served as "boundary objects" between different research communities (Arias & Fischer, 2000; Fischer, 2001) and at the same time contributed to promoting research projects to a broader audience of students, researchers, and general public. During the course of the Summer School, a number of boundary objects have been collaboratively created in order to facilitate the exchange of ideas between communities of students, researchers, and practitioners. These boundary objects contributed to establishing a common ground and shared understanding and vocabulary among community members by a significant degree taking advantage of visual symbols, interactive elements, and aesthetic means. Participants took advantage of the mutual "symmetry of ignorance" (Fischer, 2000; Rittel, 1984), allowing social creativity to be unleashed at the boundaries of different domains; demonstrating research projects to peers, experts, and other visitors; as well as getting feedbacks. The result of these activities might be what the students called "boundary projects," as appears in one of the essays: "Virtual Research Arena can be a great opportunity to foster both research activities and collaborative learning. First, it can be used as means for making every researcher aware of other research projects. We believe this is an extraordinary way to promote collaborations among different projects. Using this approach new cross boundary projects may come out." In this way, our experience shows the potentials of 3D visualizations for supporting learning and exchange of ideas in a virtual workplace as well as enhancing creativity across boundaries of different CoIs.

Implications for TARGET learning process. Boundary objects seem important in the learning environment. On the one hand, they represent to the individual learners an exposure to multiple perspectives. On the other hand, they represent common points of reference to the community of learners. Boundary objects may be seen as parts of the trading zone between the various disciplines and the participants of a community that represent these disciplines.

Community/Network

Recommendation. The process of seeding a community should to a substantial degree be based on existing social networks in order to be successful. At the same time, establishing connections across communities is important (Fischer et al., 2007). Establishing mutual trust and "investing in social capital" are crucial (Bos-Ciussi, Augier, & Rosner, 2008).

Realization in Summer School. During the Summer School, we studied how the students collaborated around their creative visualizations, building upon constructions from previous student generations. The Summer School has also demonstrated the ideas of community seeding, evolution, and reseeding model (Fischer & Ostwald, 2002) where the "seeds" represented by students' projects grew on the "soil" generated by the evolution of earlier student generations at the Virtual Campus, and were later integrated in the VRA, reseeding the new community of TARGET researchers and early adopters.

A number of events, such as seminars, gatherings, and a role-playing session, during the course of the school allowed extending social networks across countries and institutions. The potential of the VRA was mostly seen in promoting presented research environments by creating a socializing and gathering place around project presentations.

Increased awareness among researchers, students, university departments, research groups, institutions, and the general public was emphasized as a way for promoting collaboration and an important opportunity for establishing new contacts. In this way, our experience with the Summer School highlighted the importance of informal communication spaces for working, community building, and collaborative creative activities.

Implications for TARGET learning process. Establishing productive and creative communities rests on a delicate and complex balance between the "symmetry of ignorance" and the symmetry of interests amongst the participants. Both formal and informal means of interaction are needed as well as openness towards other communities and networks. Learning under these affordances requires a highly flexible infrastructure.

Practice

Recommendations.

(a) The first step in terms of establishing a community practice is creating a preliminary design for the community, based on the "Seven principles" (Wenger et al., 2002), such as launching the community with dedicated community spaces, both private and public, and corresponding initial community events (Wenger et al. 2002).
(b) It is recommended to provide initial boundary objects and introducing shared artifacts as catalysts of collaboration (Thompson, 2005; Wenger, 1998) such as "monuments" (symbols strengthening identity within the community, e.g., logos); "instruments" (an infrastructure-supporting interactive communication); and "points of focus" around which the interaction and collaboration will be structured.
(c) It is necessary to identify early what knowledge to share and how, laying an initial plan for a community repository, identifying ways to capture and store "soft" knowledge to be embedded into community practice and stored into relationships (Wenger et al., 2002).

Realization in Summer School. In order to create a preliminary "design" for the community/communities in question, there have been introduced dedicated community spaces (e.g., lecture halls, campus buildings, reconstruction of Trondheim central square with exhibition tents) and associated community events: Summer School seminars and the Virtual Science Fair in conjunction with the real one. According to student feedbacks, these arrangements were suitable for connecting communities of students and researchers: "We think the Virtual Research Arena (VRA) is highly suitable for research activities. Researchers at university level are often geographically distributed across countries. This is due to the fact that research projects often need top specific knowledge in small domains that is hardly available inside its own country boundary. With limited resources (money) available in the project, and bearing in mind the CO2 emissions from flight travels, researchers may like to have a platform to meet that mimics real life meetings."

As a part of establishing shared practice, we have introduced a number of shared artifacts as catalysts of collaboration such as TARGET stand as a “monument” (Fig. 8.3), building tools and meeting facilities as “instruments” and “points of focus,” such as campus buildings, constructions on the Virtual Science Fair, and both previous and recent student constructions (Fig. 8.2). These focal points were demonstrated to the public facilitating collaboration within and between communities of students, researchers, TARGET partners, and the general public (Fig. 8.4).

In addition, we have explored innovative ways of capturing, storing, and mediating knowledge through 3D creative visualizations and role plays. The 3D constructions capturing the knowledge and experiences acquired by different generations of students and researchers will be stored in a “project gallery” constituting the community repository, where they can be retrieved and updated/annotated by community members at any time. The work on such a gallery provides one of the directions for future research, i.e., exploring alternative and innovative ways of visualizing, storing, and managing community knowledge.

Implications for TARGET learning process. A game scenario that encompasses experiences and challenges that interacts on the balance between the symmetry of ignorance and symmetry of interest seems fit to be the event or the monument that attracts participants into these kinds of learning environment.

Conclusions and Future Work

In this chapter, we describe a sociotechnical platform that fosters workplace learning in the field of project management. We have presented and discussed initial testing results of a community seeding methodology, outlined in the TARGET community framework, and explored different aspects of community building in the context of serious games and 3D CVEs. The purpose was to explore learning environments by inviting participants into practices where knowledge and insight are emergent from the diversity of the contributions.

We asked to what extent a 3D CVE facilitates *reflective dialogue* in communities to support lifelong workplace learning. Our experience demonstrated that 3D CVEs *can* support reflective dialogue in learning communities in the following ways:

- By providing boundary objects to enable dialogue between learners from different backgrounds and disciplines
- By providing a flexible infrastructure and both formal and informal meeting and workplaces for members of different “CoIs”
- By providing a set of shared artifacts as catalysts of collaboration and a shared repository for storing and 3D visualization of community knowledge
- By enriching reflective dialogue with innovative expression forms, such as role plays and 3D visualization

It is important to understand that attempts to control such communities directly are in most cases destined to fail, according to the principles and understanding suggested by Wenger (Wenger et al., 2002). In this tradition, the design principles for vibrant and alive communities are not meant to be "recipes" and are not the same as most organizational designs. They could rather be seen as triggers and catalysts for a community's natural evolution, often based on preexisting social structures.

Also, communities cannot be measured in conventional ways as traditional methods are not likely "to appreciate the creativity, sharing and self-initiative that are the core how a community creates value" (Wenger et al., 2002). Following this understanding, we outline a number of implications for TARGET learning process and organizational learning in a serious game context in general:

- The importance of 3D visualizations for supporting learning and exchange of ideas in a virtual workplace as well as enhancing creativity across boundaries of different CoIs
- The importance of informal social spaces for community building and collaborative creative activities
- The need to explore alternative and innovative ways of visualizing, storing, and managing community knowledge

For the future work, we plan to continue seeding and nurturing reflective and creative TARGET communities according to the principles and guidelines outlined above, contributing to the development of associated community social tools and support systems. In addition, a new TARGET Summer School (in collaboration with EU CoCreat project (http://www.cocreat.eu/)) was held in autumn 2011, with a focus on collaborative virtual workplaces for creativity support. During this process, future work will encompass a number of research issues as follows:

- Further exploration and development of the community methodology in the context of serious games and 3D virtual workplaces
- Providing support for creative communities and CoIs in 3D virtual worlds in a cross-disciplinary and multicultural context
- Exploring the potentials of role playing and serious games for supporting learning at the workplace
- Further experiments of integrating serious games in workplace development programs
- Further exploration into threshold concepts as content identifiers in complex learning environments
- Further development of methods for community repository building and maintenance

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Chapter 9
The Role of Communication and Facilitation for CSCL@Work

Andrea Kienle

Introduction

Coordination is more difficult for groups working on complex tasks with dependencies between members that emerge while work is taking place. CSCW research focuses on understanding group work on complex tasks. Previous research pointed out that workers often need information about the tasks and to learn new skills in order to perform the task (Randall & Salembier, 2010; Schmidt, 2011). Such skill development typically occurs during the course of performing work, and is an exemplar of informal learning using computer-supported collaborative learning in the workplace (CSCL at Work) approaches.

Collaborative learning is framed by the constructivist approach to learning, within which learning is viewed as an active process of constructing rather than acquiring knowledge (Duffy & Cunnigham, 1996). The active role of the learner is a central characteristic of collaborative learning (Koschmann, 1996). This implies that participants learn from each other by actively co-constructing knowledge (Stahl, 2002). This active co-construction of knowledge based on the theory of constructivism is *the* "motivating theory in CSCL literature" (Suthers, 2006).

Computer-supported collaborative learning can include temporally and physically distributed users. In these cases learning mainly focuses on communication, since direct experience of a situation and learning by observation are mostly inapplicable in distance learning processes. Most CSCL research views communication as a precondition for CSCL (see for example Pea, 1996, or Stahl, 2002).

Within an organization there are two types of CSCL at Work. Type One occurs when there is an expert at the workplace who knows an answer to a problem and can help the learner. Type Two, which is the focus of a number of chapters in this book

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and a key difference between CSCL at Work and traditional knowledge management, occurs when the answer to a problem is not known and new knowledge has to be co-constructed within the organization. This chapter focuses on the second type.

Type One: This type of CSCL at Work is most similar to traditional knowledge management approaches. The main distinction is the use of computer support for both facilitation of learning activities and retrieval of information. Type One approaches often deal with a combination of storing content and enabling communication within one system (see, e.g., Kienle, 2006).

One problem in this dimension is to find an appropriate expert. This problem was for example addressed in the project Advanced Process-Oriented Self-Directed Learning Environment (APOSDLE, partially funded under the sixth framework program (FP6) for R&D of the European Commission within the Information Society Technologies (IST) work program 2004).

In this project an approach to discover collaboration partners and adequate advising experts in a workplace-embedded CSCL-system was introduced (Lokaiczyk et al., 2007). The following steps towards a successful collaboration initiation are proposed.

In the beginning, the user's current process task needs to be identified. Taking into account the knowledge about the current process, the availability of experts, as well as organizational and social distance, relevant experts regarding the actual work task of the learner are preselected. The selection of matching collaboration partner and learning resources is calculated in a server component, the platform. The platform is also used to store extensive user profiles, which contain user history, task dealt with, and competencies acquired. But also the availability of potential experts and the current work situation are kept there.

Depending on the preselection and users' preferences, the potential collaboration partners are displayed in an expert list. Directly from a sidebar, the user is able to initiate collaboration with the desired expert. Both collaboration partners join a common collaboration room, where context information about the task of the learner, etc. are presented and they can exchange text messages und collaboratively work on or discuss about certain documents and presentations. Consequently, the invited expert is able to get quickly an idea of the problem of the learner and can provide help uncomplicatedly. That way, the learner is able to initiate beneficial collaborations, whose transcripts are used to enhance the existing knowledge base of learning documents.

Type Two: When knowledge does not exist in an organization, it needs to be created within it. As Fischer (Chap. 2) points out, this involves organizational infrastructure to help people to solve problems in cases when the knowledge required does not already exist in the organization. This is like constructing new knowledge but at both the institutional and individual levels. It is a joint process involving several learners. In work reported here this involves not just the technical system where CSCL at Work is supported, but human facilitators who support and inspire the communication processes for knowledge construction (also see Chap. 7 by Prilla and Herrmann, titled *Collaborative Reflection at Work* for a description of different roles like reflection helper). The need to support communication in CSCL processes changes the role of the moderator or the facilitator[1] (Hansen, Dirckinck-Holmfeld, Lewis, & Ruegelj, 1999; Kienle, 2006) which needs to be supported by appropriate functionalities within the CSCL-system in order to achieve different tasks successfully.

The approach of designing tasks of the facilitator and functionalities of the technical system relates to cluster B in the CSCL at Work framework (see Chap. 1) and addresses two of the questions posed by Fischer (Chap. 2):

Question 4—How can media (technical system) facilitate the dialogue towards reflective communities to cope with systematic problems? To what extent do we need a facilitator who fosters learning communities at work?

Question 5—How do we create and design socio-technical systems for learning when the answer to the problem is not known?

The rest of this chapter is organized as follows: Section "Theoretical Background" deals with the facilitation of learning in face-to-face and online settings and describes a model that systematizes the activities of a facilitator in computer-supported setting. Section "Case Studies of Computer-Supported Facilitation Within CSCL" reports two case studies illustrating the tasks of a facilitator and technical support for facilitation by using an explicitly socio-technical design. One case is related to an asynchronous setting, and the other one to a synchronous setting. From these studies a set of principles for the design of computer support for learning facilitation in a CSCL at Work context is refined. I also reflect on the findings related to the tasks of a facilitator in the model of communication we describe in the cases (section "Design Principles for the Facilitation Within CSCL"). The chapter ends with a discussion of topics for further research.

Theoretical Background

Facilitation in Face-to-Face and Online Settings

Moderating discussion in face-to-face settings is widely discussed in the literature (Klebert, Schrader, & Straub, 2000). However, it remains unclear how collaborative learning processes are best moderated and how this moderation can most effectively be supported within a technical system. Friedrich, Hesse, Ferber, and Heins (1999) emphasize that the direct transfer of methods used in face-to-face situations to computer-supported situations is not suitable. Furthermore new methods have to be developed since communication rituals and procedures developed on the fly in face-to-face situations have to be facilitated explicitly in computer-supported situations (Friedrich et al., 1999).

[1]There is sometimes confusion about the wording for this role: in English literature the term "facilitator" is dominant, and in German literature the term "Moderator" is used. In this chapter the terms facilitator and moderator are used as synonyms.

Most of the present literature on facilitation in computer-supported settings addresses the primary concerns of practitioners in the field, e.g., Collison, Elbaum, Haavind, and Tinker (2000) and Salmon (2011). This body of work describes a moderator's duties and responsibilities in computer-supported situations as being similar to activities well known from face-to-face situations: "The best e-moderators undertake the 'weaving': they pull together the participants' contributions by, for example collecting up statements and relating them to concepts and theories from the course. They enable development of ideas through discussion and collaboration. They summarise from time to time, span wide-ranging views and provide new topics when discussions go of track" (Salmon, 2011).

Up to now little and sometimes contradictory advice can be found concerning the relation between the facilitation of computer-supported collaborative learning processes and the well-known traditional techniques of facilitating face-to-face meetings. Friedrich et al. (1999) conducted a much-cited study on asynchronous moderation techniques, comparing two different methods for initiating a discussion. One relied on a (a) neutral opening statement, while the other made use of (b) problem-centric, curiosity-arousing wording when initially characterizing the discussions' objective. They confirmed the assumption that the latter type (b) discussion initiation results in an increased number of contributions from discussion participants. Furthermore, the fewer statements by moderators to the discussion, the greater the number of participant statements. Thus, one result is that the moderation style of the facilitator directly influences participant engagement in computer-mediated settings.

In addition, it seems necessary to develop new strategies when moderating computer-supported communication processes (although the tasks may be similar): "Moderators must learn new strategies that are appropriate to the online venue, and, through continued practice, study the range of their effects (…) The goal is to help learners as their own thinking evolves" (Collison et al., 2000). The goal of this chapter is to mine these activities and provide appropriate technical support to users.

The support of synchronous facilitation is often related to "reducing chat confusion" (see, e.g., Thirunarayanan and Perez-Prado, 2007). Chat confusion occurs when discussion threads are developed in parallel and problems arise relating incoming contributions to the appropriate discussion. To solve that problem, Pimentel, Fuks, and Pereira de Lucena (2005) propose a system called Mediated Chat that includes conversation techniques, e.g., a circular contribution where users are organized in a circular queue. But the evaluation showed that such techniques are not flexible enough and do not avoid interruptions of discussion threads and chat confusion (Pimentel et al., 2005).

A more restrictive way is followed in the Instructor-Controlled Chat System (ICCS) (Thirunarayanan & Perez-Prado, 2007). Here the facilitator controls the discussion in the same way as in the asynchronous applications: all contributions are sent to the facilitator and he decides whether and when the contribution is published to the others. Problems known from asynchronous settings are strengthened in the synchronous situation because the facilitator has to analyze all incoming contributions very rapidly: "The rapid nature of content analysis may also lead to the instructor leaving out some potentially interesting and significant comments or including some comments that do not add to the content of the discussion" (Thirunarayanan & Perez-Prado, 2007, p. 2).

To summarize, scientific publications dealing with the transfer and use of moderation techniques to computer-supported settings are rare. The work reported here frames this gap more clearly, and begins to propose mechanisms for filling the gap in future research.

Tasks for the Facilitation of Computer-Supported Discursive Learning

Generally speaking, tasks of a facilitator are (a) the initiation of discussions, (b) the guidance of the discussion process (includes asking appropriate questions to push students to think deeply on the learning content), and (c) the stimulation of summary generated by the learners (Hmelo-Silver, 2002). This generic level Hmelo-Silver presented is applicable for various scenarios (various group sizes, aim of the learning process, etc.).

The cases described here are related to groups of 8–15 participants discussing, developing, and learning methods and content (that is not necessarily known in the group before). The participants were students working on a joint artifact (e.g., article or presentation). In the asynchronous case the participants are students of computer science, and in the synchronous case of educational science. The strategies of facilitation presented here can be used for formal as well as informal collaborative learning processes in both university or company settings.

Figure 9.1 shows a first version of systematizing the activities of the facilitator for CSCL. This model differentiates between synchronous and asynchronous settings for two reasons: (1) the technical functionalities are different in CSCL-systems supporting synchronous resp. asynchronous learning for the learner and in conclusion also for the facilitator and (2) with respect to the socio-technical design the functionalities and tasks are influenced mutually.

The model combines in the middle the tasks of the facilitator that build the facilitation strategy (elements with rounded corners) and functionalities of the technical system (rectangles). At the top the participating roles in facilitated discussion are shown: communicators who add communicative contributions, recipients who read them, and the facilitator who supports the communication. The role reversal indicates that participants (e.g., the students of the evaluated seminar) can take the role of the facilitator as well of a discussant (communicator or recipient). Concerning the roles it is important to emphasize that the participants should be aware of their actual role and its activities. The activities of the discussants are summarized in figure with the activity "dialogue" at the bottom of the framework. They are detailed in other publications (see, e.g., Herrmann and Kienle, 2008).

Pre-studies emphasized that processes of computer-supported discursive learning and communication need an initial step of preparing and structuring the following

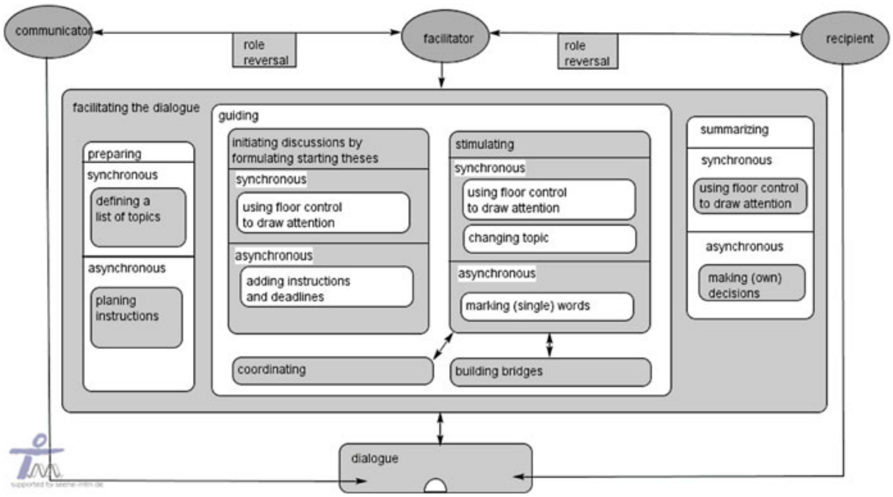

Fig. 9.1 The model of triadic communication

process (Herrmann & Kienle, 2008). For synchronous situations a list of topics as a scaffold of the communication process is suggested. In asynchronous situations an overview of the activities the facilitator planned for the following communication is helpful.

During the communication process a facilitator initiates the discussions with starting theses. In the case studies (as described in the following section) no difference between an initiation by a question, a statement, or an expression of opinion was found. However, to achieve a high participation in synchronous communication processes the facilitator has to draw the attention of the participants on the starting theses. A feature of floor control within the CSCL-system supporting synchronous communication is one way to direct the attention of the participants (see Fig. 9.4). Floor control means the technical supported management of contributors' rights to "speak"—giving the floor is comparable to asking a participant to speak in the face-to-face settings.

Drawing the attention of the participants in synchronous situations is also important for the stimulation for further contributions and the final conclusion. In asynchronous situations for example instructions and deadlines (e.g. what activity is requested by the participants) lead to higher participation; in the case study described below this and other strategies of asynchronous facilitaion are discussed in detail.

For ongoing discussions the facilitator has the task of stimulating the discussion. In synchronous situations a change of the topic of discussion has a positive effect on the amount of contributions of the participants. In asynchronous situations hints on or highlighting of content in contributions of others should be given. The stimulation is often accompanied by activities of building bridges and coordination acts.

At the end discussions should be summarized. In order to increase the perception of these summaries facilitators should ensure that participants be aware of these summaries. From a technical point of view summaries should be placed in a prominent manner to emphasize their relevance. This especially became apparent during the analysis of fluent transitions between synchronous and asynchronous discussions (Kienle, 2009) and is also relevant for the integration of discussions and activities concerning material from digital libraries. For asynchronous settings it is important that the facilitator should include decisions made during the discussion. If necessary the facilitator makes decisions on he/she own—in contrast to face-to-face settings where the facilitator is not responsible for the content of decisions.

This model (see Fig. 9.1) is a tool for the requirement analysis of the computer support for triadic communication (triadic means communication with the three roles: communicator, recipient, and facilitator). It shows tasks for the facilitator that has to be supported within a CSCL-system. Functionalities for both synchronous and asynchronous situations are developed and evaluated. They are described in the following section.

Case Studies of Computer-Supported Facilitation Within CSCL

The guidance of computer-supported collaborative learning by a facilitator is especially requested in processes of discursive learning where knowledge or statements of the participants have to be exchanged, combined, further discussed, and even enhanced to new knowledge. In these processes the facilitator needs to structure and guide the communication-intensive steps as shown in the section before.

For CSCL at the workplace such situations can be related for example to the development of new knowledge about methods (e.g., question of a department of sales and marketing, "how can we improve our sales approach in order to increase the number of successful customer deals") as well as products (e.g., question of a product manager and he/she team, "how can we improve our product to reach more accepted products"). By trend these situations address a definable group of participants that are "invited" for the discursive collaborative learning and communication process and guided by the facilitator.

The studies described in this section are university courses where groups of students (8–15 participants in each group) learn and discuss methods about the topic of collaboratively teaching and writing. The type of students was described above. The tutors in both studies gave initial material but also had the demand to develop new knowledge collaboratively. As far as I experienced during my work on intertwining knowledge management and CSCL (Kienle, 2006) the findings from these studies can be transferred to the scenario of CSCL at Work.

The studies reported here used the CSCL-system KOLUMBUS 2 (for further information see Herrmann and Kienle, 2008; Kienle, 2006; or Kienle, 2009). KOLUMBUS 2 is a Web-based CSCL-system that was developed by the University of Dortmund, Informatics and Society and the Ruhr University of Bochum, Information and Technology Management, both located in Germany. A former version was built to support the integration of asynchronous communication (in the form of annotations) and joint work on learning material. The central feature is the segmentation of content into small units (called items), enabling the members to use and annotate the stored content in a very flexible manner. While communicative contributions have the form of annotations content is represented by text, pictures, binaries, links, or annotations. Items of material can be inserted at the same hierarchical level of another item or on the next lower level. In this way users can build a hierarchy of their contributions. All existing functions (e.g., annotate, add, copy, and change) can be applied to every item. Discussions occur by annotating annotations. Basic concepts of that work are still part of the actual development.

Case Study on Computer-Supported Asynchronous Facilitation

To support the task of the facilitator in asynchronous discussions technical features were realized based on the concept of role-based access control (RBAC, see Kienle and Ritterskamp, 2007, for details).

In a discussion thread, the *facilitator's contributions are highlighted* with bold type, directing attention of the discussion's participants to the facilitator's inputs. This bold type of the facilitator's statements also visually structures the discussion and reduces the necessity to reconstruct the course of a debate when working asynchronously. By this structuring, the initiation and leading over to the next phase as well as the summarization are, respectively, supported.

To promote contributions to an ongoing discussion two functionalities are offered: Emphasis can be placed on single contributions to a discussion by using a *highlighting functionality*: to label an element of a discussion thread, the facilitator can choose from a variety of background colors. Marking contributions in this way can be used, for example, to group similar contributions or to accentuate important arguments or to stress (intermediary) results of a discussion. There is no predefined meaning to the usage of different colors: it was intended that a user group develops the corresponding conventions without a predefined meaning. The discussion of the meaning assigned to the applied colors fosters the development of shared understanding of the applied functionalities.

System-internal links can be established if contributions that are semantically related to each other have to be interconnected. Establishing a relation between elements in such a way is especially reasonable if they deal with similar aspects of a topic but are distributed over several discussion threads and not directly connected to each other.

Figure 9.2 shows a facilitated asynchronous discussion using these features. In the study the technical support of the facilitators' tasks and different facilitation strategies were analyzed. Here the main results are presented in short—more details about the study can be found in Kienle and Ritterskamp (2007).

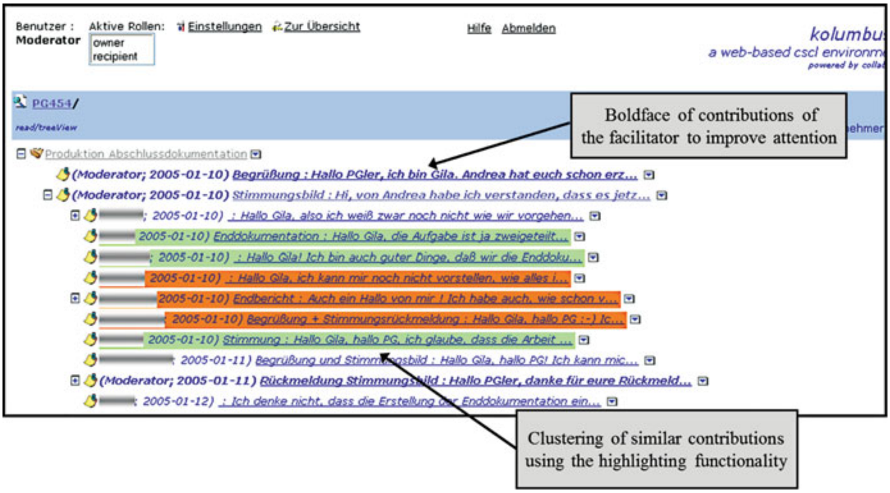

Fig. 9.2 Facilitated asynchronous discussion

Setting and Methods of the Study

The aim of the study was both the development of a hypothesis concerning the methods of moderators' intervention in asynchronous CSCL-processes and detection of further requirements for the technical system and evaluation of the functionalities described above.

During a period of 2 months the moderator facilitated a group of 12 students. This group had the concrete task to document their year's work. Focus on this group led to a design different from conventional experimental studies in which new groups are formed to work on a virtual task for a short time. The task was divided into five steps. For each step the moderator planned interventions in cooperation with the researcher (see Kienle and Ritterskamp, 2007, for details).

Quantitative data about the student group was gathered by logging all events in the CSCL-system. Furthermore, qualitative data was recorded in an audio file at group interviews conducted every 2 weeks.

The audio files of moderator and group interviews were analyzed with respect to the methods of moderators' interventions and their implications on group behavior as well as the technical support and its further improvement. The evaluation of the log files was conducted using a technical tool for analysis within the CSCL-system.

Results Concerning Different Facilitation Strategies

In face-to-face facilitation it is emphasized that a facilitator only has to lead a communication process without any responsibility for the content of the discussion.

In our study we analyzed various facilitation strategies to get an answer for the question of to what extent tasks of a facilitator can be transferred from face-to-face to computer-supported settings:

Open questions without any instructions: At the beginning of the study the facilitator asked open questions as is similarly the case with traditional facilitation in face-to-face groups. Students described obscurities concerning the (subjective) cognition of the progress in a discussion thread, especially whether a discussion was finished or not. With respect to this open-endedness, the students' preference for explicit deadlines became apparent in their answers.

Instruction, deadline, and finalizing conclusion (one step towards more responsibility of the facilitator): In step 2, the facilitator used more instructional contributions which included deadlines. This strategy led to higher participation levels in the discussion. The analysis reveals for the first time that students worked at a rhythm similar to that given by the facilitator: on deadline days more contributions were added. Although participation was high, the discussions were not terminated, for example, in the form of an artifact that includes the discussion results. Students felt termination or finalizing should be done by the facilitator.

Conclusions with decisions by the facilitator (full responsibility of the facilitator): In a third step, the facilitator intervened more than during previous steps. She did not only formulate more instructions which included deadlines but also terminated discussions. If some topics did not come to an end by the deadline, the facilitator decided to stop, and proposed a solution. Students confirmed that the progress of the process was achieved by the facilitator's intervention. From these findings we conclude that the activity of summarizing discussions has an increased relevance in computer-supported settings.

Results Concerning the Technical Support of the Facilitator's Tasks

Students affirmed that emphasizing a facilitator's statements by using bold fonts proved to be helpful in following the course of a discussion. Since the contributions of a facilitator often brought up a new topic and thus resulted in a new discussion thread, emphasizing them pointed out the structure of an extensive discussion more clearly. For instance, if two facilitator statements were displayed one below the other, topics thus far not discussed became rapidly apparent. Regarding the highlighting functionality, the facilitator emphasized that the highlighting of single words would be more appropriate than highlighting the whole item. In terms of the communication model and additional activities of a facilitator, this fine-grained highlighting supports the facilitator in directing attention to the topic of the contribution.

The facilitator proposed further functionalities for an improved support for activities typical to the facilitation of both face-to-face and computer-supported discussions. Firstly, a facilitator should be able to "assign questions and work orders individually" by means of a collaboratively shared task list. Supporting the assignment and handling of tasks are closely related to functionalities which foster the participant's awareness of the current state of the collaborative process in which they are

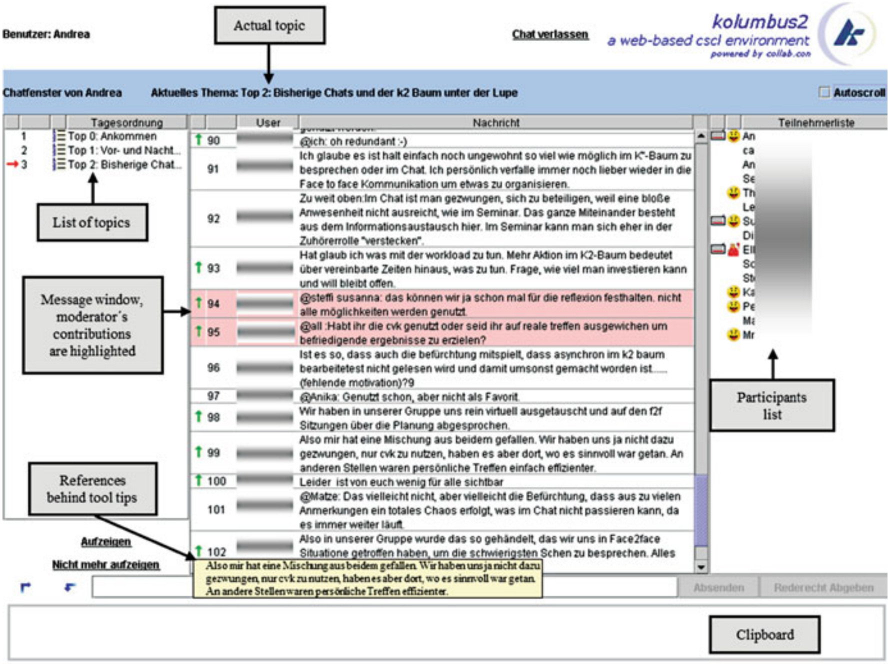

Fig. 9.3 Facilitated synchronous discussion

involved. Furthermore, the facilitator asked for a means to support synchronous voting in order to speed up the process by which participants reach a group decision.

Case Study on Computer-Supported Synchronous Facilitation

Based on the initial CSCL-system the KOLUMBUS Chat was developed with a facilitated and a non-facilitated mode. Following the concept of KOLUMBUS, a chat is represented as an item and can be added at every position in the content structure. When starting the chat item in the integrated view a chat window opens (see Fig. 9.3). In the following basic features of the facilitated chat are presented since it is more complex than the non-facilitated chat and offers more functionality (for more details see Kienle, 2007). Facilitator's contributions are highlighted by a background color in the message window in order to direct attention of the participants to the facilitator's inputs. As in most chat systems a list of participants (here at the right side) is available. Different icons indicate the status of the members (typing, having the floor, etc.). The floor is given by the facilitator.

The *list of topics* supports the integration of material and synchronous communication as well as the later integration of the chat contributions into the integrated

KOLUMBUS 2 content structure. Topics can be text (realized) and (in a conceptual status) links to other material sections. The topics are not only part of the content structure of KOLUMBUS2 but also used during the chatting step to structure the discussion process. The list of topics is a functionality that supports the facilitator.

In the facilitated chat participants have to request the floor and the facilitator is able to give the floor to one or more participants. Each user has—independent of the floor—the possibility to type up to three messages and store them in the *clipboard* at the bottom of the chat window. Before sending to the audience a user takes a prepared message from the clipboard to the input box, edits it if necessary, and sends it to others.

Participants can explicitly refer to an existing contribution by clicking on the accordant message and compose the own message in the input box. *Reference*s are indicated by an arrow in front of the message. The arrow is a tool tip that shows the referenced message when moving the cursor on it. The explicit reference also has an effect on the later permanent storage of the chat contributions. References are a functionality to reduce chat confusion. When a chat is finished the chat contributions are inserted in the integrated content structure of KOLUMBUS. For details concerning the integration see Kienle (2009).

For synchronous facilitation KOLUMBUS offers functionalities for the preparation as well as the guidance of the chat. To support the preparation and prestructuring of a chat discussion the *list of topic* (as described above) is offered that is defined by the facilitator before the chat starts. During the chat the facilitator is able to choose a topic (by clicking on it) that is then placed in the headline of the chat. When changing the topic a contribution in the message window is generated by the system in order to direct attention on it.

In facilitated chats the facilitator *gives or deletes the floor* to one or more participants. Therefore two ways are offered (see Fig. 9.4): the facilitator can choose members from the participant list (A1 in Fig. 9.4) and give or delete the floor for them (A2). The second way takes request of participants into account: the facilitator has an overview list of the participants who requested the floor (B1) and he/she can use this list to choose members and confirm their requests (B2). The design of requesting the floor is inspired by the strategy of raising hands in face-to-face settings.

Setting and Methods of the Study

The aim of the study was to learn about the facilitation strategies and the computer support in synchronous settings. With respect to the facilitation strategies for preparing, guiding, and summarizing the chats were analyzed. With respect to the technical support the usage of the functionalities supporting the facilitator was evaluated.

Facilitated chats were used and analyzed in a seminar at the University of Dortmund (Germany), Education Institute, during the winter term 2004/2005. Fifteen students which formed four subgroups of 3–4 students participated in the seminar. The seminar was carefully prepared as a blended learning seminar that combined work on given learning material from digital libraries and the elaboration

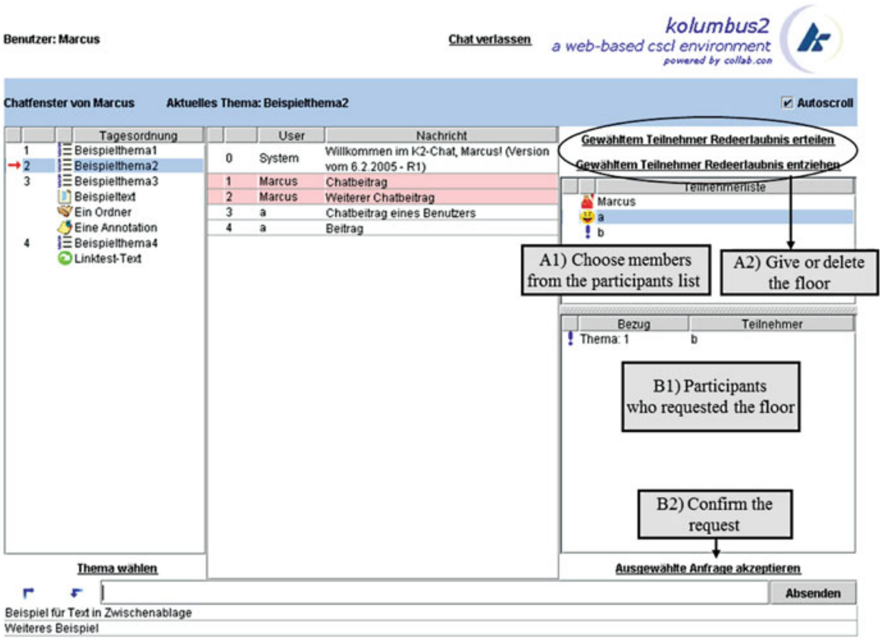

Fig. 9.4 Floor control

and discussion of the results of the subgroups in facilitated seminar chats and face-to-face meetings of the whole group. The overall topic of the seminar was the potential of e-learning for the support of learning at universities and at the workplace. Each subgroup had to work on a preparation of a facilitated seminar chat and a talk that had to be given in one of the face-to-face meetings.

The whole group met in a rhythm of 2 weeks rotational in facilitated chats and face-to-face meetings. The chats prepared by a subgroup dealt with the chosen topic of the concerning subgroup and should give a feeling for the problem to the whole group. Furthermore the facilitated chat was before the presentation of the subgroup so that the content of the chat had to be reflected for the concluding talk. In both the facilitated seminar chats and the face-to-face meetings, a common sense for problems and solutions should be found. The facilitation was done by members of the student groups; each of these chats lasted 45 min. One exception was the first chat that was facilitated by the tutor of the seminar: it had duration of 90 min and dealt with an overview of the content of the seminar.

For the collection and analysis of data a mix of quantitative and qualitative methods was used. The analysis of the chats was done with Chatline (Holmer, Kienle, & Wessner, 2006) that enables a postcoding (e.g., the relation of chat contributions to a discussion thread) of a chat transcript and allows its analysis concerning different measures and patterns like person-related analysis or the occurrence of (parallel) discussion threads as well as graphical representations of the results. For this analysis the five seminar chats were post-referenced by two independent experts in order to mine discussion threads.

The qualitative part of the study was mainly based on group interviews of the student group after each face-to-face meeting and a closing interview at the end of the seminar. The interviews are recorded, typed, and analyzed in order to add reasons to the quantitative findings and evaluate the concepts of KOLUMBUS and the seminar.

Results Concerning Technical Features and Their Usage

The results are presented here as a combination of technical features and their usage because usage of technical features in synchronous settings has an immediate influence on the development of the chat and the intervention of the facilitator.

The study showed that the facilitators in the various chat used the floor control to different extents; the part of participants who have the floor varied from one person (8 %) to all participants (100 %), the average per chat between 27 and 41.5 % of all participants. No coherence was found between the number of participants who have the floor and the initiation of discussion threads by participants. This made clear that the floor control is not the only factor for the success of a synchronous facilitation. In fact the chat was ranked highest, where the facilitator used a combination of extensive usage of floor control and a high amount of own starting theses for discussions (as one way to fulfill the task initiating as proposed in the model of triadic communication).

Regarding the communication process it was found that the usage of floor control was not used to that extent we expected. Only in a few situations the floor of participants was deleted in order to draw attention on the change of the topic, an initial contribution or a conclusion by the facilitator. Facilitators mentioned an excessive demand in the simultaneous content-related guidance by formulating own statements and the usage of floor control. An improvement was achieved in these chats where the content-related and the organizational guidance was shared by two facilitators.

Design Principles for the Facilitation Within CSCL

The studies showed insights into the facilitation strategies and technical features that support the facilitation. They confirmed that guidance of computer-supported collaborative learning by a facilitator is especially requested in processes of discursive learning. The guidance of the communication process by a facilitator can lead to high participation, focused discussions, and results agreed in the group.

With respect to computer-supported discursive learning at the workplace (like drafted at the beginning of section "Case Studies of Computer-Supported Facilitation Within CSCL") a facilitation of the learning processes can benefit from these

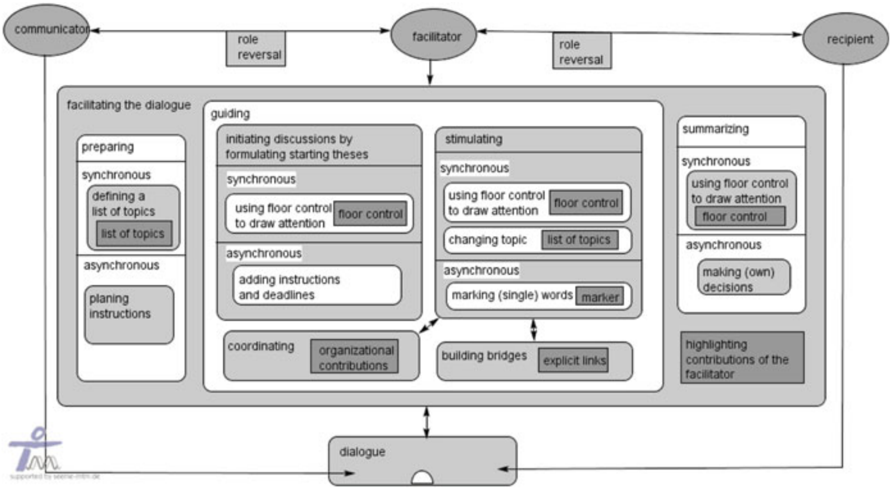

Fig. 9.5 Design principles in the triadic model of communication

findings: more knowledge of the participants is involved and shared (as a result of higher participation), communication about the topic of interest (as a result of focused discussion), and a result that is accepted by the group of participants. Whatever the topic of the CSCL situation is (in section "Case Studies of Computer-Supported Facilitation Within CSCL" the example methods and products are mentioned) a facilitation might lead to better results in shorter time.

The studies showed first results on the technical features as well as on the facilitation strategies. In this section the main results are summarized in the form of design principles and an extended model of triadic communication. These findings can be used by others as a framework for the design of own CSCL-systems that support facilitation and as a background for planning own facilitated processes.

These design principles can be reflected and integrated in the light of the model of triadic communication. Figure 9.5 shows the model that combines the tasks of a facilitator and the technical features. It emphasizes that the design for facilitation support is a development of tasks of a role, technical features, and their interference in the tradition of socio-technical design.

Conclusion and Further Research

This chapter dealt with the role of communication and facilitation for CSCL at the workplace. Communication was presented as an integral part of CSCL since direct experience of a situation and learning by observation are mostly inapplicable in distance learning. To guide the process of communication a facilitator can be helpful. Based on related work on the facilitation of face-to-face and computer-supported communication a model of triadic communication was developed that focuses on

Table 9.1 Principles for the design of computer-supported facilitation

Design principle	Impacts for the communication process	Setting	Example for realization
Highlight contributions of the facilitator	Draw attention on the contributions of the facilitator	Asynchronous and synchronous	Highlighting by color or boldface
Artifacts for prestructuring the communication process	Focus on the content of (parts of the) discussion	Synchronous, facilitated group discussions	List of topics
Give and delete request to contribute	Draw attention, organizing discussion process	Synchronous, facilitated group discussions	Floor control
Highlight (parts of) contributions	Activate and compact discussions	Asynchronous, facilitated group discussions	Marker
Link of contributions	Create synergy by mining parallel discussions	Asynchronous, facilitated group discussions	Links/references

the tasks of a facilitator. For these tasks technical support within a CSCL-system is developed and analyzed in two case studies.

The study on the facilitation in asynchronous settings provided first insights into the impact of the different strategies and functionalities employed to support facilitation. For example, if the facilitator used instructive wording when formulating his contributions and appointed deadlines for the completion of tasks, participation initially increased. However, this was not sufficient to foster the development of mutually agreed-upon results, e.g., a task list or an outline of an article that had to be written collaboratively. Findings from the case study suggest that for this purpose a moderator occasionally has to make decisions on their own and needs to present intermediary results in condensed form. Compared to face-to-face situations, a facilitator is to a greater extent involved in activities concerning decision making and leadership taking when moderating asynchronous computer-supported discussions.

The study on the facilitation in synchronous settings also revealed results on the technical features as well as the strategies of facilitation. It was found that floor control as a single functionality does not seem to be an appropriate vehicle to guide the discussion. A sufficient strategy for facilitation was achieved by an appropriate combination of starting discussion threads, using the list of topics and floor control.

From the results of the two studies generic design principles for the facilitation of communication within CSCL at the workplace are derived and integrated on the model of triadic communication. This final model emphasizes that the design for facilitation support is a development of tasks of a role, technical features, and their interference in the tradition of socio-technical design.

The facilitation strategies and design principles are first steps in the field of facilitation of CSCL. Further research and studies have to be conducted in order to get a resilient fundament for the socio-technical design of computer-supported facilitation.

The results reported here give valuable hints for settings of CSCL at Work, especially in cases of evolving and mining new knowledge in the company. Whenever bringing a group of learners together it is required that a facilitator prepares, guides, and summarizes the group discussion as described in this chapter in order to increase the effectiveness of the discussion. For the designers of technical systems for CSCL at Work functionalities for the support of a facilitator should be added (as shown in Table 9.1) in order to offer appropriate support for the facilitators of communication processes within CSCL at Work.

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Part III
Unexpected Learning Places

Applying collaborative technology to workplace learning is a central theme in CSCL at Work.

King's example (Chap. 10) shows how the skills required to collaborate through technology are acquired through play. MUDs, MOOs, and MMORPGs are two decades into our culture. King's case centered on the World of Warcraft as a place for developing collaboration skills in the twenty-first century adds both perspective and practical significance to activity participants regard as *merely* fun. And there are a lot of participants in these games. For example, an astonishing 37 % of US boys and 24 % of US girls participate in such games at least weekly. Similar numbers likely hold true in other digital economies. King's case provides an illustration of how a fun, gaming environment helps to cement *Homo Interneticus* in both work and life.

Gurzik and White (Chap. 11) illustrate the positive effects of social media on workplace productivity. Social media enable workers to tap into their personal social networks (PSNs) to acquire knowledge they do not already have and cannot find in their workplace. This perspective on social media in the workplace, particularly as a site for knowledge acquisition, is little explored elsewhere. The incorporation of the PSN as a mechanism for raising organizational performance levels is compelling.

The researcher and practitioner alike should be inspired to consider how CSCL at Work might be instantiated in unusual and unexpected places. These chapters share recognition that learning is a social activity. The strength of each chapter's perspective is the central position of social engagement as a component of CSCL at Work.

Chapter 10
Massively Multiplayer Online Role-Playing Games: A Potential Model of CSCL@Work

Elizabeth M. King

Introduction

Workplace studies and messages in the popular press suggest that the American workforce has become increasingly ineffective, often characterized as lacking appropriate twenty-first century skills (Friedman, 2006).

Typically, the culprit is identified as a deficient education system producing students who are declining on internationally compared measures of academic achievement, a situation so severe that it is often labeled as a crisis within the American K-20 (kindergarten to college) educational system. More realistically however, the condition has resulted from not only the outdated educational environment but also tumultuous changes in business dynamics that have put pressures on business, as well as education, to be better, faster, and stronger: in short, more competitive at every juncture.

As Hagel and Brown (2005) describe, the distributed nature of the workforce and consumer markets has caused a tremendous push to digitize all dimensions of the production process. By implication, the Internet and digital networks have evolved as the preferred medium for distribution, and production alike. In the process, the workplace has become saturated by technology and technology-embedded processes. This has increased the need for workers to have a conceptual understanding of technology as a mode of conducting work (Bell, 2005). Technology also facilitates collaboration in the twenty-first century workplace, both in collocated contexts and distance work (Cummings & Keisler, 2002).

This technology-rich world increasingly relies on connectivity that links people, ideas, products, and mediums of distribution. Most significantly *connectivity* has become a route toward collaborative workflow processes. According to Hagel,

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Brown, and Davidson (2010), this level of connectivity has spurred the development of new business models that center on providing consumers access to distribution channels and allow both consumers and producers access as never before to high levels of personalization and individualization. These developments have also shortened product life cycles, frequently rendering life cycle trajectories unpredictable even with the most sophisticated data.

As a result, new models of workplace practice have emerged, which, by extension, require new skill sets in order for workers to thrive in what is often described as the twenty-first century workplace (Twenty-First century skills, n.d.), or the knowledge economy (Cairney, 2000; Drucker, 1985; Powell & Snellman, 2004). It is this situation that has caused the educational system to plunge into crisis at both the K-12 and postsecondary levels, as stakeholders struggle to meet the educational needs of students entering the uncharted landscape of the modern business world (Tough choices, 2008). In K-12, postsecondary, and adult continuing education alike, the use of technology is disjointed from learning and practice in the classroom (Collins & Halverson, 2009). This is not a new observation; as Fisher (2007) points out, even when technology is integrated into the classroom, it is "used as add-ons ('gift-wrapping') to existing practices" (p. 2), disconnected from the learning process and is more a content to be mastered instead of a mode of operation.

Unfortunately this does not seem to change beyond K-12 where models continue to revolve around didactic teaching and the dissemination of information, rarely true collaborative learning that is supported by the tacit application of technology (Tough Choices, 2008). This is also carried over into workplace education whereas even industry reports addressing the types of skills workers need for the modern workplace (i.e., Anderson, 2006) separate computing and information technology (IT) skills from other skills. For example, discussions of IT skills are typically disaggregated from collaborative and team functions. This seems to assume a disaggregation of computer-based activities, almost considering computing as more of a content-related skill, rather than an applied skill or route toward the operationalizing of such activities as communication and collaboration. Nowhere is this more vital than in the process of learning within the workplace, which in twenty-first century terms is both collaborative and collective, and certainly perpetual (Fischer, 2007). Compartmentalizing IT skills from workplace practices, which inherently include dynamic learning processes, is the very crux of the computer-supported collaborative learning (CSCL) at work issue raised by Goggins and Jahnke (Chap. 1). Skills and practices facilitating workflow in the modern workplace require ongoing collaboration and learning which are *socio-technical* in nature, not merely social dispositions disaggregated from technical skills.

The technology-rich and collaborative processes necessary for workplace effectiveness involve dynamic learning leveraging tools, resources, and networks whereas workers engage in critical thinking, problem solving, or innovating (Hagel & Brown, 2005). However, these skills are not the stuff of the current standard-based regime or the focus of standardized and high-stake testing, both of which are the current focus of K-12 education reform (Gee, 2007; Tough Choices, 2008; Wagner, 2008). And they certainly are not the types of learning modeled in the lecture halls permeating postsecondary education (Gee, 2010). Traditional education does not appear to support modeling the types of CSCL and CSCW practices that could be efficacious if implemented in the workplace.

If workers are not learning how to integrate technology and collaborate with colleagues in school, and are not having CSCL/CSCW processes modeled very effectively within postsecondary education, how are they to learn these essential skills? If this is not taught in formal settings, how are established business organizations to know how to leverage these processes? Where are we to find potential models of collaborative workflow practices that might be leveraged to influence the process of educating students for the demands of computer-supported collaborative working associated with modern workplaces? This chapter offers an illustrative example of related practice, however obtained in a very unlikely place, the informal gaming practices and affinity space involvement associated with massively multiplayer online (MMO) role-playing games. The intent of this case study is to show how informal learning practices associated with an online video game may provide participants with highly efficacious models of CSCL at Work, which, in turn, may orient participants to dynamic collaborative learning processes in the workplace.

The example of an afternoon of gaming depicts MMO gaming as an informal learning space providing exposure to collaborative workflow processes whereas socio-technical resources are accessed and leveraged within the process of doing the work of the game. Learning is not a stand-alone process separated from situated activities. Instead, a variety of opportunities for learning are actualized while developing related goal-based competencies. Inherent in this space is what Goggins and Jahnke (Chap. 1) describe as a “high social design” that calls into practice “knowledge co-construction … [and] opportunities for knowledge exchange” (p. 18) within a highly informal learning environment. As Goggins and Jahnke (Chap. 1) state, although there is a concerted effort to change workplace learning, currently “engaging in participation and collaborative learning through technology in the workplace is novel” (p. 3). The CSCL at Work affordances attributed to the MMO environment suggest the potential for drawing upon the informal learning experiences of youth engaged in digital media practices as fodder for considering models of CSCL situated within workflow processes.

Additionally, models of collaborative and collective learning processes in these online communities of practice (CoPs) and affinity spaces may inform new conceptions of virtual collaboration within the workplace and across business entities. As these models of collaboration provide for varying levels of connectivity, engagement involvement around a whole host of interest-driven niches, they are likely to illuminate design considerations for the development of environments to support similar practices in the workplace and larger business community. Although this has been discussed in the literature (e.g., Hagel et al., 2010), empirical evidence is emerging and in need of additional study. Considering the affinity space framework (Gee, 2004, 2007) as a route toward better understanding broader patterns across online spaces may offer new avenues toward this goal.

Massively Multiplayer Online Role-Playing Games: Potential Model of Collaborative Learning-Integrated CSCW

Given the limitations of current educational systems, efficacious CSCW skills might actually be more readily modeled and incubated (Steinkuehler & King, 2009) in the informal learning spaces and interactive play spaces associated with gaming and digital media. In fact, research into the affordances of gaming and digital technologies shows a propensity for promoting broad-based twenty-first century learning skills (21CLSs) (Twenty-First Century Skills, n.d.) embedded with CSCL practices. For example, evidence suggests that involvement with these sorts of technologies may sponsor the development of key literacies involved with IT skills (Hayes & King, 2009; King 2009a, 2009b; King et al., 2011) and information literacy (King, 2010b), computational literacy (Steinkuehler & Johnson, 2009), as well as the development of areas of interest-driven expertise (Barron, 2006; Squire, in press) facilitated by long tail niches (Anderson, 2006; Collins, Fischer, Barron, Liu, & Spada, 2009). While there are many genres of gaming, this chapter provides a discussion of one specific genre of gaming, MMO role-play gaming, and particularly the game World of Warcraft (WoW), as an illustrative example of CSCW in practice (Orlikowski, 2000).

Playing MMOs is a worldwide phenomenon with over 55 % of Internet users also participating in online game play and over 16 million MMORPG active subscribers worldwide (Woodcock, 2008). In the United States, 21 % of the population plays MMOs, with the highest concentration of players comprising teenagers, whereas 37 % of boys and 24 % of girls engage in MMO gaming (United States National Gamers Survey, 2009). Steinkuehler (2007) described this type of game space as,

> [H]ighly graphical two- or three-dimensional video games played online, allowing individuals, through their self-created digital characters or "avatars", to interact not only with the gaming software—the designed environment of the game and the computer-controlled characters within it—but with other players' avatars as well. The virtual worlds that today's MMO gamers routinely plug in and inhabit are persistent social and material worlds, loosely structured by open-ended (fantasy) narratives, where players are largely free to do as they please—slay ogres, besiege castles, craft a pair of gaiters, barter goods in town, or tame dragon hatchlings. (p. 298–299)

Behind the narrative of slaying ogres and taming dragon hatchlings, MMO game play is in fact quite complex. Literature suggests MMOs and virtual worlds as potentially affording opportunities for participants to engage in practices involving 21CLSs involving areas of critical thinking and problem solving (Thomas & Brown, 2009), computational literacy (Steinkuehler & Duncan, 2008), creativity and innovation (Hagel & Brown, 2009), economics (Castronova, 2001, 2003), financial management and entrepreneurship (Dibbel, 2006; King, 2009a), as well as information technology skills (Hayes & King 2009). Interestingly, these kinds of skills are listed in prominent workforce studies (e.g., Casner-Lotto & Barrington, 2006; Casner-Lotto & Silvert, 2008) as necessary for success in the modern workplace.

Pertaining to the potential affordances of gaming practices involving collaboration and distributed learning processes similar to CSCW, the works of Ducheneaut, Yee, Nickel, and Moore (2006) as well as DiMarco, Lesser, and O'Driscoll (2007) have discussed WoW in specific as a game space that promotes the practice of collaboration, teamwork, and application of leadership skills. Supporting this literature, John Seely Brown and associates have widely published on the workplace-related practices embedded in WoW game play. Hagel and Brown (2009) highlight the practice of self-organized collaboration, or collaborative arrangements that arise "on the fly" which are referred to as "pick up groups" in game. However Brown and Thomas (2008) indicate that underlying the motivation to engage in collaborative work processes is a *disposition* that orients MMO gamers, particularly WoW gamers, to collaborate, saying:

> Diversity is essential in the world of the online game. One person can't do it all; each player is by definition incomplete. The key to achievement is teamwork, and the strongest teams are a rich mix of diverse talents and abilities. The criterion for advancement is not "How good am I?"; it's "How much have I helped the group?"

The Affinity Space: A Theoretical Framework to View CSCW Practices in an MMO

However, these practices become in fact much richer, and more applicable to the study of CSCL/CSCW, when considering practices that connect game play to online spaces of participatory engagement designed around niche specific interests supporting. Within these spaces, trajectories of learning facilitate interest-driven pursuits around and beyond games (Steinkuehler, 2007) and popular culture (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006). Gee describes these learning processes as stemming from collaboration and participation where participants come in contact with larger discursive patterns (Gee, 1999). This is because learning is a way of participating that involves learning to "be" and learning "*how*," instead of the more common types of "learning *what*" (Brown, 2006; Thomas & Brown, 2007, 2009). These sorts of learning processes are centered on situated experiences (Gee, 2004) and ways of thinking about specific phenomena, developing tacit understandings (Brown, 2006), rather than coming up with definitive content that is covered; blending individual and collaborative activities is key.

In addition, these online spaces expose participants to high standards of practice and trajectories of developing expertise which afford reflective self-improvement (Schon, 1996; Squire, in press) in pursuit of an individual passion (Brown, 2006; Hayes & King, 2009). Put another way, Brown and Adler (2006) describe these learning processes as "demand pull" whereas learning is initiated through a specific situation and not front loaded and delivered as a curriculum. These self-driven trajectories of learning arguably resemble lifelong learning practices (Fischer, 2007; Fischer & Konomi, 2007) and inseparably involve technology integration centered on collaboration and collective workflow processes.

Naturalistically, these are spaces that often appeal to individuals who do not have access to a local peer network involved in similar practices (Gee, 2004; Hayes, King, & Lammers, 2008). Instead, they must rely on distributed resources either to teach themselves independently or work in collaboration with other members of the community if they are to learn new skills, or resolve challenges. While the features of these online spaces vary, a commonality is that they typically provide access to tools for communicating, collaborating, and acquiring and disseminating information. However, they are made valuable and relevant by the participation of the members themselves, and are characterized by a participatory culture (Jenkins et al., 2006) of content creation. It is this participatory culture that urges many to move across the continuum of consumer to producer, and along the way, develop enhanced expertise. This process of moving from consumer to producer frequently offers novices the opportunity to "rub virtual elbows" with experts often working together to solve problems and frequently across continents and time zones. It is precisely this type of connectivity and interaction that is foundational to computer-supported collaborative working which is often studied through the lens of a CoP (Lave & Wenger, 1991).

Wenger and Snyder (2000) defined CoPs as "groups of people informally bound together by shared expertise and passion for a joint enterprise …" (p. 139). Brown and Gray (1995) further clarified this concept in relation to distributed groups of professionals working together and observed that work is predominately conducted through the efforts of a collection of peers collaborating around a common purpose. Building upon this idea, specifically considering virtual communities, Lueg (2000) pointed out that the purpose of these communities is mainly for knowledge creation and knowledge communication. Often the study of CoP interaction relies on the process of integrating participants into the practices of the community, or becoming a member (Wenger, 1998). This process is described as a trajectory from a more limited or peripheral participation into fuller or legitimate participation (Lave & Wenger, 1991). However, a central key to the CoP framework involves membership and belonging (Wenger, 1998).

While CSCW has a well-developed line of literature addressing CoPs, a growing body of research specific to digital media practices and spearheaded by Gee (2003, 2004) offers an additional conceptualization particularly relevant to online, interest-driven, and niche-specific learning: *affinity spaces* (Gee, 2005, 2007). Gee does not suggest the affinity space concept to replace the CoP framework; instead this is an additional conceptualization to offer stronger differentiation between online practices. According to Gee (2005, 2007), affinity spaces are distinct from CoPs in that instead of a *community* focus, the affinity conceptualization incorporates a "*space*" orientation that, in comparison to the CoP framework, downplays "membership." Instead, the affinity group concept considers more loosely related constellations of participation across many content-specific spaces, as well as knowledge sharing processes that allow for more permeable boundaries than a CoP. Instead of focusing on bonding with participants and moving toward membership in a community, or traversing toward full participation within one CoP, digital media culture tends to encourage participation across numerous spaces based upon pursuit of interest as the primary motivator rather than bonding with members.

Another distinction is that the study of CoPs is often approached through the lens of understanding the interactions and learning occurring within a specific community (cf. Hayes & King, 2009). This is an issue of concern as youth and young adults engaging in interest-driven learning in online spaces tend to work across many interest-specific affinity spaces as a route toward what is described as "geeking out" or developing extensive expertise in a domain (Ito et al., 2008). I argue that studying the trajectories of participation across affinity spaces as engaged in by youth and young adults who tacitly participate in these spaces may add value toward the development of models of holistic lifelong learning practices that can be adapted to inform models of CSCL at Work. In fact, as Gee (2007) notes:

> Affinity spaces are common today in our global high-tech new capitalist world (Gee, 2000, 2001; Rifkin, 2000). Many businesses organize such spaces for their customers. For example, the company that [made] the Saturn car creates Web sites and activities (e.g., social gatherings, newsletters, Internet chat rooms) around which its customers can identify as Saturn owners. Businesses in the new capitalist era (Gee, Hull, & Lankshear, 1996) of cross-functional, dispersed, networked teams and project-based work often seek to create affinity spaces to motivate, organize, and resource their [workers and affiliates] (p. 101).

Therefore this chapter features an affinity space theoretical framework to consider the CSCL and workflow processes involved in the informal gaming activities. As the case study (an afternoon of gaming) will show, within this space, people are learning and developing competencies using socio-technical tools to facilitate workflow, including communication and knowledge building, as well as leadership skills. The following section details the methodology and research context involved in the case study.

Context of Research and Methodology

This study is based in a longitudinal, naturalistic case study (Stake, 1995) of a friendship group of teenage boys playing video games "in the wild" (Hutchins, 1995). Participants were collected through the snowballing (Creswell, 2007) of friendship group connections as they evolved over a duration of 3 years based upon school friendships, participation in an after-school gaming program, family relationships, and a mutual passion for playing video games. This group of 17 teenagers (aged 12–19) were involved in playing console games to varying degrees and were heavily involved in playing the MMO role-playing game, WoW.

Case study methodology (Stake, 1995) was used for studying the friendship group with the goal of capturing peer-based, naturalistic play across multiple affinity spaces (King, 2010a). Observation and participation traversed both face-to-face and virtual contexts in naturalistic gaming environments that included casually hanging out with friends, gaming parties, and also individual gaming in home settings. Data were documented through field notes, video and audio recordings, and photos. Observation and participation data were primarily collected during online play within WoW game setting, and were documented through chat logs, screenshots, as well as audio and video recordings.

The compiled data set was coded using thematic coding (Huberman & Miles, 1994) involving themes aligned to the twenty-first century skill standard (Twenty-First Century Literacies, n.d.), which were studied for patterns across themes, considering both individual practice and clusters of group practices. For this study in specific, an illustrative example from the naturalistic data corpus containing an observation of a Saturday afternoon of gaming was purposefully selected to demonstrate a typical gaming session for one of the youth in the study. During the observation, clarifying questions were asked as necessary to draw out additional information about his activities. Afterward, three levels of analysis were conducted, first to obtain a general timeline of his activities and then to build a description of the activities. These descriptions were generated based on direct interpretation (Stake, 1995) determining major practices embedded in his play. Subsequently, interpretations were triangulated (Creswell, 2007) with the informant, during which time he provided additional information about the nature of resources consulted and background information on the activities involved in the afternoon of gaming. The third step of analysis involved identifying thematic areas of interest-driven involvement and unpacking related affinity space involvement. Please note, in order to maintain anonymity the names of all participants, including screen names, are presented with a pseudonym.

Findings and Discussion

The following example illustrates MMO gaming practices as viewed through the lens of one participant engaged in what he self-reports as a typical afternoon of gaming that encompassed independent play, collaboration with friendship group members, and a wide variety of affinity space participation (Gee, 2004). Bronson, a ninth grader at the time this example was collected, is of biracial, decent with African American and Hispanic roots and lives in an inner city neighborhood of a small urban city in the Midwest. He had been identified as "at-risk" in his school setting and throughout the study he earned very poor grades; as a freshman in high school, he had already been labeled severely credit deficient. On the other hand, Bronson described himself as a "pretty good gamer," and reported a strong interest in history and war-related games in addition to playing WoW.

In this example, Bronson is playing WoW, which, for him, involves both playing the game and pursuing interest-driven activities he and his friends were starting to develop. Figure 10.1 provides a timeline-based overview of his game-based online activities as they unfolded during one afternoon of gaming.

What is clear from examining the figure is that his activities feature a wide variety of activities, not only playing the game but also interest-driven pursuits beyond what might be considered more typical gaming, such as embarking on game-based quests (although questing is certainly involved in his afternoon of gaming). In addition, his activities are largely collaborative, drawing on his friendship group and peers from several different affinity spaces. In the following section, a closer examination

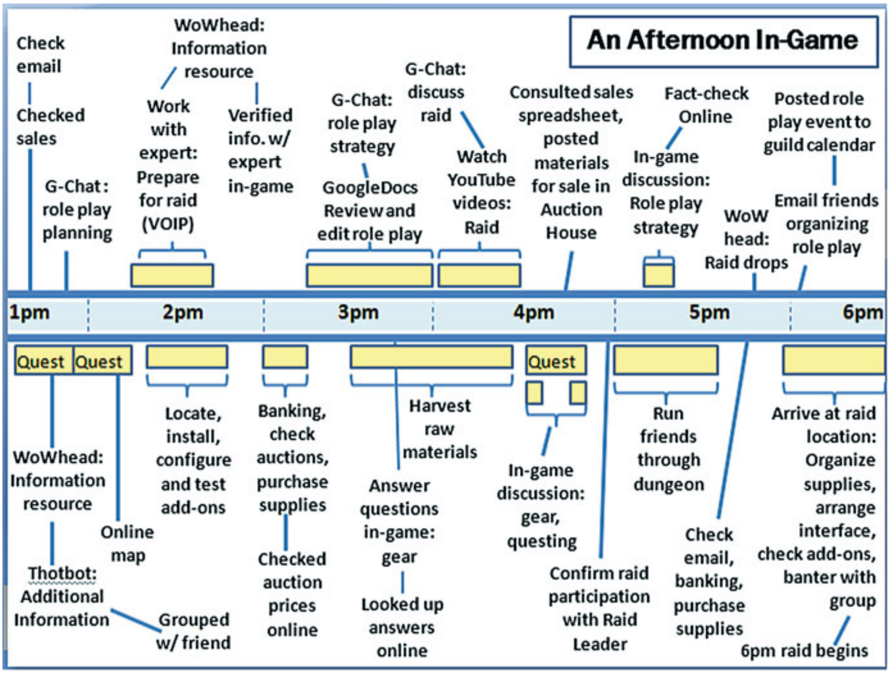

Fig. 10.1 In-game example: Activities involved in an afternoon of gaming

of Bronson's activities is presented centering on two of the most prominent practices involved in his afternoon of gaming: collaborative writing of role-play scenarios and preparing to engage in a raid are presented.

Collaborative Writing Activities

One of the practices that emerged among a subgroup of the friendship group was role playing that they organized on special server designated for role-play activities within WoW's game space. Their activities involved strategizing role-play sessions during face-to-face gaming parties and then implementing them either during the party or virtually thereafter. Over time, their role playing began to involve increasingly complex characters and plots and evolved into a dynamic process of collaborative writing. The writing activity first developed as a practice between Bronson and another boy as a tool to hash out the developing storyline, but later also integrated a larger population of the friendship group. To facilitate this process the boys used GoogleDocs to save, share, and collaboratively write and edit their role-play scenarios. As the timeline depicted in Fig. 10.2 indicates, during this one afternoon of gaming, Bronson engaged in collaborative writing activities with his friendship group that incorporated a variety of tools to facilitate collaboration, activities that spanned multiple affinity spaces.

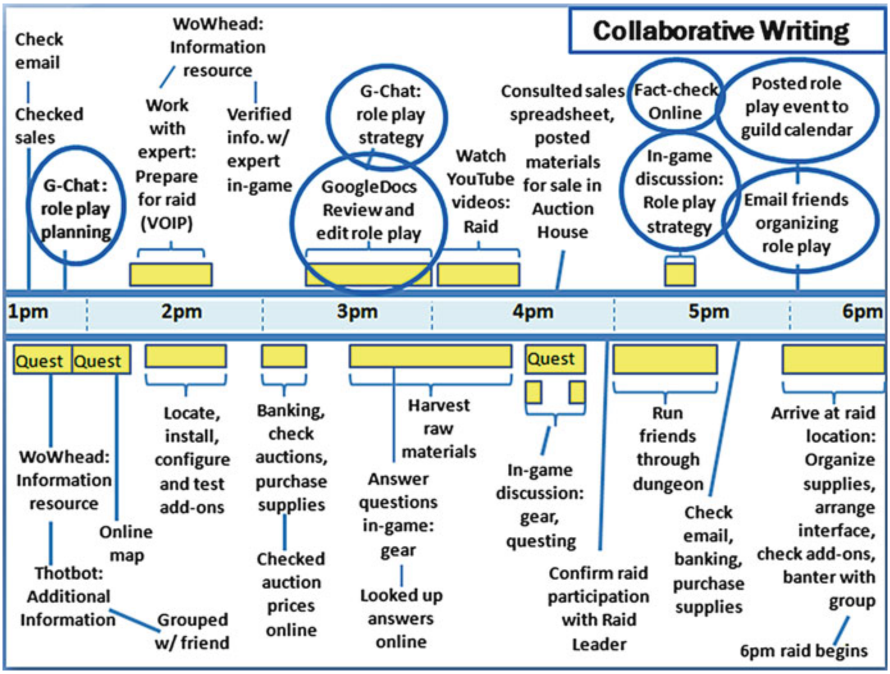

Fig. 10.2 In-game example: Collaborative writing role-play scenarios

Figure 10.2 highlights where Bronson's collaborative writing is situated within his afternoon of gaming. While engaged in developing a group role-playing scenario, Bronson was involved in planning, writing, and editing a script in conjunction with other members of his friendship group. In addition, since this was essentially a script to be enacted in game, the scenario needed to be planned, an activity that involved selecting the setting, gathering props, and costuming. In addition, Bronson also assumed a leadership role in organizing and managing the group. Within this one afternoon of gaming, his leadership activities involved communicating instructions to the group, delegating responsibilities, and using the tools of the game space, along with Google, to plan for their in-game role-play event. In addition, he drew upon his elaborate network of *colleagues* to solicit participation, or "extras" from a larger population via e-mail. However, this was just one activity involved in his afternoon of play; in between playing the game and working on the role play, he was also preparing to *raid* later that evening.

Collaboration En Route to Teaming: Preparing to Raid

Raiding is a practice that is strongly associated with WoW game play. In general, raids (sometimes also called instances) are group activities that typically involve between 5 and 40 people who work both collaboratively and virtually in order to accomplish successively challenging goals. These team activities are highly complex and involve a great deal of strategy and orchestration communicated by the raid leader via text-based and voice over Internet protocol (VOIP) modes of communication. According to Wolfenstein (2010),

> Raid instances represent encounters with some of the most powerful nemeses of the game. However in terms of game play raid instances are better understood as carefully structured problem spaces that require certain strategic solutions. In other words, the written game narrative about the dragons and demons players are fighting winds up being much less important than the game mechanics which work to structure the played experience…. The primary challenge in end game raiding is for players to learn the behaviors of the non-player characters (commonly referred to as mobs) and respond appropriately as a team with each player enacting their prescribed role.
>
> Reaching and defeating … mobs is the primary designed objective of end game raiding in WoW, and when players are victorious the group is rewarded with particularly powerful virtual items. Not only does this gear enhance their effectiveness in future play, but high-end weapons and armor often times have fancy graphics as well.

Gaming and digital media scholars have begun discussing areas of alignment between participating in raiding and associated collaboration and leadership skills (for example, DiMarco et al., 2007; Reeves & Malone, 2007). Findings suggest actively engaging in high-level raiding activities as a route toward not only experiencing virtual collaborative processes but also perhaps more crucially, practicing emergent leadership based upon specialized skills or areas of expertise similar to cross functional teams (Rosen, 2007). However, looking beyond participating in the actual act of raiding, what is unique about this example is that the focus is not on participating in the raid. Instead, this data point (Fig. 10.3: Preparation for Raiding) illuminates the "demand pull" (Hagel et al., 2010), or just-in-time knowledge acquisition processes (Gee, 2003), involving a variety of affinity spaces as Bronson engaged in activities to prepare himself to participate in a raid.

Since this was the first time Bronson was participating in a raid of this level of complexity, he felt he needed a great deal of preparation. What is interesting is that his preparations, while involving self-directed learning processes, spanned multiple collaborations with his peer-based affinity space as well as other affinity spaces for resourcing and information. Starting with modifying the user interface of the game, he needed to install open-source software into his game. Referred to as "add-ons" or "mods," the software installed additional meters within his game interface. These add-ons were designed to enhance his ability to monitor the group members he would be assigned to support during the raid and also gauge the level of assistance he needed to provide. They also supplied a medium for him to monitor his own progress and the status of his resources.

He also needed to set up what is referred to as *key-bindings*, a type of shortcut similar to setting speed dial numbers on a cell phone that is designed to tie specific keyboard keys to recursively enact functions in the game. However, when he began experiencing challenges he could not resolve by accessing the affinity spaces he typically used to inform technical troubleshooting, he consulted an expert within his peer network for assistance. Using the expertise of his colleague, he was able to resolve the challenges and continue setting up his interface. Because raids are undertaken by a group of individuals collaborating virtually toward achieving a common goal, extensive

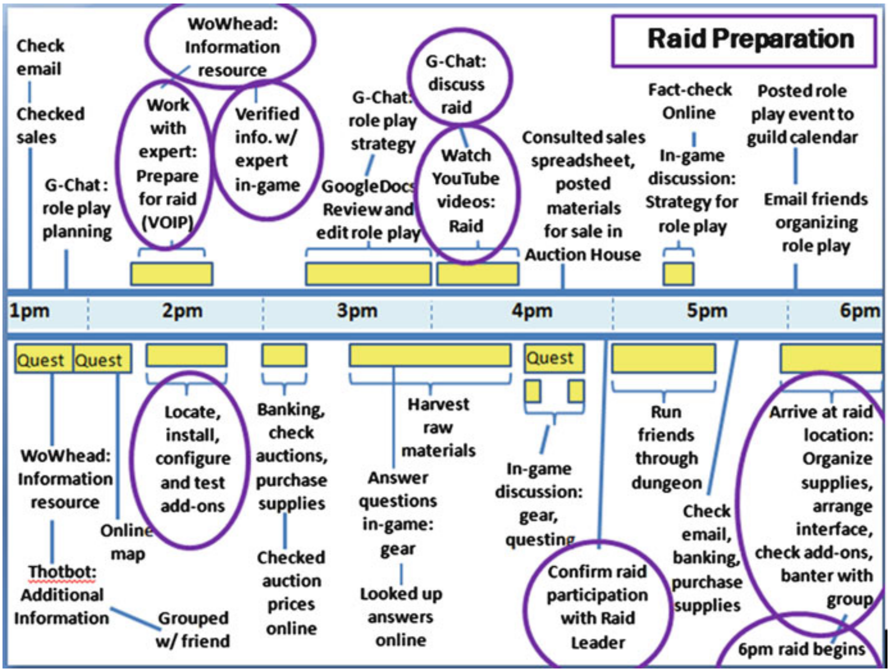

Fig. 10.3 In-game example: Preparation for a raid

communication between members of the raid team throughout the duration of the event (in this case, several hours) is required. To this end, his raid team required the use of both in-game chat (text based) and also real-time voice, or VOIP, referred to as Ventrillo, or "Vent" for short, within the WoW community. Working with a friend from his raiding guild, he tested his ability to use Vent, thus ensuring that he had the necessary communication tools to participate in discussions. In short, what was required was the integration of multiple different technologies as a tool for continuous collaboration and co-creation of knowledge while progressing through the collaborative activity.

Since he was new to this specific game content, he felt it was important to *study* the impending activities to gain an understanding of both his role and also the manner in which the overall action was to unfold. He commented that he previously "… spent a bunch of time reading like a bunch of stuff on Wowhead and online" and that he already knew "pretty much about [the raid] just from hanging out." But, as an additional measure, he consulted a resource he indicated frequently using to inform his game play, YouTube. Using this video resource as a sort of professional development activity, he watched several videos, produced by other WoW players, depicting the activity involved in the raid.

While it might seem unusual to consult YouTube as a tool for professional development, within the context of gaming this is quite commonplace. In fact, it is accepted practice for guilds and raid groups to create videos that can serve to evidence their prowess while also serving as a tutorial of sorts for others wishing to embark on the raid. In addition, one of the norms associated with raiding is an orientation to efficiency and productivity, as well as professionalism. One of the ways Bronson demonstrated his professionalism was by using in-game collaboration and communication tools to communicate with the raid leader to confirm his participation in the impending raid. As described above, also he engaged in a great deal of preparation in the hours leading up to the raid, making sure that he was knowledgeable and had the technical tools and skills required in order to participate. In addition, although the raid was scheduled to begin at 6:00 p.m., he arrived at the raiding location one-half hour ahead of time, prepared with the appropriate supplies, ready and able to perform his specific roles within the group. While he was waiting for the entire group to assemble, he engaged in "social banter," the game-based equivalent of *schmoozing* in the business world.

Discussion: Game-Based Informal Learning and Connections to Computer-Supported Collaborative Learning at Work

As Gee et al. (1996) describe, new capitalist environments are characterized by distributed workplaces whereas technology is integrated into every aspect of the workflow process. Collaboration and collaborative workflow processes are indeed central to the framework of the modern workplace. These are themes that are readily apparent during Bronson's afternoon of gaming. Looking at the example in aggregate, the manner in which Bronson pursues his interest-driven activities could be said to resemble a typical day in the office involving work on multiple projects. It is readily apparent that he is multitasking, vacillating between several different projects of sorts. Throughout this afternoon, his activities span collaboration across his social network, activities that were both predetermined as well as on the fly. In fact, as depicted in Fig. 10.4, both collective and collaborative processes of knowledge building are consistently visible across his afternoon of play.

The route he uses to acquire (as well as share) knowledge is not by sitting in a classroom, attending a seminar, or completing an online "module" about the problem at hand. In contrast to the formal learning environment, he goes about engaging in knowledge building processes by tapping into the informal learning spaces, the affinity spaces, around the video game he is playing. These range from synchronous affinity spaces offering access to user-created materials such as wikis, blogs, maps, forums, and videos to more synchronously available human resource networks he collected over time. He does not simply passively consume this information he acquires, either. Instead he both acquires and contributes knowledge as the need evolves, calling resources into action as appropriate and recruiting collaboration on the fly in the process of doing the work of the game. This sort of "demand pull" (Hagel et al., 2010) requires extensive reliance on social and information ecologies populating the inter- and intra-game space, or leveraging affinity spaces. The following table (Table 10.1) depicts the array of different affinity spaces accessed within the span of this one afternoon.

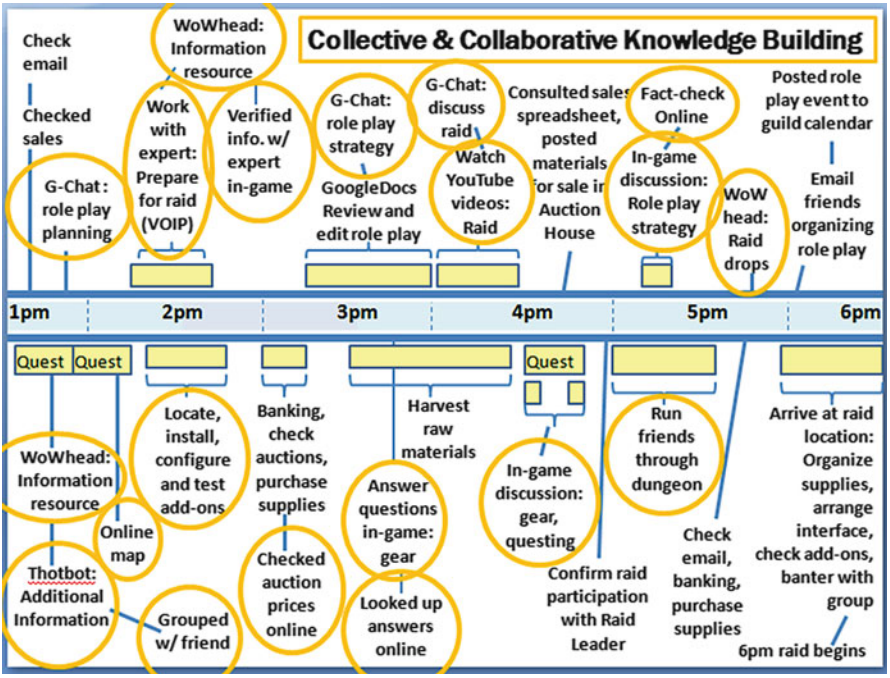

Fig. 10.4 Collective and collaborative knowledge building activities

Table 10.1 Affinity spaces involved in one afternoon of gaming

Crossing multiple affinity spaces	
Online multimodal information resources	Human resources and social networks
Wowhead	Friendship group
Thottbot	Raiding guild members
Curse gaming (add-on)	Friends in-game
Wow Wiki	General game players (general chat, trade chat)
World of Warcraft forums	
Guild forum	After-school program guild
YouTube videos	Raiding group

And, he certainly does not evidence the effectiveness of his knowledge acquisition processes through test taking or writing a paper, as is the norm in formal learning environments. Instead, he evidences his skills and abilities through a more authentic assessment involving not only his individual abilities but also the collaborative efforts of his entire raid team. Raiding as well as role playing in essence are public performances where all participants can view each other's performance both visually as well as statistically. Contained within the game's interface and the additional, required add-ons are meters that measure individual performance numerically.

In this way the activities, including verbal and written communications, as well as the overall effectiveness of each participant, are visible to the entire group. This renders all facets of his participation not only a public performance but also a public assessment of his effectiveness, knowledge of the raid, and overall ability to operate his character for maximum impact within the scope of the team.

An additional factor that is essential to acknowledge is that what's backgrounded throughout the entire example is a tacit use of a range of technological tools for communicating, collaborating, and engaging in workflow processes. At a foundational level, he is using the game's interface as the route toward organizing, tracking, and accomplishing the "work" of the game. As discussed previously, this environment allows for users to individualize and install add-ons to enhance usability, which for Bronson involved installing additional tools for monitoring the progress of his group members as they engaged in a collaborative activity. And, in order to participate in that team activity, it was necessary for him to configure additional tools for communication involving VOIP technology. In addition, his collaborative writing activities relied heavily on the use of GoogleDocs, instant messaging, as well as collaborative calendaring tools. Interestingly, these are very similar to the sorts of tools used in many modern businesses to facilitate collaboration and communication. Certainly, these are tools similar to modern advanced information systems that operate as a tool to house an organization's knowledge capital and organize collaborative workflow processes. Interestingly too, these are the sorts of technology-mediated processes frequently involved in modern workflow processes. However, this sort of backgrounding technology as the mode for operationalizing communication, collaboration, or the flow of production is what is often missing in the classroom—at both the K-12 and higher education levels (Fischer, 2007).

Concluding Thoughts

Given the dismal condition of education in the United States, there is a strong push to bridge the twenty-first century skills developed in digital media spaces toward improving academic skills and standardized test performance. This misses the point of twenty-first century skills entirely; they were designed to promote success in career and life, not the classroom (Wagner, 2008). Therefore it seems appropriate to urge instead a consideration of how these practices and skills may (1) provide participants with a foundation of skills and dispositions that could serve as preparation for future workplace learning (Bransford & Schwartz, 1999) and perhaps, (2) provide models of efficacious CSCL at Work practices as a route toward conceptualizing both inter- and intra-business collaborations. The argument presented in this chapter evidences the potential affordances of using MMO gaming as a route toward experiencing CSCW practices that bear similarities to the formal workplace.

Business, as a professional practice, requires people to develop situated competencies which involve a combination of "know what" and "know-how" applied within the context of individual effort and more frequently in conjunction with collaborative processes (Thomas & Brown, 2009). As discussed in the previous section, the literature indicates digital media, gaming, and virtual world participation as potentially providing participants access to vitally important twenty-first century workflow practices, and skills related to CSCL at Work. The example of an afternoon of gaming depicts MMO gaming as an informal learning space providing exposure to collaborative workflow processes whereas socio-technical resources are accessed and leveraged within the process of doing the work of the game. Learning is not a stand-alone process separated from situated activities. Instead, a variety of opportunities for learning are actualized while developing related goal-based competencies. Inherent in this space is what Goggins and Jahnke (Chap. 1) describe as a "high social design" that calls into practice "knowledge co-construction … [and] opportunities for knowledge exchange" (p. 18) within a highly informal learning environment. As Goggins and Jahnke (Chap. 1) state, although there is a concerted effort to change workplace learning, currently "engaging in participation and collaborative learning through technology in the workplace is novel" (p. 3). The CSCL at Work affordances attributed to the MMO environment suggests the potential for drawing upon the informal learning experiences of youth engaged in digital media practices as fodder for considering models of CSCL situated within workflow processes.

Additionally, models of collaborative and collective learning processes in these online CoPs and affinity spaces may inform new conceptions of virtual collaboration within the workplace and across business entities. As these models of collaboration provide for varying levels of connectivity, engagement involvement around a whole host of interest-driven niches, they are likely to illuminate design considerations for the development of environments to support similar practices in the workplace and larger business community. Although this has been discussed in the literature (e.g., Hagel et al., 2010), empirical evidence is emerging and in need of additional study. Considering the affinity space framework (Gee, 2004, 2007) as a route toward better understanding broader patterns across online spaces may offer new avenues toward this goal.

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Chapter 11
Online Personal Networks of Knowledge Workers in Computer-Supported Collaborative Learning

David Gurzick and Kevin F. White

Introduction

A hallmark of online communication is the ability to connect individuals regardless of physical location. With the right technologies and configurations, an individual can interact online with a friend halfway across the globe just as easily as with a coworker in the next room. With the right technologies and configurations organizational boundaries blur and a host of opportunities emerge for ad hoc cross-organizational interactions. Communication that connects employees to social contacts outside of their organization increases knowledge flow, but there has also been extensive criticism of this practice. Organizational theorists (e.g., Lee, Lee, & Kim, 2004; Lim, 2002; Robert Half Technology, 2009; US Department of Treasury, 2003) frequently cite the negative consequences from uncontrolled and unfettered communication, and often recommend that organizations establish barriers between work and personal communication. Nonetheless, for many, information and communication technologies enable a pervasive social experience that extends beyond traditional boundaries between an organization, the individual, and the individual's *online personal network*.

We define an online personal network as the technically supported connections representing the combination of weak and strong tie relationships acquired and maintained by an individual in a capacity beyond his or her employment role. In contrast to a social network, an open personal network is mainly regarded from an individual's perspective. Though intensely social, the term online personal network

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was chosen over the term online personal network so as not to connote a reliance on social networking technologies as a means for accessing one's personal connections. These are the Facebook and Linkedin friends and colleagues, the Twitter followers, the e-mail and listserv addresses that are used to exchange formal and informal information, and other connections that would likely persist if the individual changed employer. While these connections may include members of an individual's current working organization, the prevailing basis of these members' inclusion is socially motivated rather than organizationally mandated.

Online personal networks are used in a variety of ways, allowing people to interact to exchange ideas and knowledge (Turoff, Rao, & Hiltz, 1991), offer encouragement and emotional help (Maloney-Krichmar & Preece, 2005), and maintain collegiate and personal relationships (Ellison, Lampe, & Steinfield, 2009). In an organizational setting, these interactions offer the potential to provide both the information that facilitates the production of better knowledge work and a socially supportive context in which knowledge workers are motivated towards high levels of performance and contribution. Under such thinking, the productivity of an employee is impacted by the extent of the relationships he or she has, many of which exist outside of their workplace, yet are accessible through his or her online personal network.

Despite the value that employees might derive from their online personal networks, many organizations have taken steps to limit employee access to these resources. To examine the prevalence of such limitations, one can turn to any number of contemporary surveys. For example, in a survey conducted by Robert Half Technology, it was reported that 54 % of businesses prohibit the use of social media by employees. The survey polled 1,400 chief information officers from the US companies with over 100 employees (Robert Half Technology, 2009). In similar fashion, a survey by employment law firm Jackson Lewis LLP found that 38 % of organizations actively prevent employee access to social networking sites via Web site blocking software and other technical means (Winkler, 2009). Unfortunately, these are not isolated instances; the trend to block access to online personal networks, like Facebook and Twitter, is on the rise according to security firm ScanSafe (a Cisco-owned company). Their mining of more than a billion Web requests in 2009 revealed that 20 % more of their customers chose to block social networking Web sites over the first half of that year, equating to 76 % of the total number of their customers (Goodchild, 2009). When examining the specific types of Web material that is filtered, ScanSafe indicated that "[social networking] is now a more popular category to block than online shopping (52 %), weapons (75 %), alcohol (64 %), sports (51 %), and Webmail (58 %)." With such staggering statistics, it is relevant to explore the rationale and impact that different degrees of access to online personal networks has on today's knowledge worker.

The rationale that organizations use to block specific Web site categories generally stems from a combination of the employer's desire to maximize productivity as well as to avoid risk. The former stems from a perception that time spent "surfing the Web" for non-job-related information is at best wasted, unproductive time, and at worst theft; after all, the employer is paying each employee to do work, not to conduct personal tasks and certainly not to consume the valuable bandwidth that their productive workers require. In fact, the loss of productive time at the hand of "cyberloafing" or "cyberslacking" was estimated to cost the US employers a combined US$178 billion dollars in 2006 alone (Websense, 2006). Though this may be true, there is an opposite viewpoint to be considered. According to a survey conducted by the University of Maryland (National Technology Readiness Survey (NTRS), 2002), there is also a corresponding *increase* of work that is completed for the benefit of employers while they are at *home*, reducing the overall negative impact on the workplace. Likewise, some degree of cyberslacking may actually benefit productivity by enabling employees to relieve stress and complete personal tasks such as banking chores that were weighing on their mind, and by reducing fatigue that is caused by working on a single task for an extended period of time (Reinecke, 2009). Though research into how to maximize employee productivity with respect to Internet access continues, this is not the only concern that causes employers to tightly control Web access. A second concern of employers revolves around the perceived risk that the open exchange of information online will permit disclosure of trade secrets or other proprietary information.

In light of these concerns, we ask if the perception of social media as a risk overlooks and stifles its potential benefits to a firm's competitive position. Specifically, as we show, social media creates opportunities for an employee's personal network to benefit the firm with knowledge exchange, informal learning, and social support for learning.

This chapter examines the role of social media as a vehicle for CSCL at Work that reaches outside traditional organizational boundaries. First, we review learning theories and the current organizational realities that characterize the modern operating environment for firms (e.g., the prevalence of knowledge workers, flattened organizational structures) as a means to frame our examination of the use of online personal networks. This chapter then shifts to examine current trends in practice today by presenting a review of the workplace social media/networking policies and procedures from over 50 US organizations. These policies are classified into three broad organizational profiles to illustrate how online personal networks and social media use are practiced in the US organizations. In the conclusion, we propose future directions for organizational support for CSCL at Work that leverages online personal networks.

Learning in Personal Networks

Formal organizational learning and information dissemination can been traced back to the early nineteenth century, when simple routines and individual memories were captured and stored using paper records (Yates, 1990). In the beginning of this era, working knowledge, existing practices, and information were transferred to new generations of employees through *apprenticeships*, transferring domain knowledge directly from expert to novice and forming organization-based expert networks.

The benefit of this approach lay in the ability to transfer tacit knowledge as required for job performance during job performance. Implicit knowledge, which is often overlooked or not recognized as important for task performance when experts are mentoring novices, is more reliably acquired through interaction with a mentor whose skill level is nominally greater than the mentee. In some ways, this diminishes the need for an expert to recognize and document their know-how. In these times gone by, when an expert prepared to leave the organization, their protégé acquired the vast majority of expertise owned by their mentor, providing continuity to the organization and a rich understanding of historical decisions and processes that could be used to guide future work.

Organizational learning—the process of working, learning, and innovating—has been the subject of extensive research. For example, in 1991 Brown and Duguid examined the ways in which Xerox workers shared information across the company by telling stories during lunch breaks and coffee breaks. In 1996, Orr described the richness of stories told between copy repair technicians and the ways in which such stories increased the likelihood of remembering lessons learned by others (Orr, 1996). The form of work-based learning described in these examples is generally referred to as communities of practice, a term that drew attention to the social and communal context of knowledge transfer. The process of organizational learning was further operationalized by Nonaka and Takeuchi in their book, The Knowledge Creating Company, which described a Socialization, Externalization, Combination, and Internalization (SECI) model of knowledge creation and transfer within organizations. In the "Socialization Phase" tacit knowledge is shared between individuals through observation, imitation, and practice (Nonaka & Takeuchi, 1995) (i.e., the apprenticeship model of organizational learning). In this phase, understanding observed processes is achieved through shared mental models that are understood without the aid of oral explanations. Mental models are derived, at least in part, by a shared understanding of the traditions embedded within the organization and diverse environmental factors which form the framework for meaningful knowledge transfer. In the "Externalization Phase" tacit knowledge is translated into oral form. In this stage shared mental models provide necessary implicit background information to negotiate common ground without long, laborious, and detailed explanations. The "Combination Phase" is highlighted by the combination of multiple chunks of learned information to derive new knowledge. In order to successfully apply knowledge to new situations the knowledge worker must understand those financial, political, and cultural factors which serve to limit potential solutions to a subset that are acceptable to the organization as a whole. Finally, in the "Internalization Phase" new knowledge is transferred from explicit to implicit and the more tacit knowledge is often remembered in the specific context in which it was originally created. Yet, these processes primarily concentrate on knowledge generation and transfer *within* organizations. It does little to extend opportunities to glean new information from personal networks that exist beyond the bricks and mortar of the entity—a critical necessity for competing in the modern knowledge economy. Without new knowledge flows, organizations quickly become stale and lose their competitive advantage.

In order to acquire new information and expertise beyond what is already available within organizations, it is critical for employees to build personal networks. "Technological Gatekeepers" fill this role through their formal and informal relationships with outside contacts (Allen, 1977). Gatekeepers, while typically not a formal position within organizations, are highly valued employees due to their ability to build and manage collaborative relationships with outside entities. As first-line supervisors, gatekeepers are highly knowledgeable in their own discipline. In order to establish and maintain relationships with external experts they participate in meetings and seminars and make numerous phone calls. They share their expertise and internal contacts with outside partners in exchange for new information and ideas that they then disseminate throughout their organization (Allen).

Today, the notion of "Technological Gatekeepers" is quickly becoming outdated. Every member of an organization is able to build and leverage personal networks through systems including Linkedin, Twitter, Facebook, and similar applications. Such capabilities provide every employee an opportunity to acquire needed information, to develop new ideas, to improve their own effectiveness within their company, and to improve the operational effectiveness and competitive advantage for the organization as a whole: all without requiring a middleman to negotiate, interpret, filter, and pass along information.

Learning in the New Workplace

The necessity of crossing organizational boundaries to acquire needed information reflects how learning in the modern working environment has evolved. Whereas the "old workplace" was characterized by routine, specialized tasks conducted in an environment where knowledge sharing was institutionalized and limited by strong organizational boundaries, the "new workplace" is characterized by empowered employees who are given range to develop new efficiencies through identifying, acquiring, and sharing information and ideas with their colleagues (Daft & Marcic, 2008). In contrast to the rigid decision-making hierarchies common to the old workplace, the new workplace exhibits a flatter, peer-based structure with work organized and accomplished by networks and teams.

Particularly for younger generations (though by no means is this a phenomena exclusive to them), work-related questions are routinely asked and answered among online networks of close friends. This perhaps seems inefficient, given the nearly infinite amount of information that can be readily found through Internet sources. However, information search processes is starting to trend towards the use of personal networks as a complementary approach to traditional techniques such as broad Internet searches. For example, in a study by Morris, Teevan, and Panovich (2010), the researchers found that information gleaned from personal networks is often highly tailored to meet individual needs and expectations (a result of shared context according to Wohn et al., 2011) and is highly trusted, whereas broader Internet searches yield more objective, though generic, data. Additional benefits of using personal networks include the creation of feedback loops where additional questions can be posed and understanding tested and there is greater probability of receiving an answer faster than by posting questions within online forums (Morris et al., 2010). The primary detractor of asking questions to personal networks lies in the inability to remain anonymous, and therefore subjecting oneself to losing face in front of colleagues and friends.

Personal networks, though, represent more than merely a socially enabled means of acquiring answers to challenging questions. There is a social support component embedded within these networks that is a key to effective learning.

Social Systems Support as a Resource for Learning

People learn from each other, and the processes they use for doing so are well understood. Despite this, much organizational learning continues to be viewed as knowledge transference between individual, interchangeable human resources. This draws attention to the perspective that learning actually occurs within both formal and informal channels and from both direct interaction and peripheral observation. Social learning theory (Bandura, 1986) suggests that individuals acquire new skills in an ordered process of first observing the skills being used by another person, like in apprenticeship, and then imitating or reproducing that performance, ultimately in an exact manner. Once this level of apprenticeship is accomplished, the new skill performer will have developed a conceptual understanding of the skill and be able to adapt it in a range of contexts.

Understanding how people acquire new skills and are then able to adapt those skills in new contexts provides a helpful frame for thinking about CSCL at Work and social media. It is through social learning that knowledge workers gain competency in the more cultural aspects—the norms, mannerisms, and conventions—of the acquisition and use of information. Exposure to the actions of the more advanced professionals in one's online personal network provides a window through which observation can take place. The knowledge worker can see how these professionals respond to particular situations, the rhetoric they use, and the way they respond to feedback. Likewise, through interaction in these networks, workers can practice the skills they have observed, all the while developing a community of practice.

People are social, and developing skills fills innate needs that they have. In this way, social media could be viewed as a vehicle for encouraging what folks do naturally: interact with each other to meet a range of human needs. This holistic benefit has the potential to improve work satisfaction and performance. In the early 1940s, Maslow (1943) introduced his hierarchy of needs, contending that higher level functions of knowledge work and learning would be constrained if underlying needs were not met. Maslow ranked these needs, beginning first with physiological needs (food, clothes, shelter, warmth), then safety needs (feeling secure with one's family, employment, and health), and needs related to love and belonging (having friendship and intimacy). Assuming that one's physiological, safety, and love/belonging needs are met, Maslow then indicated that one must satisfy his or her esteem-related needs before reaching the level of self-actualization—the highest level of the hierarchy, where the best problem solving occurs. Esteem needs are met when one feels a sense of accomplishment, confidence, and has respect by others. The necessity of fulfilling social needs, like those of esteem and love/belonging, for the benefit of productive knowledge work intersects findings of other researchers studying group behavior. McGrath (1984), for example, notes how interpersonal social relations are essential to the creation of supportive environments and constructive group work. Such findings have been seen in communities of international learners (Haythornthwaite, 2003) and software developers (Sawyer, Farber, & Spillers, 1997).

CSCL at Work emerges as a frame for fostering deliberate learning interventions in the workplace, using natural inclinations that people have, instead of viewing the new forms of interaction in social media as a threat or danger. Social media is, in our view, a promising new socio-technical approach to skill development. By helping people fulfill their natural needs for social interaction and self-actualization in knowledge work, organizations have the potential to benefit through a more adaptive workforce and lower rates of employee attrition.

Right now, the average length of time spent in a given job by an individual is decreasing (United States Department of Labor, 2006, 2008) and the percent of employees classified as temporary and contingent workers is on the rise (Daft & Marcic, 2008); real concerns arise around ensuring that the social needs of workers are met. The advantage of online personal networks in this environment comes from the way that they can augment workplace ties by broadening the availability of connections from which social support can be drawn. Indeed, it may well be to the organization's advantage to shift from a paradigm of prohibiting access to online personal networks (or perhaps adopting a neutral approach in which they simply ignore them) towards a position in which they accept and embrace such applications as a means of increasing efficiency and creativity. In today's workplace, human capital is a high-value commodity that cannot be wasted. Efficiency and creativity come part and parcel with increased information visibility, an embedded capability within most online personal network applications. The act of making information visible occurs as members of an online personal network post regular updates, a process which typically takes less than a minute and that naturally occurs as part of active membership within the social media application. By posting current interests and activities, employees promote social awareness, potentially avoiding duplication of effort simply by being aware that an activity has (or is) being undertaken by a peer. Further, information awareness can lead towards collaborative opportunities, reducing inefficiencies that result from developing ideas, concepts, and materials in parallel but separate spaces. Finally, even in cases where collaboration and/or access to developed resources does not ensue, information visibility has significant potential of fostering a creative atmosphere by reprocessing activities and ideas that are posted by others into new branches of thought.

With an understanding of the potential advantages that may be derived from employee access to their online personal networks, including increased information accessibility and the social supports that they facilitate, we now turn our attention to considering how organizations are approaching these new resources.

Understanding Organizational Policies for Online Personal Networks

Over the summer of 2010, a set of 19 graduate students were tasked with collecting and reporting on organizational policies for employee use of social media and personal technology. These students constituted a mix of those pursuing a Masters of Business Administration degree and those pursuing a Masters of Information Technology degree. The overwhelming majority were working professionals.

The analysis method included the following processes:

1. Each student was tasked with collecting and reporting on the policies of at least two organizations. Together, the group collected policies from 50 large organizations (>500 employees), spread across a wide range of industry types, including healthcare/pharma, apparel, business services, computer hardware/software, food/beverage, media/publishing/entertainment, automotive, aerospace/defense, nonprofit, and the US government agencies. Many students had close ties to the organizations they evaluated. Often these organizations represented their employer, or that of spouses, significant others, family, or friends. While a convenience sample of sorts, the gamut of industries covered reflects a large cross section of organizational policies and potential insight into common norms.
2. Each student was given a common rubric that guided the examination of their chosen organization, thus ensuring a level of consistency between reviews.
3. The full set of organizational reviews was independently examined by multiple reviewers using a bottom-up open coding process. This initial coding process enabled the natural emergence of the principal technical factors (system controls) and social factors (rules and policies) related to the governance of social media and personal online technologies.
4. After the initial coding process, a joint list of codes was compiled, collated for distinction, abstracted as necessary, and then grouped to create a master list using the constant comparison method (Glaser, 1978).
5. Once the master list was established, codes were categorized into groupings of similar organization practices by way of axial coding as recommended by Strauss and Corbin (1990) in order to discover relationships between the codes in a manner that was grounded in the data.

From this analysis, three general groupings emerged representing, at a high level, the predominant stances taken by organizations in the sample. These stances of (1) *online personal network lockdown*, (2) *online personal network disregard or denial*, and (3) *guided use of online personal networks* are described in the following sections.

Profile 1: Online Personal Network Lockdown

The first of the organizational stances is the most restrictive and limiting of employee use of online personal networks. Firms in this group were seen to restrict access to online personal networks through a combination of system controls (chiefly Web-filtering software and monitoring and reporting systems) and administrative policy. Fannie Mae, a financial product and services company operating in the housing industry, was among the organizations in our sample that exemplifies this large degree of control.

The security policies at Fannie Mae prohibit the use of Fannie Mae IT property (e.g., desktop computers, laptops, Fannie Mae-provided PDAs) for any application other than those that pertain directly to Fannie Mae business or the individual's professional contributions to Fannie Mae. These policy restrictions are technically enacted through security software and a managed firewall.

The technical restrictions at Fannie Mae prevent access to the typical channels one might use to access their online personal network, as social networking, instant messaging, and personal e-mail sites. Should an employee attempt to access one of these sites, a pop-up warning appears notifying how the site cannot be displayed due to firewall restrictions and informing the user that an infringement of Fannie Mae's technology usage policy has occurred. These infractions are maintained in a log and, along with records of Internet usage patterns, are provided to management on a routine basis. Corporate e-mail accounts undergo scrutiny as well, with screening performed on e-mails received from non-whitelisted addresses. This process can noticeably delay the receipt of e-mails. When e-mail is received from a non-whitelisted account, a security message is sent to advise caution and discretion in e-mail usage.

Regulatory guidelines, which limit the disclosure of protected information outside of the organization, offer some rationale for Fannie Mae's strict guidelines on online personal network use. However such tight lockdown of policy was not restricted to Fannie Mae alone; similar policies were also reported in other agencies. Five Star Quality Care, a national manager of senior residential communities, was reported to use Web-filtering software with similar limits to Fannie Mae. Five Star's computer usage policy states that employees are only to use the Internet and e-mail to conduct business. As a further means to enforce these policies, the company randomly audits their employee's e-mail accounts and Web usage.

Profile 2: Online Personal Network Disregard or Denial

The second of the organizational stances represents those firms that either ignore or are indifferent to the use of online personal networks by employees. While the organizations classified under this approach may enact similar technical controls (mostly Web-filtering) or broad policies as the previous group, the primary differences are an incongruence between policy and controls and a vagueness around acceptable use of online personal networks. Two examples of organizations categorized under this profile are the American Red Cross, a national emergency response organization, and EMA, the parent company to a collection of residential care communities.

Social media and online interaction are important topics to the American Red Cross (2010). As a donation based nonprofit, they use a variety of channels to present their message to the public, including the use of online communication to support outreach and public relations efforts. Correspondingly, employees are provided access to a host of materials recommending different strategies to most effectively engage the public through social media and few technical restrictions or blocks are placed on the networks or computers of employees.

Despite their attention to social media, The Red Cross has no policies or guidelines on the use of online channels of interaction *outside* of a public relations context. This point is made evident in the omission of any mention of online interaction in the Red Cross's *Compliance and Ethics Handbook*, despite sections on Internet and computer usage. As such, access to one's online personal network resides in a gray area as something that is not formally supported (or discussed) by an organization that has otherwise adopted a progressive social media stance.

Much like the Red Cross, who allows employee access to online communication channels (but is vague in their use outside of a public relations standpoint), the company EMA shows indifference to online personal networks while technically allowing access to these resources. A counterpart to Five Star Quality Care, EMA operates in the continuing care space, managing a number of residential senior living communities. Unlike Five Star, which controls Internet content and audits access logs, EMA relies less on technical controls and more on policy to direct employee use of online resources. This policy is made known to employees at hire and is reiterated in a pop-up screen shown each time a user logs on to a company computer. Employees are told that "Access to the Internet may be provided as a tool with which to improve their ability to complete tasks and otherwise carry out the necessary work of EMA." While Web filters prevent access to potentially dangerous material (e.g., weapons, adult content), access to most social network sites and Webmail is allowed. This follows the company's belief that misappropriate use of allowed resources would be covered by the policies on resource use or through the diminished productivity of the employee and thus would be handled through general management practice.

Profile 3: Guided Use of Online Personal Networks

The final classification describes those organizations that actively support online personal networks, offering guidance to employees on best practices in the use of these resources. Through policies, tools, and executive championship, firms under this classification foster the exchange of knowledge and social support that are characteristic of these networks. Two organizations, IBM and Zappos, offer examples from our sample of firms with unique approaches to the ways they guide employees in their use of online personal networks.

IBM is a business services company with a technology-steeped tradition. At IBM, a significant focus is placed on supporting employees with uncovering, making sense of, and deriving value, opportunity, and innovation from information resources. As a large organization with over 300,000 employees, it recognizes the challenge that comes with large-scale knowledge management. IBM meets this challenge by nurturing a culture of collective knowledge sharing and collaboration with social computing promoted as a central means for its many employees to interact around new ideas, transfer information, discuss the company's direction, and improve professionally (Palmisano, 2010). IBM currently has over 17,000 internal blogs, with 100,000 employees using them to communicate internally. Several thousand IBM employees are on twitter and post content to their own external blogs, and 50,000 participate in alum networks on Facebook and LinkedIn (IBM, 2010). Interactions in these forums are guided by the policies laid out in the Social Computing Guidelines (IBM), a comprehensive set of best practices originally developed in 2005 that cover exchanges both internally and in non-IBM-managed systems.

Beyond supporting employee interactions through the use of preexisting social computing outlets, IBM was proactive in helping employees to extend their online personal networks within the company. In late 2007, IBM formed *Beehive*, a company-specific internal system of personal networking. Beehive allows IBM employees to share individual information within the company without the restrictions that would generally be applied to information shared on public sites. Studies on the use of the Beehive social network (later rebranded as *Social Blue*) have shown its ability to "attract large numbers of employees from around the world, … aid in socialization of new employees, and … enhance employees' access to new people and sources of expertise around the company" (Steinfeld & Huysman, 2011).

Tech-savvy Zappos, an online apparel retailer, also encourage their employees to participate in blogging, Facebooking, tweeting, and the use of other social computing channels to cultivate resources and engage the public. Led by the model of CEO Tony Hsieh, an avid "tweeter" and social media advocate, employees are given range to leverage and extend their online connections for personal enrichment and to further the Zappos brand. Premised on the belief that an employee-focused culture revolves around a happy environment where employees take ownership for the brand, Hsieh promotes communicating through social networking, especially Twitter, for the dynamic role it can play in fostering happiness, noting that "the benefits aren't just personal—they also spill over into what we want the Zappos brand and business to be about: Zappos is about delivering happiness, whether for customers (through customer service) or for employees (through company culture)" (Hsieh, 2009).

Zappos' incorporation of social networking and online communication into the general work life of the organization comes with minimal policy or restriction. Aside from minor guidance on proper use of the company name and logos, employees are simply reminded to be considerate and mindful of how they represent the company. Hsieh explains that "We don't have a specific social media policy. In fact, we try to avoid policies about anything as much as possible, because usually policies are used to address the 1 % of people causing a problem at the expense and inconvenience of the 99 % of people that are not. Our philosophy is to hire the right

Table 11.1 Summary of organizational approaches to online personal networks

Online personal network lockdown	Online personal network disregard or denial	Guided use of online personal networks
Technical and/or policy measures constrain the use of online personal networks	Limited or conflicting policies for the use of online personal networks	Proactive approach to educating employees on effective use of online personal networks
Often the result of adherence to regulatory guidelines	Narrow view of OPN and often consider it under the purview of more general work/technology policies	Organizational attention to supporting or developing online personal network infrastructure
		High-level executive sponsorship and incorporation into workplace culture

employees (employees whose personal values match our corporate core values), make sure everyone understands the long-term vision, provide ongoing training and development opportunities, and then trust our employees to do the right thing" (Hsieh, 2009).

The major characteristics for each of the organizational approaches to online personal networks are provided in Table 11.1.

Future Considerations for Online Personal Networks

While organizations such as Zappos and IBM have successfully transitioned towards an open embrace of personal online networks, it cannot be said that organizations that fail to do so are doomed to immediate failure.

Organizations such as Fannie Mae, which represent a lockdown approach, have logical reasons to eschew open access. Such entities have understandable concerns that stem from strict legal requirements. Yet with ready access to personal devices that provide access to the very applications that are blocked internally, such policies may ultimately fail in the long term. The ubiquity of smart phones and unfettered at-home access to social systems is such that it is no longer possible to fully block access to these unique media outlets.

Within this new learning and knowledge exchange environment, management must therefore be careful to educate employees on the information that they should and should not disclose over the Internet in order to appropriately protect and further their interests. Instead of overly restrictive controls, the methods used to set expectations for using online personal networks should be developed in such a way that employees will accept self-responsibility for their actions. As we saw in the "Guided Use of Online Personal Networks" profile, including the examples of Zappos and IBM, one of many potential means to achieve this balance is to encourage senior management to participate in the same forums and media outlets as

Table 11.2 Future considerations for online personal networks

Unless well justified, "lockdown" approaches limit the potential benefit available from employee use of online personal networks
Mobile-technology and home computing systems provide employees the means to sidestep many organizational controls to use of these systems
Rather than focusing on technical and policy controls, organizations should consider how to orient their culture towards beneficial use of online personal networks
As the use of online personal networks evolves, organizations will have to continue to evaluate their practices, policies, and stance towards these systems

employees. Doing so they serve as a model for practices of acceptable use to their staff. The modeling of appropriate behaviors has the potential to be among the most powerful means to promote successful and appropriate use of online personal networks.

As information technology changes, expectations of consumers and "pro-sumers" evolve. The proliferation of online communication has enabled new opportunities to acquire knowledge and be supported in the learning process. It is only natural then for knowledge workers to utilize the same tools that facilitate learning in their non-work lives as a means to improve their effectiveness at work. Organizations operating under a lockdown profile, then, will undoubtedly need to make a choice. They can continue to put up roadblocks that have a high likelihood of either being circumvented by their employees or reducing their efficiency, or they can adopt controls that are rational and provide necessary protections while supporting users in the best practices for the use of online personal networks. Both for those that fall under strict legal requirements governing information dissemination and those without such concerns—it is clearly possible to devise policies where appropriate use of online personal networks is leveraged. For such organizations, examples like IBM and Zappos can serve as guides for ways of directing resources and developing policies to more readily embrace online personal networks.

Though the state of knowledge work is clearly moving towards increased use of experts that are readily available through online personal networks, companies continue to struggle to find the right balance between complete lockdown and open access. In the process of finding the right balance, organizations must consider their own unique circumstances, including the culture of their organization, the context of their work, and their own projection of the future value from employee access to their online personal networks. This is not an easy or straightforward proposition; many concerns must be considered. While doing so, organizations must keep an open mind and address emerging concerns with solid research and an eye towards the future. See Table 11.2 for a summary of future considerations of online personal networks.

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Part IV
CSCL@Work in Product Design and Mechanical Engineering

CSCL at Work is a necessary change in our model of knowledge management because a good deal of work involves solving problems when the answer is not known. Designers have known this problem intimately since the first Homo sapiens built the first hut… and rebuilt it because it collapsed in the rain. And then somebody suggested that we plan what we will need for the structure prior to assembly. She was right. Computer support for design practice is a specific type of CSCL at Work, and in many ways the foundational example of learning when the answer is not known.

Lund, Prudhomme, and Cassier (Chap. 12) describe how making the process of design visible for novices will enable more rapid design processes and shorter periods of apprenticeship. The goal here is not merely to solve problems where the answer is not known but also to develop these capacities in new people and facilitate expert communication about expertise.

Terkowsky et al. (Chap. 13) describe PeTEX—a Platform for e-Learning and Telemetric Experimentation. This CSCL system aims to foster educational and training programs in the field of manufacturing engineering. The authors present the challenge of how to transform actual laboratory test beds, domain-specific content, and social interaction modes into a web-mediated socio-technical system to bring learning and the workplace together as CSCL at Work. This chapter also addresses the critical dimension of distributed creative work.

Mørch (Chap. 14) problematizes the concepts of e-Learning at work and CSCL. CSCL is about computer support for two or more people to engage in a collaborative inquiry process (colocated or distant), where learning is the primary activity. E-learning at work, in contrast, is about providing employees with timely access to information for conducting everyday work while respecting business goals. Traditionally, learning in these cases is a secondary activity (work is primary activity). His chapter reports two case studies—customer service work and software product development. Results are (a) a description of challenges associated with the multiple means for information access and engagement in collaborative knowledge construction within and outside the organization (e.g., with customers) and (b) identification of opportunities for collaborative learning that arise in conjunction with adoption of social media in the organizations.

Chapter 12
Pivotal Moments for Decision Making in Collaborative Design: Are They Teachable?

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Introduction

Nowadays, manufactured products are becoming increasingly more complex (Suh, 2005), integrating many different technologies. In order to make the best decisions as soon as possible about the product, many experts concerned with the whole product life cycle have to collaborate closely from the beginning of the design process. Concurrent engineering (Womack, Jones, & Roos, 1990) is a widespread form of organization implemented to enable groups of experts from different domains, gathered in project teams, to collaborate and to cooperate for the achievement of the design task.

During concurrent engineering, designers with different expertise gather in meetings called project reviews (cf. section "Project Reviews" for more details) in order to evaluate the product they are designing. During these project reviews, they argue about the product being designed, propose solution elements and criteria that must be respected, negotiate both solutions and criteria, and agree (or not) on important decisions. In doing so, they learn informally by sharing in a collaborative way part of their expertise, through collaborations around solutions and criteria used to evaluate solutions. But they also informally learn about the process they implement

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for making these design decisions. We demonstrate that pivotal moments exist during this process where designers abandon one solution in favor of another and that these pivotal moments are fundamental elements of the design process.

This chapter's objective is to identify and to characterize such pivotal moments and to reflect upon a way to teach them with the goal of making the decision process more efficient. The chapter is organized as follows. We first present our theoretical framework after which we define our research questions. Second, we present our empirical study within the context of project reviews in the AB Volvo company. Third, our results pinpoint two types of pivotal moments that we characterize as pivotal moments for choice and pivotal moments for emergence. Finally, we conclude and give perspectives for further work, notably about possible training concerning such pivotal moments.

Theoretical Framework

In this section we first describe what we mean by designers' potential collaborative learning during the type of project reviews we studied. Second, we present our theoretical view on how to consider argumentation during the project review part of collaborative design and third, we discuss the literature on decision making in collaborative design. When we present our analytical approach further on in this chapter, we also describe how theoretical constructs such as activity theory, situated action, and distributed cognition influenced our thinking.

Collaborative Learning During Design Activities

Group design activities give specific opportunities for collaborative learning. Designers with different competencies and experiences (e.g., mechanical engineers vs. electrical engineers vs. assembly line personnel) must work together to create common ground that helps them find a solution (Boujut & Blanco, 2003) so that all designers are satisfied that the solution respects their evaluation criteria sufficiently. In this case, there is opportunity to (1) learn about other designers' professional knowledge, notably the criteria they use to evaluate solutions, but there is also opportunity to (2) render explicit one's own criteria and (3) understand the relation between one's own criteria and the criteria of others.

However, learning about these criteria in isolation (e.g., a list of which criteria are important for which profession and their possible relation from within and between professions) is perhaps not immediately applicable to situations where solutions are discussed and debated because one would not learn the dynamics of how specific actors propose these criteria and solutions, when they choose to do it, and how such dynamics could move the decision process forward. Indeed, the ways criteria are mobilized to argue for and against solutions are heavily dependent on the context. Such learning is best done in situ if the goal is to give designers new understandings of their own solution-evaluating and decision-making practices. Learning can become collaborative if designers take charge of their understanding of their own practices, of the practices of other designers, and of the relation between the two and if they participate together in decision making as reflective practitioners (Schön, 1983).

In this chapter, we analyze how designers propose criteria for evaluating solutions and we discuss to what extent it is possible to characterize them in order to render them teachable. Having said that, we know that designers attribute different degrees of importance to evaluation criteria. They argue and explain their viewpoints such that they are either able (1) to decide on which solution they agree on either tacitly or explicitly (Brissaud, Garro, & Poveda, 2003) or (2) to agree not to agree on a particular solution aspect. These difficulties make it challenging to separate the proposal of evaluation criteria from practice itself, so our aim is to decompose the dynamics into more manageable parts in order to make learning easier.

Argumentation During Collaborative Design

Argumentation has been studied from many different disciplinary perspectives: language sciences (e.g., van Eemeren & Grootendorst, 1992), philosophy (e.g., Hempel & Oppenheim, 1948), mathematics (e.g., Balacheff, 1987), and educational psychology (e.g., Baker, 2009) to name a few. Argumentation has been studied in multiple contexts as well, for example literary criticism, logical reasoning, proofs, pedagogical tasks, and collaborative design. We focus on the kinds of argumentation taking place during collaborative design and more specifically, during project reviews (cf. section "Project Reviews"). Our disciplinary perspective combines language sciences, psychology, and mechanical engineering with a focus on collaborative design in the workplace, as it occurs as a natural part of designers' professional life.

Our view of argumentation within collaborative design is inspired in part by that of Baker (2004). He defines five dimensions of analysis with the goal of understanding the processes leading to co-elaboration of knowledge during argumentative interactions:

– The dialectic dimension considers the game of argumentative interventions (attacks, defenses) relative to theses under discussion.
– The rhetorical dimension deals with the changes in attitudes about the propositions being discussed.
– The epistemological dimension takes up the nature of knowledge under consideration in the dialogue; depending on its origin, perceptually, cognitively, and socially, knowledge is more or less anchored, acceptable, and legitimate.
– The conceptual dimension addresses the ways in which the universe of reference is (re)conceptualized as the dialogue progresses.
– The interactive dimension focuses on how knowledge is transformed and reformulated through language.

We argue that project reviews—where designers argue and explain their points of view in order to come to decisions on a certain number of points—can be qualified as argumentative interactions incorporating processes leading to co-elaboration of knowledge. These five dimensions are therefore also pertinent for our context and we track them in the following ways. The dialectic dimension is manifested by criteria that are mobilized during argumentation about proposed solutions to the designers' problem. Either these criteria attack or they defend proposed solutions. We track the rhetorical dimension by noting when and if each designer expresses an opinion on the arguments put forth and which solutions are eliminated or further considered as a result. Concerning the epistemological dimension, we connect expressed criteria to the professional sphere of practice of each designer and analyze how criteria play out together in the dialogue. We use the conceptual dimension to analyze how the designers modify in a concrete technical way the solutions they propose through arguing about them. Finally, in the interactive dimension, we note how arguing with and about criteria help to transform knowledge about solutions. In this chapter, all five dimensions are analyzed and in each dimension we focus on the criteria used to argue in favor of or against solutions proposed by designers during project reviews.

Decision Making During Collaborative Design

Researchers studying design have built up a literature around the notion of design rationale (hereafter DR), also dealing with solutions and criteria that evaluate them. The following four definitions of DR relate it to decision making.

1. DR expresses the elements of reasoning that were at the origin of artifact design (Shum & Hammond, 1993).
2. DR is the reasoning and the argumentation that leads to a final decision about how the intention of conception was carried out. The intention of conception is the predicted effect or the behavior that the designer wanted so that the object could accomplish the required functions (Sim & Duffy, 1994).
3. DR represents the information that explains why an artifact is structured like it is and why it has the behavior it does (Conklin & Burgess-Yakemovic, 1996).
4. Finally, DR does not only include the reasoning that is behind a design decision but also the justification of this decision, the other alternatives that were considered, the differences that were evaluated, and the argumentation that led to a decision (Lee, 1997).

Different systems of notation were developed for recording design reasoning (or design rationale). We don't have the space to present them in detail, but we give a short goal for the three most popular and we note their similarities (summarized in Table 12.1). The goal of Issue-Based Information System (IBIS) is to represent the discussion space (Conklin & Burgess-Yakemovic, 1996). Question–Option–Criteria (QOC) attempts to capture how design moves forward (MacLean, Young, Belloti, &

Table 12.1 Objectives and concepts in design rationale methods

	Goal	Criterion	Argument	Solution	Issue
QOC	To represent the discussion space	Criterion		Option	Question
IBIS	To capture how design moves forward	Criterion	Argument	Position	Issue
DRL	To understand how argumentation develops during design	Goal	Claim	Alternative	Decision problem

Moran, 1996). The goal of Design Rationale Language (DRL) is to understand how argumentation develops during design (Lee & Lai, 1996). Although all three were developed to follow software design and not mechanical design (the context for this chapter), the same types of dialogical objects are present as discussed in the previous section. Criteria are present as *Criteria* in QOC and under the label of *Goal* in DRL. Arguments are present as *Argument* in IBIS and as *Claim* in DRL. Proposed solutions are present as *Position* in IBIS, as *Option* in QOC, and as *Alternatives* in DRL. Issues are present as *Issue* (IBIS), as *Question* (QOC), or as *Decision problem* (DRL). Concerning this last point, we do not rigidly distinguish between design problem and design solution, arguing instead that they are two sides of the same coin and evolve together as designers move towards decisions (Dorst & Cross, 2001). In this chapter, our results will meet all three goals discussed above: represent the discussion space, capture how design moves forward, and show how argumentation develops during design.

Research Questions

In light of our views on collaborative learning, argumentation and decision making during collaborative design and taking into account the corpus we collected (cf. section “Empirical Study”), and the focus of this book, what are our research questions? We postulate that there are moments during collaborative design that we could qualify as pivotal for decision making. Our first goal is to describe the decision-making activity, characterize these moments, and explain in what ways they are pivotal. Our second goal is to reflect upon how such moments could become teachable.

Empirical Study

In this section, we first present the notion of a project review, the situation in which the aspect of collaborative design we studied took place. Second, we describe the context of our empirical study. Third, we present our four-part analytical approach. In the first part, we describe how we collected our corpus. In the second, we illustrate our content and function analysis of the designer interactions. Finally in the third and fourth parts, we explain two techniques we use to model argumentation and decision making during project reviews of collaborative design: static and dynamic visualizations of criteria and solutions. These techniques trigger the emergence of pivotal moments for decision making, giving us means for helping designers become aware of their own dynamic practices.

Project Reviews

During a collaborative design process in a concurrrent enginnering context, two types of phases alternate, not necessarily in a predefined order: synchronous phases where experts work at the same time on a common subject and asynchronous phases where each expert works at the same time on his or her own task, even if this task is a part of the collective finality. Synchronous phases correspond to project-review activities. During project reviews, designers gather to evaluate the product being designed and to make decisions about work still needed. Due to globalization, companies are increasingly technically specialized and geographically distributed around the world. As a consequence, project reviews are increasingly distributed across space and rely on informatics technology. This is the case of the project review described below.

Description of Context

We observed a project-review meeting at AB Volvo in the business area "Renault Trucks." It took place at the two sites, separated by 700 km as shown in Fig. 12.1 (Blainville, near Caen, and St. Priest, near Lyon).

At Volvo, these project reviews were called AMS for *Acceptation Maquettage Série* or Accepting Serial Prototyping. The aim of the AMS we studied was to evaluate design solutions elaborated by specialized designers working in St. Priest. Different aspects of the solution were presented by St. Priest to Blainville in a shared distant computer interface (the computer screen at the left of the bottom photo in Fig. 12.2 shows the solution). These aspects had to be assessed by the assembly experts working in Blainville. They had to verify if the product defined by designers and illustrated with a 3D-model could be built by factory workers on assembly lines. During the AMS, each designer had a specific role (cf. Fig. 12.2).

The project manager had the most complete view of the project and ran the meeting. A person called project management support (PMS) took notes of the decisions made. One designer was specialized in the domain of electricity and he generally presented his solution with the representation of the 3D model (available for all

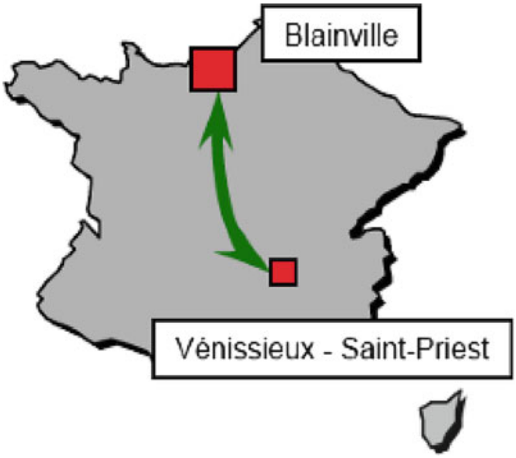


Fig. 12.1 The two sites for the Volvo project review

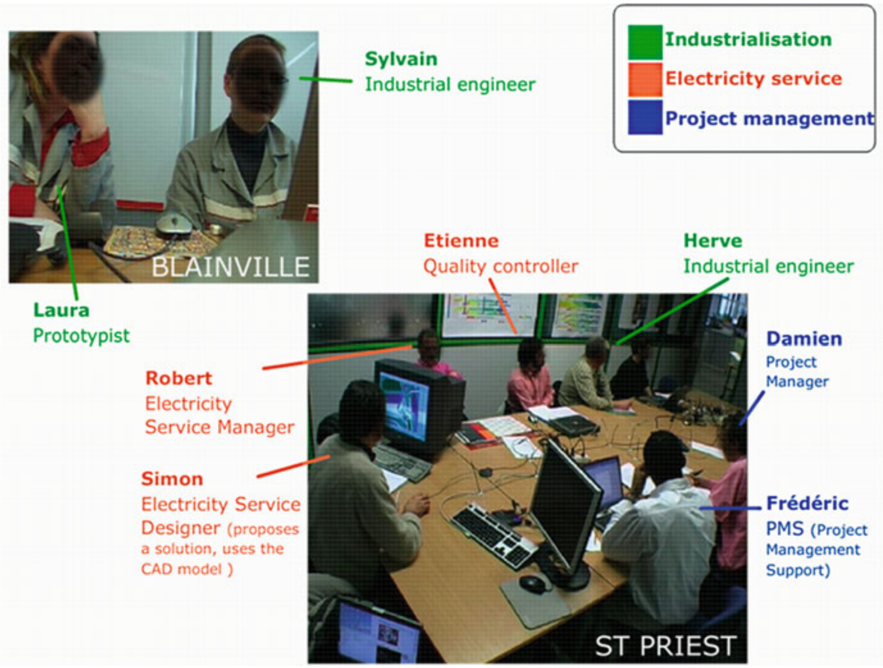


Fig. 12.2 Role of participants on the two sites, Blainville and St. Priest

experts on different screens). His boss, an electricity service manager, accompanied this designer. Designers spoke about the routing of electric cables along the chassis of a truck and they dealt with 20 different discussion points (in our view as analysts) during the 1 h and 20 min of the 2-h meeting we were able to study.

Analytical Approach

In this subsection, we describe how we collected our corpus and how we constructed our analytical objects, both video and transcription. We give an example extract of our transcription that has been coded using the grid we developed called the Design Interaction Framework (DIF). Next we discuss the theoretical constructs that influenced how we performed and critiqued our analyses and we briefly present the DIF. We describe the nature of our initial results based on coding and counting categories and why they were not satisfactory for describing how arguments influence the decision process. We then describe a second analysis method, based on the DIF and regarding the concepts of static and dynamic visualizations of solutions and criteria in project reviews. We discuss how this second method, built on the first, does indeed give insight into the dynamics of project-review interactions.

Collecting the Corpus for Analysis

We filmed the project-review meeting with six cameras on the two sites. We recorded audio with one microphone on each site. We gathered general information about each participant and about the global process. We synchronized four of the best video recordings (cf. Fig. 12.3) in order to see all the actors as well as the 3D representation and we remixed different audio tracks to get the best overall sound.

The video CAD model is shared between the two sites (Blainville and St. Priest), but only the designer of the electricity service can control it. Other designers have to ask him if they want to change the view or zoom in on a particular aspect of the picture. In the upper right corner and bottom left corner, we can see two videos recorded in St. Priest at the same time, one full-face and one from behind. The video recorded in Blainville is in the bottom right corner.

We transcribed (cf. Fig. 12.4) the utterances and actions of the different designers during the project review. The transcription is taken from sequence 5, one of the sequences illustrated in "Results" section.

In Fig. 12.4, the intervention number is on the left, followed by its start-time, the participant, the dialogue itself, and finally images from the video pertinent to understanding the interaction (e.g., Catia™ CAD or document manipulations). The conventions for the multimodal transcription of video were inspired by the work of Ivarsson (2010) and Lund (2003).

Twenty different issues were treated during the 1 h 20 min we analyzed and either led to decision making at the time or were put off for later discussion. Such episodes lasted between 30 s and 16 min with an average time of around 4 min. They were defined in one of the three ways: (1) designers explicitly stated they were addressing a new issue to decide upon, (2) the electricity service designer rendered visible the area representing the new issue to decide upon on the 3D shared image, or (3) issues were separated by periods of silence (up to 30 s).

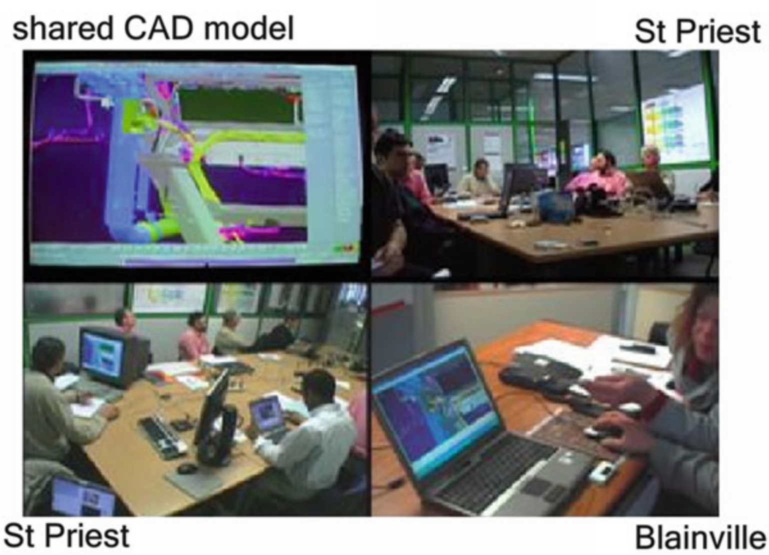


Fig. 12.3 Synchronized video of the Volvo project-review AMS meeting

N°	Time	Participant	Interaction	Illustration	Remark
260	*00:20:49*	SYLVAIN	Ok, fastening is made by 4 screws		
261	*00:20:27*				Simon is moving the 3D representation to show the good point of view
262	*00:20:50*	SYLVAIN	Fastening is made by 4 screws, so er…		*Robert and Damien share some words in a private conversation*
263	*00:21:02*	LAURA	Where are the holes for the screws?		Rotation of the 3D representation
264	*00:21:04*	SYLVAIN	Holes are here for one, for another here … and another here. So what would make sense is to have a pre-centring or a pre-positioning of the lid on, on the (2s) case … because in fact, there, we are going to bring the lid in (1s) and we will have to hold the lid with one hand and pin it with the other hand, It's not very practical, right? (1s) What would be nice is that we have uh… I don't know … in the middle … in the middle of the case, at the top, a sort of… of hook that comes out or a little thing that appears above the bottom of… of the case and in which one might come… upon which one could hang the lid, okay ? To have something that maintains it in a right position, you know what I mean.		Damien and Richard share some words in a private conversation. Damien is writing on a paper.

Fig. 12.4 A transcribed extract of the interaction, corresponding to part of sequence 5 in "Results" section

In the next section, we consider the theoretical constructs that we used to question our methodological approach, initially based on the aforementioned coding-counting schema called DIF used to categorize designers' interactions and subsequently deepened by our analysis of how evaluation criteria played a role in the dynamics of project-review design activity.

Content and Function Analysis of Interactions

A grid to characterize actors' actions when they are involved in an activity is frequently used by researchers. Such an approach raises classic questions such as (1) what is an activity or action, (2) how can activities and actions be described, and (3) what are the indicators that identify or classify activities and actions. In order to attempt to answer these questions, we mobilized Activity Theory and models of situated action and distributed cognition.

Activity theory provides a minimal meaningful context for individual actions, that of activity (Kuutti, 1995). According to Kuutti, an activity is a form of doing that is directed towards an object and that transforms it into an outcome. Outcomes are not instantaneous, but are reached through a process; activities consist of *actions* or chains of actions, which in turn consist of *operations*. Activities are driven by motives, actions are driven by goals, and operations are well-defined routines used subconsciously as answers to conditions faced during the performing of an action. Kuutti gives the following example: completing a software project is on the activity level, programming a module or arranging a meeting is on the action level, and using operating system commands or selecting appropriate programming language constructs is on the operation level. It's important to realize that there are no firm borders between these levels, depending both on contextual viewpoint and how activity evolves. Concerning the former, a software project may be an activity for the team members, but the executive manager of the software company may see it as one of many actions within the company's activity. In regard to the latter, an action can become an operation, once it has been practiced long enough and becomes second-nature. In this chapter, we concentrate on goal-oriented actions and explore whether sequences of actions carried out by multiple participants are teachable. In our context, designers are carrying out a project-review activity that is motivated by coming to a common decision on different design aspects so that the outcome is a blueprint for completing the product design. Their actions are carried out in part within their project-review meetings and include arguing with the goal of convincing fellow designers and explaining with the goal of rendering explicit a particular solution part. An example of one of the designer's unconscious operations could be the relatively seamless manipulation of the 3D software program that was used to orient discussion on decision points by sharing the visualization of different parts of the design object.

Nardi (1992) notes that the organization of situated action (Suchman, 1987) emerges from the moment-by-moment interactions between actors and between actors and the environments in which they carry out their actions. This notion of actions being carried out within and by interactions allows us to bridge between situated action and Activity Theory and thus between a detailed interaction analysis and a more macro-understanding of activity.

Finally, the notion of distributed cognition (Hutchins, 2000) is also relevant for understanding our corpus in regard to how Hutchins views the notion of cognitive processes. He first notes that cognitive processes may be distributed across the members of a social group and we shall see how the process of decision making is distributed across the designers participating in the project review. Secondly, cognitive processes may be distributed in their coordination between internal and external (material or environmental) structures. Hutchins uses Vygotsky's construct of internalization (Vygotsky, 1978) to illustrate this: high-level cognitive functions appear first as an interpsychological process (in interaction with others and with artifacts) and only later as an intrapsychological process (where the child becomes capable of the high-level cognitive process without help from a peer or an adult). According to Hutchins, this sort of individual learning can be viewed as a propagation of a particular sort of pattern through a community. In this chapter, we reflect on the feasibility of teaching designers the notion of pivotal moments for decision making within a design team—also understood as sequences of goal-oriented actions in the Activity Theory framework. Third, such processes may be distributed through time so that products of earlier events transform the nature of later events. Our analyses will show in what ways the criteria used to evaluate arguments in favor of or that attack proposed design solutions influence the decision-making trajectory.

Our final DIF grid (cf. Fig. 12.5) was inspired by previous work on analyzing argumentation during debates in the classroom on social issues (e.g., Baker, Andriessen, Lund, van Amelsvoort, & Quignard, 2007), on analyzing collaborative design (e.g. Détienne, Boujut, & Hohmann, 2004) and on analyzing talk-in-interaction (Levinson, 1983) and by confronting successive refined versions of our grid with our corpus. We categorized each utterance in terms of propositional content or topic: project, task, tools, communication, solution, criteria, or social relation and in terms of dominant pragmatic function: management, proposition, explanation, argumentation, and opinion. Category names, definitions, and examples are given in Fig. 12.5. We equated this latter to the goal or function of the utterance-as-action and we analyzed it as being understood both by the speaker (illocutionary force) and as manifested by the other designers (perlocutionary effect) as the interaction played out (in so far as we could glean this from reviewing the video and transcribed interaction). We did not categorize speech acts;[1] rather we categorized utterances from a given turn that were divided into their main propositional contents as (oftentimes) belonging to a sequence that carried out a local goal (characterized by dominant pragmatic function such as propose, manage, explain, argue, etc.).

Categorizing the illocutionary force (Austin, 1962) of particular individual utterances within human interaction has been criticized because the functions that utterances perform are in large part due to the place utterances occupy within specific interactional sequences (Levinson, 1983) and thus can vary. While this is true, our categorization task is made somewhat easier because project-review design meetings are highly scripted processes which reduce possible utterance types. Having said that, a simple "yes" can either be understood as managing communication or giving an opinion on a solution, depending on the context. Another difficulty is that utterances are very often multifunctional (e.g., "It's five past twelve" gives the time,

[1] A speech act is an utterance defined in terms of a speaker's intentions (illocutionary force) and the effects it has on a listener (perlocutionary force) (Austin, 1962).

Categories	Definitions	Example of subject addressed
Management	Synchronization at communication or social levels Project or task forecasting	Project, task, communication, social relation
Proposition	A designer proposes for the first time a new solution, part of solution or a criterion.	Solution, criterion, task
Explanation	A designer describes and defines what he proposed.	Solution, task
Argumentation	Expression of an argument or a counter argument which attacks or supports a proposition by the use of a criterion	Solution, project, task
Opinion	Designers take a stand on an issue or a subject which is in debate	Solution, task, project

Content	Definitions : mention of	Example
Project	References to what has been done before in the current design project or in an another previous project; what has to be accomplished after the meeting; a method or standard to use	Knowing that this assembly will be the same as on the sweeper
Task	References to actions in relation to the current moment in the meeting	I am going to speak about a new point I note your comments about studs
Tool	Technical tools that help designers to carry out their actions in the meeting	Could you increase the sound volume of your microphone
Communication	Sentences or gestures for managing exchanges	"Yes, I heard you, I'm here"
Solution	A solution, a sub solution, part or element of solution	The material used for a part
Criterion	An indicator which is used to evaluate a solution	Cost, weight, reliability
Social relation	An intervention that does not directly address design work content	Humor, politeness

Fig. 12.5 The pragmatic functions and propositional content/topic of utterances from the Design Interaction Framework (DIF), developed for analyzing project-review interactions

but can also mean the speaker would like to order lunch); the meaning again depends on the context. When we encountered multifunctional utterances in our dataset—while watching and listening to the video/audio—we chose what we considered the "dominant" pragmatic function as we understood it from analyzing the participants' interaction (e.g., "Do you see where the last ring is that we talked about" is managing communication but also the beginning of a solution proposal—as yet unknown at this point in the extract of interaction to which this utterance belongs). In this particular case, we—as analysts—decided that its dominant pragmatic function was one of introducing a solution proposal because it was treated by the other designers in the interaction as an emerging proposal.

N°	Time	Participant	Interaction	Function	subject	Criterion
260	00:20:49	SYLVAIN	Ok, fastening is made by 4 screws	Explication	Solution flat lid	
261	00:20:27					
262	00:20:50	SYLVAIN	Fastening is made by 4 screws, so er…	Management	Communication	
263	00:21:02	LAURA	Where are the holes for the screws?	Explication	Solution flat lid	
264	00:21:04	SYLVAIN	Holes are here for one, one another here … and one here.	Explication	Solution flat lid	
			So what would make sense is to have a pre-centring or a pre-positioning of the lid on, on the (2s) case …	Proposition	Solution lid with a hook	
			Because in fact, there, we are going to bring the lid (1s) and we will have to hold the lid with one hand while we pin it with the other hand, It's not very practical, right? (1s)	Argumentation	Solution flat lid	ergonomic Assembly
			What would be nice is that we have uh… I don't know … in the middle … in the middle of the case, at the top, a sort of… of hook that comes out or a little thing that appears above the bottom of… of the case and in which one might come… upon which one could hang the lid,	Proposition	Solution lid with a hook	
			Okay?	Management	Communication	
			To have something that maintains it in a right position,	Argumentation	Solution lid with a hook	Positioning
			You know what I mean.	Management	Communication	

Fig. 12.6 An extract of sequence 5, coded according to the DIF

In spite of these difficulties (not all of which have been enumerated here), we obtained 75% agreement on pragmatic function and 78% agreement on propositional content or topic using three judges with Krippendorff's alpha test for inter-coder reliability. Figure 12.6 shows two columns, one for coding function and one for coding subject (topic) on which inter-coder reliability was calculated. The last column was coded during a second step and is explained below.

During the first step, 100 utterances were individually coded by all three judges for function and topic/subject and after calculating our agreement coefficient, the rest of the 1,500 utterances were coded by one judge. We obtained descriptive statistics about the nature of our project-review meetings (how much explanation, how much argumentation, etc.) and the roles of each actor involved (who proposed most, explained the least, etc.), both in terms of numbers of utterances and in terms of time spent. We do not report these results here (but see Cassier, Prudhomme, & Lund, 2008 for a preliminary version and our online International Designer Observatory Network (IDON) doctoral course for a description of the DIF[2]). Instead, in this chapter, we report on the dynamics of the design activity. Since the first step of our particular coding-counting method did not take into account how criteria are used to evaluate arguments in favor of and against proposed solutions, we looked more closely at the utterances we categorized as arguments and we identified the criteria that were being used to argue about the solutions or the criteria under discussion (cf. the far right column in Fig. 12.6). This analysis led to both static visualizations and dynamic visualizations of solutions and criteria, presented below.

[2] http://icar.univ-lyon2.fr/membres/lund/enseignements.htm http://www.cluster-gospi.fr/International-Design-Observation?var_recherche=idon

Static Visualizations of Solutions and Criteria in Project Reviews

A static visualization of a project-review design meeting is a nontemporal segment of an interaction representing solutions, solution elements, arguments used to attack or defend solutions, and arguments used to attack or defend other arguments. In each case, arguments use criteria to evaluate both solutions and other arguments. Such visualization gives us a representation of the conceptual relationship between the aforementioned elements/arguments. It allows us a first glimpse of which solutions are being heavily criticized or supported and in terms of which criteria for a particular point to be decided on. Figure 12.7 shows a content-free and simply labeled example of a static visualization. Arrows labeled with a "+" pointing from a criterion to a solution or solution element indicate that the criterion supports the solution. Arrows labeled with a "–" indicate that the solution is attacked by the criterion. A branch between solution elements (e.g., 3 and 4) indicate an "either–or" relationship while other segments represent a logical "and relationship" (e.g., the solution is made up of element 1 and element 2 and element 3 or element 4).

We constructed these diagrams for 14 of the 20 issues in our dataset, building them by hand by referring to our coded transcription and the relations between utterances. Indeed, six of the issues are treated quickly and are oriented towards project or task management, so they are not decision points concerning collaborative design of the product.

We hold that criteria that argue for or against solutions and criteria that argue for or against arguments are part of the design problem and that solution descriptions and solution elements represent the design solution. In order to track how both problem and solution coevolve during design, we need to represent both the designers and the chronology of their interaction together in relation to the elements of the static visualizations; we present such dynamic visualizations in the next section.

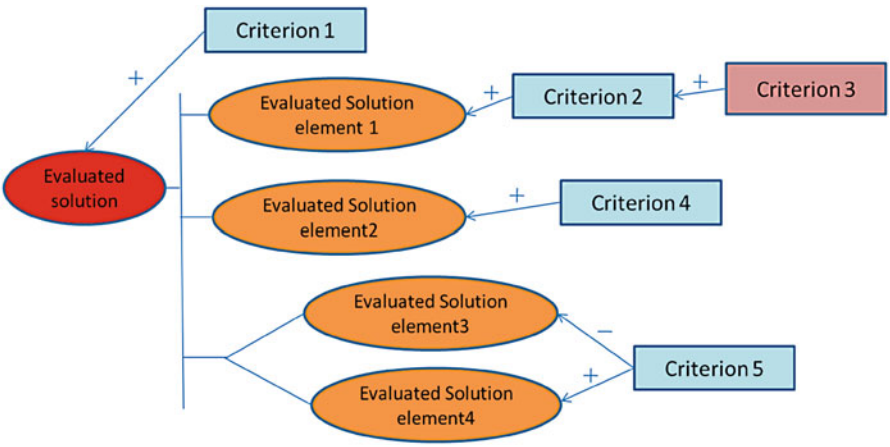


Fig. 12.7 A content-free prototypical static visualization of activity around a decision point

Dynamic Visualizations of Solution and Criteria in Project Reviews

A dynamic visualization of a project-review design meeting captures the temporal relationships between solutions, solution elements, arguments used to attack or defend solutions, and arguments used to attack or defend other arguments. It also shows which designers intervene in what ways and *when*. The descriptive statistics we mentioned earlier, issued from our DIF coding, showed us how many utterances of a specific type a particular designer spoke and how much total time he or she spent on them, but we did not know when within the interaction such utterances took place. The temporal information concerning both relations between the aforementioned elements/arguments and between designers are important for pivotal moments in the design process as we can follow in what ways decision points are resolved (or not) and by whom. We used Tatiana software (Dyke, Lund, & Girardot, 2009) to automatically produce the temporal visualizations from the coded transcriptions. Figure 12.8 gives a content-free and simply labeled example of a dynamic visualization in a similar format to Tatiana (but done by hand), following the same legend as the elements in Fig. 12.7.

In Fig. 12.8, designer 1 proposes a solution that is then attacked by designer 2 with an argument that mobilizes a particular criterion. This same criterion and argument support designer 3's solution that is proposed as a result. Next, designer 1 breaks down his solution and focuses on proposing one part of it, but before anyone responds, designer 3 supports his or her own solution with a new argument mobilizing a different criterion than that of designer 2. Then, designer 2 attacks the solution element of designer 1 with an argument mobilizing a third criterion. Next, designer 1 also supports designer 3's solution with a fourth argument mobilizing a fourth criterion. Finally designer 1 also argues for the importance of this fourth argument. It is evident that dynamic visualizations of project reviews give us a better vision of how decisions can come about than static visualizations. In addition to seeing conceptual relations between solutions, arguments, and criteria, we can also see both who proposes/critiques which solutions and arguments and when.

If we can map solutions, solution elements, arguments used to attack or defend solutions, and arguments used to attack or defend other arguments throughout a

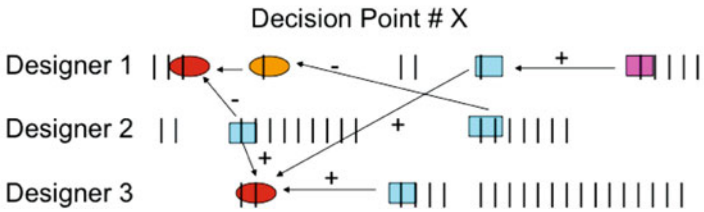


Fig. 12.8 A prototypical dynamic visualization of activity around a decision point

sequence of interaction that treats a decision point, we can gain evidence about how decisions are made in this context. It could then be possible to explore how such decision processes could be teachable and if they could become a means for designers to analyze a particular project-review moment and to learn about the dynamics of a real practice.

Results

As previously stated, our dataset had 14 interaction extracts that dealt with a decision point about the product being designed. Our analyses revealed two types of pivotal moments and a third way of treating a decision point which is more of a comparison of two or three solutions without abandoning one of them during the sequence. There were two instances of the first pivotal moment type: leading to choosing between two solutions (a pivotal moment of choice). There were three instances of the second pivotal type: leading to the emergence of a new solution (pivotal moment of emergence) and there was one extract containing both a pivotal moment of choice and a pivotal moment of emergence (totaling three pivotal moments of choice and four pivotal moments of emergence). In summary, there were six interaction extracts including seven pivotal moments. Among the eight remaining extracts, five were instances of solution comparison and two were merely an acceptance of a proposed solution. The last sequence stood apart as the solution chosen by the designers seemed to come from nowhere.

In this section we present the static and dynamic visualizations of one extract of a *choice* pivotal moment (sequence 1) and two extracts of an *emergence* pivotal moment (sequences 6 and 5), the second of which is more complicated as the solution that emerges does not do so immediately. They have been translated from French; see Fig. 12.6 presented in section "Content and Function Analysis of Interactions" for an example of a transcribed and coded interaction extract (corresponding to sequence 5). We then highlight two processes that seem to be recurrent in such decision-making activity and that can be targeted for designer reflection.

Pivotal Moment Leading to Choosing Between Two Solutions

The sequence we present here was the first of the design review. Discussion was about the integration in the global system of a subsystem called the CU box, technical jargon used by Volvo. The pivotal moment occurred when designers chose between two solutions that had already been proposed and were under discussion.

Static Visualization of a Pivotal Moment for Choice

Figure 12.9 shows the static visualization of the first extract corresponding to decision point number one. The letters and numbers below correspond, respectively, to solution elements and the criteria used to either support or attack them during argumentation. These letters and numbers are shown in Fig. 12.9 in order to appreciate the conceptual relationship between solutions and arguments that mobilize criteria.

The following parts of the CU box were discussed:

- The shape of the upper part of the box (a); it is argued that this shape is necessary for manipulation during the assembly (1).
- Metal lugs (b), which are justified by the fact that they are used to attach the electric beam (3) and support a muffler (2).
- A metal plate (c) that attaches the CU box (4) to the chassis.
- A further breakdown analysis of this metal plate led the designers to consider:
  - A hole (d), the role of which is to attach the electric beam (5) by the means of pins (e). Pins are chosen due to the lack of available space (6).
  - Connection to the chassis is discussed from two propositions: with nuts (g) or with crimped studs (f). Crimped studs are chosen because it was the solution for a previous truck and it has been satisfactory (7).

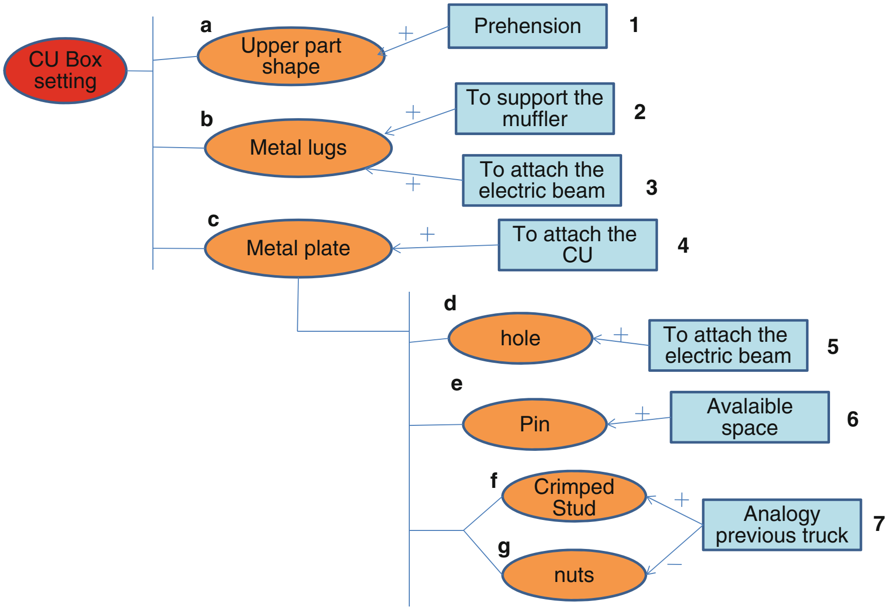


Fig. 12.9 Static visualization of sequence 1: a pivotal moment of choice

The CU box is made of the overall solution elements a, b, and c, and the metal plate contains components d, e, and either f or g (the choice between f and g is signified by the branched connected lines coming from the solution Metal plate—see section "Static Visualizations of Solutions and Criteria in Project Reviews"). At least one argument supports each solution element considered. This is represented by an arrow going from the argument that mobilizes a criteria to the solution element and labeled with a + on the static visualization. The components f and g are two possible solution elements between which a choice must be made and the analogy criterion guides the designers to choose the solution element f.

Static visualizations are technology centered. They pinpoint solution elements and criteria that support or attack these solution elements. However, static visualizations do not capture the rationale of the design process. This particular visualization is a simple example as there are no arguments about arguments.

Dynamic Visualization of a Pivotal Moment for Choice

In the dynamic visualization shown in Fig. 12.10, the *X*-axis shows the time and the *Y*-axis pinpoints the different designers participating in the project-review meeting (as shown in Fig. 12.2). Damien (D) is the architect responsible for the design of the routing; Laura (L) and Sylvain (Sy) are industrial experts responsible for the trucks' assembly; Simon (Si) is the designer who shows the others the areas concerned for each decision point with the help of the Computer-Aided Design (CAD) software. Laura and Sylvain are in Blainville while all others are in St. Priest. Robert (R) is an industrial expert normally located in Blainville who was in St. Priest during this meeting. Each intervention along the *x*-axis is shown by marks having the same meaning as in the static visualization: a red oval for the subsystem under discussion, an orange one for parts of the subsystem, and a blue rectangle for criteria used in argumentation.

The dynamic visualization reveals how the pivotal moment comes about, only suggested in the static visualization. In order to better help the reader follow the discussion represented in this dynamic visualization, we have labeled each

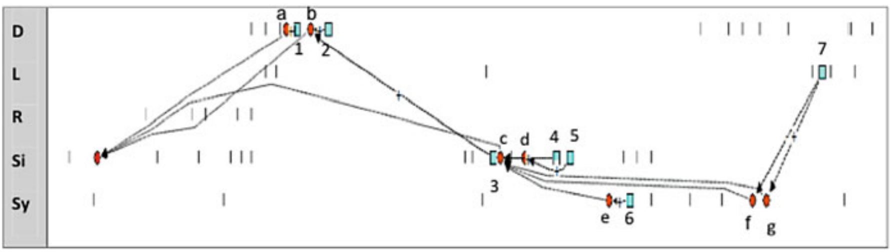


Fig. 12.10 Dynamic visualization of sequence 1: a pivotal moment for *choice*

sub-solution with a letter (from (a) to (g), matching the sub-solutions in the static visualization) and each criterion by a number (from 1 to 7, as in Fig. 12.9). The dynamic visualization shows that each criterion used to evaluate a solution element appears after the description of the solution element, so the solution elements are already "on the table" before they are argued about. In this particular case almost all the criteria are mobilized by the same designer who describes the solution elements, as if the objective was to justify it, which is not surprising, given the circumstances of the project review. Laura uses criterion (7) to compare two solution elements proposed by Sylvain (f and g), and this criterion is decisive for the choice the designers make.

Pivotal Moment Leading to the Emergence of a New Solution

This extract was the sixth decision point treated during the design review. Interactions were about the way two electrical battery clips were stacked up, the little one being under the big one. The pivotal moment occurred when discussion of criteria on a solution under discussion allowed for a new solution to emerge.

Static Visualization of a Pivotal Moment for Emergence

Figure 12.11 shows how the two solutions (red ovals) were attacked (−) or supported (+) by arguments that mobilized different criteria.

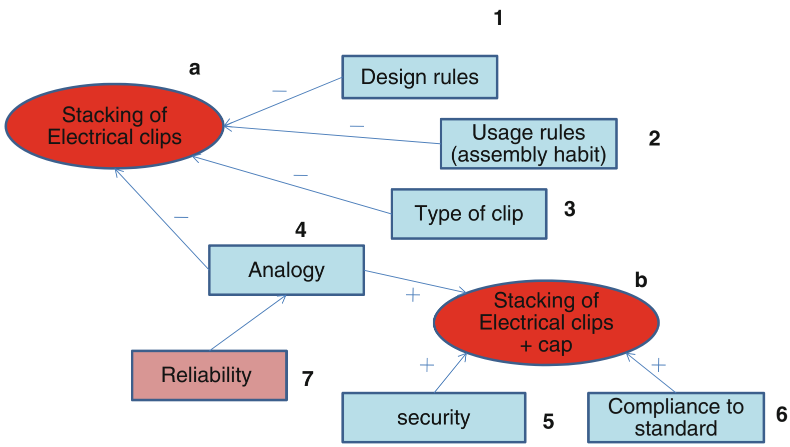


Fig. 12.11 Static visualization of sequence 6: a pivotal moment for *emergence*

Solution (a) was attacked using criteria such as design rules commonly applied at Volvo (1), assembly habits for installing electrical clips (2), and type of clips used (3). An analogy (4) to a previous assembly implemented on another truck attacks solution (a) and supports solution (b) which is organized by a new stacking, adding a cap for more security (5) and by complying with standards (6). Reliability (7) was mobilized for supporting the analogy criterion, arguing that without a cap, there was a risk that short-circuits could occur.

This static visualization shows that two solutions were discussed. Solution (a) was attacked by a set of criteria coming from different sectors (assembly, technology) and solution (b) was supported by another set of criteria from other sectors (security, standards). The analogy criterion allows for comparison of the two solutions, attacking solution (a) and supporting solution (b). However, we do not know how the discussion progressed and in what order criteria were brought to bear on proposed solutions.

Dynamic Visualization of a Pivotal Moment for Emergence

The dynamic visualization shown below is organized in the same way as the previous example. Actors were the same. The letters illustrate the same solutions as on the static visualization and the numbers illustrate the same criteria (Fig. 12.12).

Sylvain drew the attention of the group to solution (a) regarding the stacking of electrical clips. He attacked, as assembly expert, this solution with criteria 1 and 2. Laura, who is an expert in the same field, attacked this solution with criterion 3. Criterion 4 played a particular role. Damien used it to attack the solution currently under discussion and this attack allowed Laura to propose solution (b) which criterion (4) supported. Solution (b) was later supported by criteria (5) and (6) both mobilized by the two assembly experts, respectively, Sylvain and Laura. Damien's use of criterion (4) was the pivotal moment that allowed a new solution to emerge (proposed by Laura).

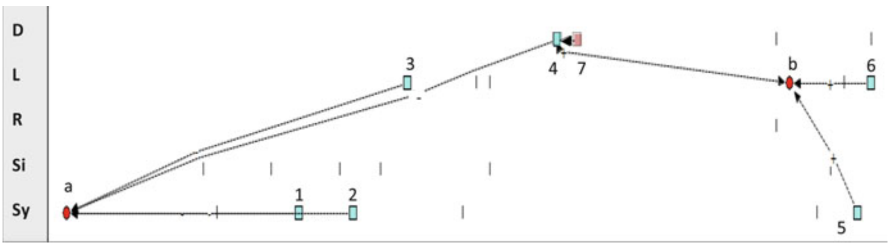


Fig. 12.12 Dynamic visualization of sequence 6: a pivotal moment for *emergence*

Pivotal Moment Leading to the Delayed Emergence of a New Solution

This extract was the fifth decision point treated during the design review. Interactions concerned different ways of designing the lid for a fuse box. The pivotal moment occurred when discussion of criteria on a solution under discussion allowed for a new solution to emerge, but in a delayed fashion. In addition, this sequence shows designers arguing about criteria that are used in arguments about solutions.

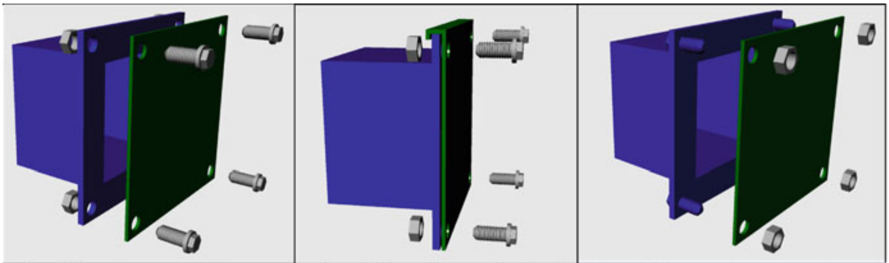
Static Visualization of a Pivotal Moment for Delayed Emergence

Figure 12.14 shows the original solution of a fuse box (red oval). Four different solution elements for the fuse box were considered (orange ovals), three of which can be seen in Fig. 12.13.[3] In fact, solution (c) is the initial expression of solution (d).

The criteria concerning ergonomic assembly, process assembly, and a way to guide the lid onto the box (blue rectangles) all favored the chosen solution (e), but how were these solutions proposed and discussed over time? The dynamic visualization will give us insight into these questions.

Dynamic Visualization of a Pivotal Moment for Delayed Emergence

In the dynamic visualization of sequence 6 (labeled letters and numbers correspond to those in Fig. 12.14), Sylvain considers the proposed fuse box solution



Flat lid + 4 screws (b)	Flat lid with a hooked edge + 4 screws (d)	Flat lid + 4 integrated pins (e)

Fig. 12.13 A drawing of the three different solutions proposed for the lid

[3] These 3D representations are our own, drawn to explain the solution under discussion here; they were not done by the designers during the observed project review.

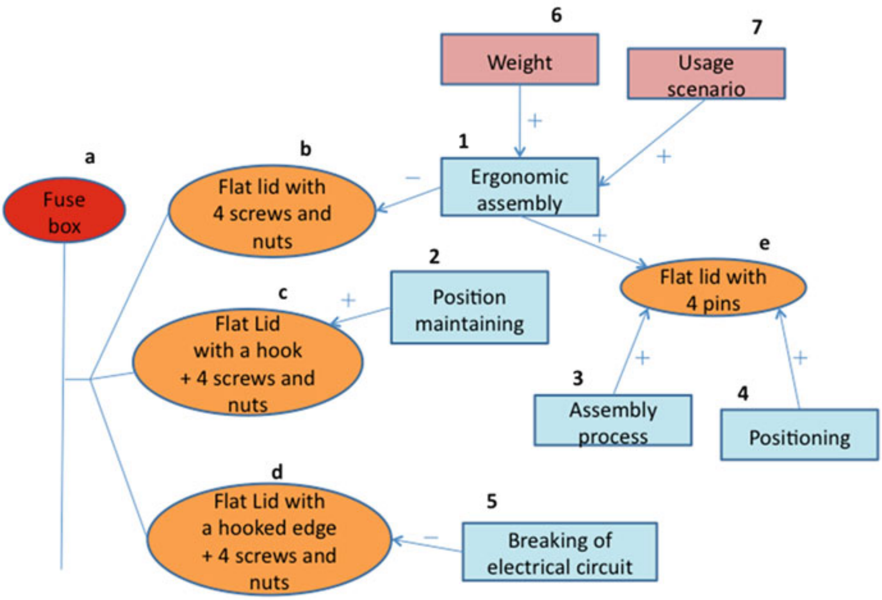


Fig. 12.14 Static visualization of sequence 5: visualization of a pivotal moment for *delayed emergence*

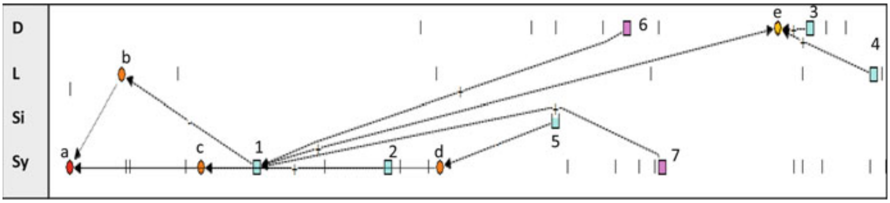


Fig. 12.15 Dynamic visualization of sequence 5: choosing between multiple sub-solutions with justified arguments

(a) and particularly the solution element that attaches a lid to the fuse box with four screws and nuts (b) rendered explicit by Laura. Sylvain proposes an alternative to (b) by suggesting that there should be a way (with a hook) to attach the fuse box lid to the chassis (c) and by arguing (1) that solution (b) is problematic if you have only two hands to manipulate and attach the lid while on the assembly line (Fig. 12.15).

According to Sylvain, solution (c) maintains the lid on the fuse box during the screwing operation (2), thus facilitating assembly. The way to attach the fuse box to the chassis is provided by a hooked edge (d), but Simon argues that a hooked edge could cut an electric beam in the same area (3). The discussion progresses by first highlighting the importance of criterion (1): ergonomic assembly and then justifying it by two arguments related to the weight of manipulated parts (6) and a working assembly line scenario (7). Damien proposes to replace the screws and nuts by integrated studs (e) and asks if that works better for the assembly criteria. He immediately argues that yes, this solution is feasible for assembly (3). Laura agrees that there is a way to attach the fuse box to the chassis as well (4). Criterion (1), proposed by Sylvain, is the heart of the pivotal moment of this sequence, enabling the designers to switch from solution (b) to solution (e), even if other alternatives (c and d) are studied before (e) was proposed.

Conclusions and Perspectives

Our first goal in this chapter was to describe the decision-making activity, characterize the dynamics of these moments, and explain in what ways some of them are pivotal. Our second goal was to reflect upon how such moments could become teachable.

Describing Decision-Making Activity

We used four dimensions to describe decision-making activity and argumentation during collaborative design: rhetorical, epistemological, conceptual, and interactive. The rhetorical dimension of argumentation in collaborative design was tracked by noting when and if each designer expressed an opinion on the arguments put forth and noting which solutions were eliminated or further considered as a result. Tracking solution evolution in terms of opinions expressed allowed us to track decisions. The epistemological dimension was tracked by connecting criteria the designers expressed to their respective professional spheres of practice (e.g., mechanical engineer, electronic engineer, assembly line expert), but we don't report results on this aspect here. We used the conceptual dimension to analyze how the designers modified in a concrete technical way the solutions they propose through arguing about them and the examples illustrate this aspect of problem solving (e.g., different fuse box lids). Finally, in the interactive dimension, we note how arguing with and about criteria help to transform knowledge about solutions. For example, through the arguments of their colleagues with different expertise, designers become familiar with other evaluation criteria and their importance.

Through reflection on these dimensions, our analyses illustrated two types of pivotal moments for decision making during a project-review meeting, but also that other decision points did not reveal pivotal moments while nevertheless allowing decisions to be made. The first type was a pivotal moment for choosing between two solutions that have already been proposed. We called this a pivotal moment for *choice* and there were three instances in our dataset. The second type was a pivotal moment that argued against a proposed solution enabling a new solution to emerge, whether this occurs immediately or later on in the discussion. We called this a pivotal moment for *emergence* and there were four instances in our dataset. We illustrated these pivotal moment types in decision making during project reviews with three example interaction extracts from our corpus (one pivotal moment for *choice* and two pivotal moments for *emergence*).

These pivotal moments show that designers who argue about one or more solutions do so by first mobilizing existing criteria or creating new ones. We do not see evidence that designers put criteria into a hierarchy in order to choose a given solution. However, the decision process we document shows that some criteria are considered most important at particular points in the interaction (e.g., if you can't put it together on the assembly line, it can't be done).

Also in relation to describing decision-making activity, we claimed that our approach met the three goals of Design Rationale (DR) and that it allowed for bridging between a detailed interaction analysis and a more macro-understanding of activity while giving us a way to characterize actions, interactions, and activity. The three goals were (1) to represent the discussion space, (2) to capture how design moves forward, and (3) to show how argumentation develops during design. Our static and dynamic visualizations both represent the discussion space while the latter captures how design moves forward. Both visualizations are needed to show how argumentation develops during design: the static visualization better illustrates the conceptual relation between the arguments whereas the dynamic visualization shows which actors (with what expertise) propose at what time which solutions and arguments mobilizing criteria.

Considering actions as being carried out within and by interactions allowed us to bridge between situated action and Activity Theory. This chapter proposes a detailed interaction analysis of design activity where argumentative interactions lead to decision making, but our framework sets the stage for relating this zoomed-in analysis with a more global analysis that would take into account activity at the organization's level.

Are Pivotal Moments for Decision Making Teachable?

Rendering these pivotal moments explicit makes them potentially teachable, but what types of interactions and activities can we carry out with designers so that they understand the notion of pivotal moments for decision making? What types of pedagogical situations can leverage these pivotal moments so that designers can learn from their own practices? Is there a way to harness such moments so that the decision-making process is qualified in some way as improved? Our future work on this aspect will focus on exploring how we can share our knowledge about pivotal moments for choice and pivotal moments for emergence with designers and this will include relating this detailed interaction analysis study to the activity system of a company doing product design with mechanical and electronic aspects.

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Chapter 13
PeTEX@Work: Designing CSCL@Work for Online Engineering Education

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Introduction/Problems

> New tasks requiring new competencies within traditional engineering disciplines have grown in number and complexity: Online Engineering, Remote Engineering, Virtual Engineering, Reverse Engineering (Auer, Dobrovska, & Edwards, 2011).

New technologies are introduced into industry at an accelerating rate, which creates a large demand for engineers and professional workers competent in new methods, processes, and technologies. Lifelong learning competencies, connected to further education and advanced training delivered through novel information and communication technologies (ICTs) will become central factors in the future adaptability of engineers and the firms they work for. "Remote engineering, also known as online engineering, is one of the future directions for advanced tele-working/e-working environments. In the last few years, we have witnessed considerable advances in the design and development of remote and virtual laboratories. These advancements are possible because of the growing technical capacity of the Internet and new models of e-learning, distance learning, and e-work" (Auer & Gravier, 2009).

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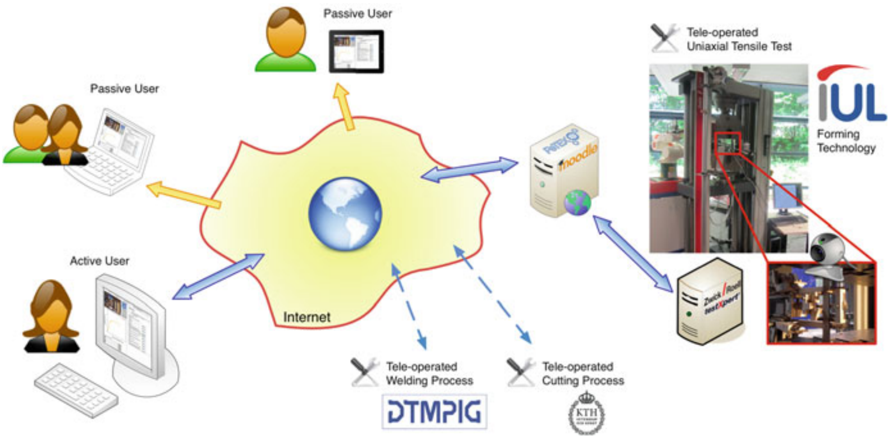

Fig. 13.1 PeTEX principle

ICT use is widespread in higher education. By now, most universities have eLearning environments accessible via the Web. But as modern industry embraces and remodels innovative technologies and strategies to increase its productivity and efficiency, engineering education facilities must keep pace with these changes. The next generations of engineers have been educated and trained by more and more enhancing support of ICT-based systems: "Many large companies have invested heavily in e-learning and content management systems, reporting high levels of satisfaction and significant cost reductions. Many large public sector organizations have also followed this path. Small- and medium-sized enterprises (SMEs; 99% of enterprises in Europe) have not followed this pattern of ICT use. Yet eLearning could help them organize training with reduced costs and less time off work" (Commission of the European Communities, 2008).

The ambition of the EU-funded project *PeTEX—Platform for E-Learning and Telemetric Experimentation* (duration: 2008–2010) was to develop a prototype as proof of concept for an online engineering education environment for knowledge and competence improvement in the area of manufacturing technology at the intersection of higher education and workplace learning (Terkowsky, Pleul, Jahnke, & Tekkaya, 2011a, 2011b). The unique aspect of PeTEX project is that teaching and learning arrangements contain interactive live experiments through real-time video-based access to three physical-real test sites, which employees and students can access in different social modes from their workplace, university, or home (see Fig. 13.1). The development and integration of tele-operated laboratory test beds and its delivery to distance learners from industry and academia participating together in a multi-country CSCL at Work community, opens new avenues for workers to gain knowledge, skills, and competencies in online- and remote engineering.

PeTEX@Work is focused on academic and professional fields where experiments are the core elements of education and training. The prototype-portfolio of the learning environment provides experimental learning for material testing and machining capabilities in the important production engineering fields of forming, machining, and welding:

1. Forming is the fabrication process in which a solid material is deformed in a controlled manner to obtain alterations of form, bulk properties, and surface structure. Using innovative forming technologies and modern strategies within the design process, road and railway vehicles or airplanes can be manufactured with reduced weight, better strength, and high quality.
2. Machining is a shaping technique that is widely used in industry. Machining by chip removal can be thought of as the action of a cutting tool that allows a part both to be cut into specific dimensions and given a particular surface finish. Machining is deployed in various industrial sectors, including the aeronautical industry where the chip removal rate can represent 95% of the part's initial weight.
3. Welding is a commonly used fabrication process that joins pieces of materials. Welding is a process that allows to permanently join parts in an unique assembly. It is able to join metals, plastics and create hybrid joints of different materials. Welding is widely used in many industries like automotive, aeronautic, aerospace, naval, and transportation.

The PeTEX@Work research-based learning capabilities for forming, machining, and welding can be deployed in a great variety of academic and professional manufacturing engineering contexts, including basic research on material and process properties (1), development of new products and practices (2), optimization of manufacturing methods (3), and quality control to achieve safe, accurate, and efficient materials and components (4).

Project Impact

The opportunity to run experiments in a tele-operated mode enables learners to achieve full comprehension of the domain-specific material processes, especially in contexts where occasions for experimental laboratory learning are not equally distributed. This will increase the potential to share valuable and highly expensive resources, like machines or a certain infrastructure with other locations which do not dispose of these specialties. PeTEX@Work offers learners from small- and medium-sized companies and university students an opportunity to enhance their technological knowledge and skills by means of CSCL at Work and 24/7 access to state-of-the-art learning contents.

Moreover, tele-operated experimentation will especially provide subject matter experts from SMEs with easy access to highly innovative technological resources for finding new solutions if the answer is not known. Conducting online, problem-situated engineering research without facing huge expenses for machines, fixtures, technical upgrades, maintenance, etc. allow this benefit.

Thus, we set out to design a research-based CSCL at Work environment through PeTEX: To what extent are we able to develop tele-operated experiment test stands for online engineering education? To what extent are we able to bring learning and work together, so that learning is no longer separate from work? To what extent does the resulting design and implementation enable a creation of new knowledge through research-based learning if the answer is not known at work? To what extent are we able to design and support reflective learning communities at the workplace?

Considering the potential impact on and the benefits for the target user groups, the development project aimed at improving conditions for lifelong learning, acquiring specialized knowledge in manufacturing technology from different European institutions, opening the educational program to different groups from industry and academia, increasing virtual mobility and new flexible forms of access to knowledge, and enhancing the communication and cooperation competencies (Terkowsky et al., 2010a).

In the remainder of this chapter, we present our project and its foundations in four sections. First, we provide a brief review of the four distinct and disparate discussions of learning at work, (1) research-based learning, (2) CSCL, (3) and remote labs in Engineering Education. This literature forms the basis for the development of PeTEX@Work. Secondly, we explain the deployed design-based research framework (DBR/eLOW) for socio-technical and didactic modeling. Thirdly, we provide a depiction of the involved production engineering's fields, and an explanation of one of the developed tele-operated testing procedures, followed by an outline of the most important steps of socio-technical and didactic integration. In the fourth place, we present a description of results from the formative evaluation of PeTEX@Work and implications for future design.

Prior Work

PeTEX@Work: Reproductive and Developmental Learning at Work

Ellström (2005) stresses that the effect of learning at work leads to two different outcomes: A reproductive one and a developmental one. Reproductive learning occurs when the learner acquires knowledge and routines already applied in the workplace by others. Developmental learning, in contrast, occurs when individuals or groups at work create new knowledge, when the answer is not already known and therefore not distributable by means of reproductive learning. The two classes of learning are not mutually exclusive, but many companies place a greater emphasis on reproductive learning and, by centering on short-term demands of production at the cost of innovation, downgrade developmental learning to a lower and less official presence. Nevertheless, Ellström claims that reproductive logic requires developmental logic, and that it is up to the different players in a firm to shape a balance between the logic of production and that of development.

PeTEX@Work: Research as a Mode to Learn Developing in Engineering

Campbell identifies practicing research in the mode of research-based learning as one of five "Engineering Education Themes" which are important for engineering education, especially in interdisciplinary subjects (Campbell 1998, p. 1). According to Tremp (2005) research-based learning means not only giving students insight into research but also weaving students into the research process. Research-based learning is didactically orchestrated by formatting the learning processes in accordance to the research processes in the respective subject, in other words it is the synchronization of learning and research cycle (Reiber & Tremp, 2007).

Research-based learning in engineering education can consist of defining the problem, elaborating the state of the art, developing the methodical design, preparing a model, carrying out the experiment, interpreting the findings in the context of methods and theory, and publishing the results. Students can participate in selected phases or in the whole process. This selectiveness in implementation of research-based learning allows for adjustment with regards to external conditions (Healey, 2005; Jungmann, 2011).

PeTEX@Work: CSCL for Research-Based Learning in the Context of Work

ICT use for learning is most common in higher education. Most universities have eLearning environments that enable distance learning via the internet. Stahl, Koschmann, and Suthers (2006) state that the use of ICT for computer-supported collaborative learning (CSCL) is "an emerging branch of the learning sciences concerned with studying how people can learn together with the help of computers. The inclusion of collaboration, computer mediation, and distance education has problematized the very notion of learning and called into question prevailing assumptions about how to study it". CSCL combines

1. Didactic approaches and theoretical discussions about the use of computers for education.
2. e-Learning as the highly scalable delivering structure of interactive learning content.
3. Cooperative learning with group-tasks.
4. Collaborative and individual learning as online and blended learning.
5. The deployment of learning management systems (LMSs), personal learning environments (e.g., ePortfolios), Web 2.0 services and infrastructures.
6. Virtual environments as immersive worlds (e.g., Open Sim).

ICT for learning is not only refining learning but has the potential to transform the learning and teaching practices and offer novel ways of education and training next to and together with more traditional instructing. The usage of ICT includes formal, nonformal, and informal education and training, whether in the workplace or elsewhere in everyday life (see Commission of the European Communities, 2008). But as Jahnke and Goggins stress in this book CSCL takes place primarily in K12 and university settings (1), it is only weakly implemented in workplace settings (2), and there is a lack of research on how to bridge the gap between CSCL and contexts of work (3).

PeTEX@Work: Remote Labs in Engineering Education

Remote laboratories in engineering education are not new. According to Gomes and Bogosyan (2009) and Auer and Pester (2009), an extensive variety of remote laboratories for online learning and remote engineering have been developed and deployed over the last 10 years, particularly in electronics, microelectronics, control engineering, and robotics. However, remote "hands on" laboratories in *production* engineering education did not exist before the development of the PeTEX-platform.

The PeTEX prototype system has been developed in the context of research-based and work-related learning in Higher Education, facilitating a platform-based learning community environment. Furthermore, it integrates engineering experiments especially designed for the novel intersection between the learning fields at universities and corporations.

Description of PeTEX Case

The unique aspect of the PeTEX environment is that teaching and learning arrangements involve interactive live experiments through a real-time video-based access to three physical-real laboratories in the fields of production engineering. The proposed socio-technical learning model for CSCL at Work consists of a learning walkthrough with tele-operated experimentations (technical dimension; interfaces from online to the physical lab) connected to learning modules with both teaching input and learning activities (educational dimension) and to a distributed learning community (social dimension).

A framework to integrate the technical, educational, and social dimensions in the design of CSCL environments is provided by the approach of socio-technical systems and networks (Reeves, Herrington, & Oliver, 2005). Instances of learning and teaching in socio-technical environments provided by the participatory design discourse suggest that new approaches should be embedded within social interactions and didactical methods and situated in a specific context (Herrmann, 2003; Kensing & Blomberg, 1998). An online learning model for CSCL at Work with tele-operated labs must include the following dimensions:

1. A didactical design (e.g., media design of LMS, WBT-modules, PLE, design of teaching and learning approaches and strategies).
2. A technical design (e.g., tele-operated test-stands, interfaces to the physical labs).
3. A socio-technical design for online learning (e.g., communication, different social modes, contact to community).
4. An appropriate interplay of all three dimensions by embedding them into a specific context or situation.

The challenge for this project was to rethink teaching and learning scenarios. Modern day learning systems are more flexible with "anytime, anywhere" access, adaptable to different existing levels of learning strategies, but are usually controlled by the teacher as well. They often do not implement concepts that embed the whole learning process into the given curriculum and empower the students to manage their own learning (Collins & Halverson, 2009). A differentiated view to different learner's roles and target groups are required.

Due to the project's interdisciplinary nature, researchers, educational experts, online learning experts and, in particular, the target groups—teachers and learners from engineering—were involved in the educational modeling processes of CSCL at Work with PeTEX. This was accomplished by deploying the *Design-Based Research* framework integrating the *e-Learning Oriented Walkthrough* method (DBR/eLOW).

Design of Experiment-Based CSCL at Work: Didactic Modeling with DBR

In the last few years, design-based research (DBR) approaches have been more heavily used, particularly in collaborative learning environment design (e.g., Wang & Hannafin, 2005). *DBR* Researchers seek to improve theories of community building by designing, studying, and refining rich learning environments by applying existing theories and working with scientists, educators, and teachers. DBR is a "systematic but flexible methodology aimed at improving educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to design principles and theories" (Reeves et al., 2005). DBR comprises several stages of examination (reflection) and design (intermediations for improving learning models). In practice, DBR combines procedures for data collection, analysis, enactment, and formative evaluation for iterative improvement.

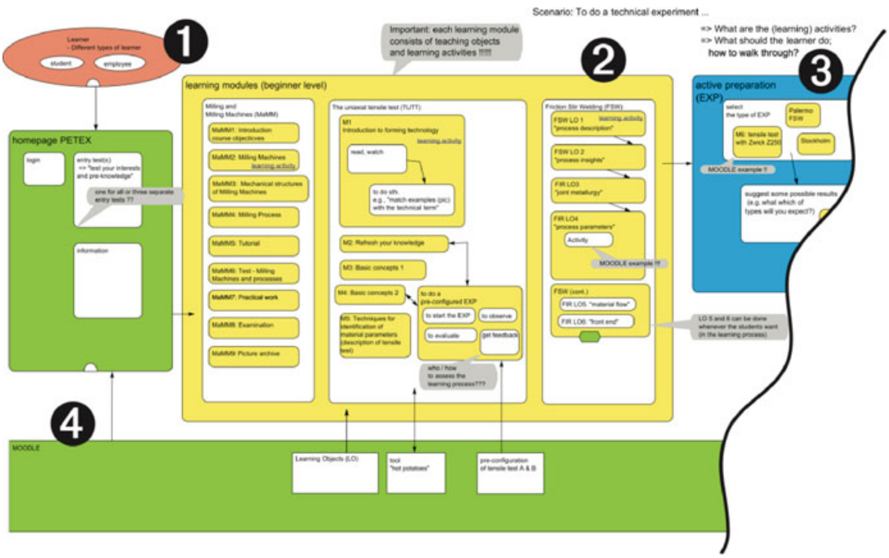

Fig. 13.2 PeTEX@Work model designed with SeeMe. The *red oval* element (1) signifies the "role" (e.g., learner, teacher), the *yellow rectangle* (2) signifies the "activity" of the role, that is, what the role does (e.g., to do an experiment), the *blue rectangle* (3) symbolizes a part of the laboratory hardware, and the *green rectangle* (4) stands for deployed the software systems

Designing PeTEX@Work with DBR/eLOW Method

We advance the notion of DBR focused on the design of PeTEX and the specific needs of its constituencies. We describe this method for planning the development within the DBR framework as the eLOW method. DBR/eLOW in practice means combining methods for design as well as data collection and analysis. According to the "Socio-Technical Walkthrough–STWT" (Herrmann, Hoffmann, Kunau, & Loser, 2004), the design of socio-technical arrangements in organizations needs the integration of all stakeholders and target group members. The modified *E-Learning-oriented Walkthrough* method (eLOW) supports such a participatory design process for the development of online learning environments.

The main aspect of eLOW is the organization of modeling workshops, together with people from the target group (for whom the online platform will be developed). In PeTEX, engineering course-designers and learners are focused. eLOW means to organize, moderate, and analyze group discussions during these workshops: teachers and learners *walk*-together-*through* the learning processes, anticipating how future learners will make use of the application. These activities are coupled with the development of a graphical model that was team-designed with the *graphical modeling software* system "SeeMe" (Herrmann, 2006). Figure 13.2 displays a section of the process model of the system specification—edited with SeeMe—for linking learning objects to the telemetric experimental platform and the learner's assessment activities.

The walkthrough is steered by definite, problem-specific questions, for example, "what is attractive online learning with tele-operated labs? What does it look like?" The facilitation process involves modeling responses to these questions using *graphical modeling software*. At the design meetings, experts discuss experimental learning processes, simultaneously design and co-construct the model, then evaluate it. Formative evaluation improves the quality of the team-design process (Rossi, Lipsey, & Freeman, 2004). This stands in contrast to summative evaluation, which focuses on quantifying outcomes.

The collection of qualitative data in group discussions is recorded by audio and video. Notes are taken by an observer and later analyzed using open coding (e.g., Bryman, 2008). The group negotiations throughout the workshops are a source of information for designing and iteratively improving the model for online learning. Seven meetings for data collection, analysis, and development in different social modes were conducted (in detail: Jahnke, Terkowsky, Pleul, & Tekkaya, 2010).

After this brief sketch of the DBR/eLOW framework, a depiction of designing the basic didactical conceptualization is given, followed by an explanation of one of the developed tele-operated testing procedures, and finally ensued by the outline of the most important steps of the socio-technical and didactic integration of the experiments into the learning environment.

Didactical Design of the Online Environment Based on Moodle

Didactical Foundation

The didactical foundation of PeTEX@Work is based on Duffy and Cunningham's theoretical conceptualization of learning. It says that "learning is an active process of constructing rather than acquiring knowledge and instruction is a process of supporting that construction rather than communicating knowledge" (Duffy & Cunningham, 1996). Therefore, a learning-centered collaborative approach promotes a re-orchestration of teaching and learning arrangements where learning is viewed from the community members' viewpoints. This viewpoint implies that learning is not defined simply as the transmission of data from one individual to another, but as a social process where knowledge is co-constructed in a complex situation within a "community of practice" (Lave & Wenger, 1998) as "situated actions" (Suchman, 1987, 2007) and in socio-technical networks (Whitworth & de Moor, 2009), e.g., in the contexts of companies' workplaces and workers' or students' "home offices". An example for this learning concept is the problem-based learning approach that mirrors the intermediate level of learners in remote laboratories (Table 13.1).

The PeTEX project team decided to deploy *Moodle* ("Modular Object-Oriented Dynamic Learning Environment", available at http://moodle.org/) as the technical and graphical user interface, because the characteristics of Moodle are compatible with the pedagogical foundation, which implies that a new balance between teacher-led

Table 13.1 Target groups integrated learning approach in PeTEX

Level/roles	Target group	Learning approach	What students do	What teachers do	Input by teachers, PeTEX	Feedback by teachers, PeTEX	Cooperative learning, PeTEX	Self-directed learning, PeTEX
Beginner	B.A.	Instruction-based approach	Students apply knowledge: 1. Remembering 2. Understanding 3. Applying	Tasks, instructions, input and feedback are given by the teacher	+++	+ Self-assessment by learning modules Feedback by teachers after the experiments	+ Cooperative learning: peer-reviewing activities after experiments	+
Intermediate	M.A. (juniors) employees at workplace (newbies)	Problem-based learning	Students find solutions for a given real-world problem (1.-3. and 4. analyzing, 5. evaluating)	Real scenario problem Feedback is given by the teacher	++	++ During the problem-solving process and at the end	++ Cooperative learning: communication with peers during problem solving and peer-review	++
Advanced	M.A. (seniors); Ph.D., employees at workplace (experienced)	Research-based learning	Students find "gaps", research questions (RQ) and solutions; finding problem and solution (1–5 and 6. creating)	Nothing except feedback is given by the teacher	+	+++ Feedback required after finding the RQ, during problem-solving process and at the end	+++ Cooperative learning: communication with peers during problem finding, solving and peer-review	+++

The pluses (+, ++, +++) define the degree of intensity of the given levels relating to the three learning levels instructions and learner-led construction must be achieved. Hence, Moodle functions as the basis of the PeTEX system.

Learning Environment Based on Moodle

A LMS is a system where the software tools are designed and integrated into the training process in order to manage learning interventions. Moodle is an online platform integrating learning objects in a highly modularized way. All learning objects are integrated in or obtainable via Moodle. Therefore, it facilitates e-learning design for individual as well as community activities in the form of path-oriented and self-directed walkthroughs.

The project team decided to also implement the e-learning authoring tool "LernBar" (http://www.studiumdigitale.uni-frankfurt.de/et/LernBar/index.html; Goethe-University Frankfurt a.M), because it permits a standard frame for integrating online teaching objects. LernBar is a system for producing and publishing interactive online learning content. Since LernBar supports the IMS- and SCORM standards, learning modules designed in the LernBar environment can be integrated into the Moodle environment without difficulty.

Figure 13.8 shows the entire Moodle screen with the opened Uniaxial Tensile Test (UTT) course, consisting of seven lessons.

Research-Based Learning Approach with Remote Labs

An interactive experimental online-environment requires the support of the analysis of experimental results. How can learners analyze the observed experiments? How will they get data?

The PeTEX remote experimentation platform offers experimental learning based on continuous monitoring of visible material behavior and varying parameters as well as on the basis of guidance through experiments for theoretical understanding. In the initial stage of the project, the existing physical laboratory equipment for the experiments has been adapted to suit tele-operated exploration. For continuous process monitoring, the equipment was supplemented with synchronized video-recording cameras located at different positions, continuously streaming the images of running experiments. Now, process data capture allows monitoring continuously changing parameters. Thus, lab results obtained from these experiments will be provided to the learner in the form of both observation and measurement. In a second step, the learners' analytical process descriptions, interpretations, and theoretical assumptions will be peer-reviewed by other, more advanced learners. In order to achieve this outcome, all of the technical as well as the social dimensions of these experimental learning and evaluation tasks must be embedded in the online learning environment (Terkowsky, Pleul, Jahnke, & Tekkaya, 2011c, 2011d).

What follows is an example for the technical design of a tele-operated material test-stand in the field of forming.

Technical Design: Material Characterization in the Field of Forming with the Tele-Operated Uniaxial Tensile Test

Formability is one of the most important properties of materials. Within the subject of forming technology, it is essential to know how a certain material behaves when it gets used within a manufacturing process or in engineering designs. For this reason, certain experiments exist to investigate the behavior of the material. One of the most important tests to investigate material properties is the tensile test. Within this test, a material specimen is loaded with a vertical force. During the test, the force is continuously increased so that the specimen elongates and changes its geometrical dimensions. These changes, the appearing elongation and the applied force, are monitored to deduce important characteristics of the tested material. Knowing the detailed behavior of the material makes it possible to set up reasonable parameters for manufacturing processes (Pleul, Terkowsky, Jahnke, & Tekkaya, 2011c). Especially in the area of forming technology, where a precise operation regarding the elastic and plastic material behavior is essential for producing a quality product, the elaborated characteristic physical quantities are used for setting up a forming process according to its technological parameters (Chatti, Hermes, Tekkaya, & Kleiner, 2010).

Generally, the tensile test is an experiment which is widely used in research and engineering education either as hands-on test or nowadays as part of experimental e-learning (Pleul et al., 2009). For this reason, this experiment has been adapted for tele-operated usage, which will be presented explicitly (for a detailed description of the other two tele-operated test stands see Terkowsky et al., 2010a, 2010b). This enhancement of traditional laboratory courses with tele-operative accessible experiments will provide learners and teachers with new possibilities to investigate engineering phenomena in order to calculate design data (Pleul, Terkowsky, Jahnke, & Tekkaya, 2011a, 2011b). The detailed knowledge of limiting material characteristics is essential for deciding whether a structure can withstand a working load without failure.

In practice, the UTT can be used with a geometrical standardized specimen as well as customized test pieces of new materials, both of which the properties are unknown yet.

For the described laboratory experiment, the universal test facility Zwick Z 250 (shown in Fig. 13.3) is used. During the first step, the tensile test is carried out by clamping (Fig. 13.4) the ends of a suitably prepared specimen in the clamping units. Then the gauges attach to the specimen for precisely measuring the change in length and width during the test. Finally, a continually increasing uniaxial load with a certain test-velocity is applied until necking starts and failure occurs.

To use this facility as an experiment controlled from distance, the developed interactive human–machine interface as shown in Fig. 13.5 was developed. It consists of an implemented live camera stream (1). By changing the camera view, the user can investigate the surrounding test apparatus, e.g., the clamping units or the gauges detecting the geometrical variations of the loaded specimen. Afterwards,

Fig. 13.3 PeTEX test stand for tele-operated material characterization (Tensile test machine Zwick Z 250)

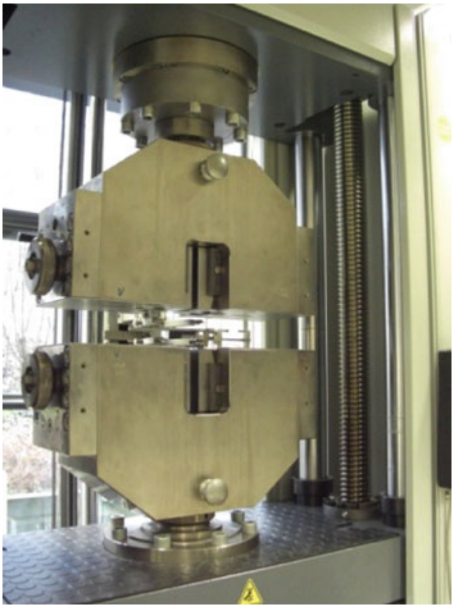

Fig. 13.4 Test clamps

the learner would initiate the preparation of the experiment (2). Doing so, the integrated 6-axes robot presents the specimen to the user by holding it in front of the streaming camera (Fig. 13.6). The specimen's geometrical shape, surface, and overall topology can be investigated.

Once the specimen is judged as appropriate, the relevant test parameters (3) are set by the user. The variable parameters of the chosen subset is held within reasonable limits: (a) providing guidance for the learner with preconfigured test specifications and (b) preventing damage of the machine.

Fig. 13.5 Graphic user interface of the tensile test

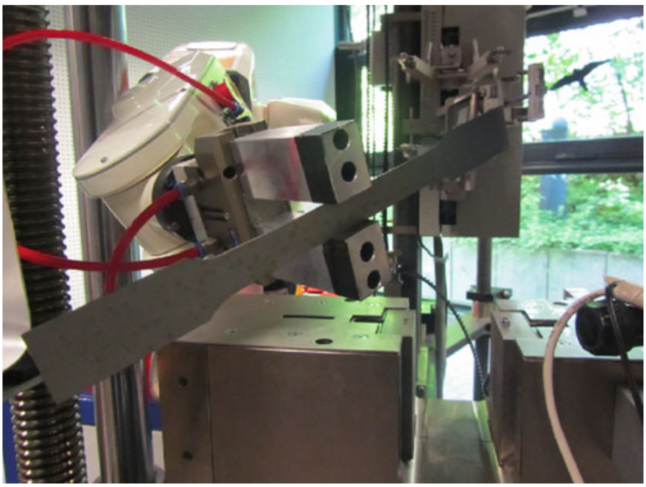

Fig. 13.6 Six-axes robot used for automated setup of the experiment (the robot takes the appropriate specimen from the magazine and presents it to the user by holding it in front of the streaming camera)

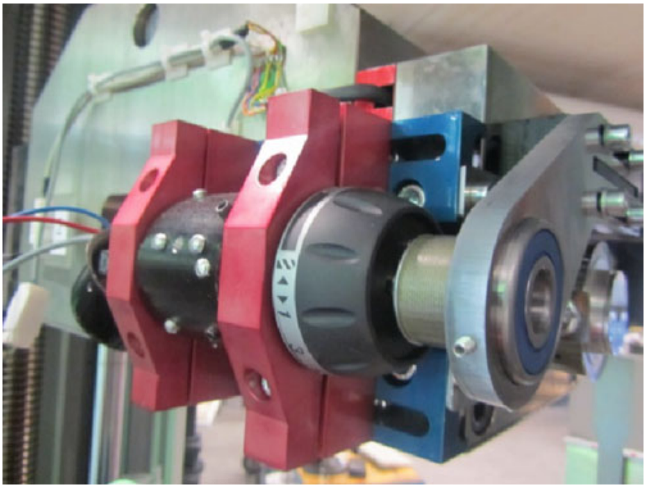

Fig. 13.7 Self-developed automated clamping unit (force and distance controlled)

After the test has been started (4), the robot places the specimen in its clamping position, where it gets clamped automatically. For this purpose, an innovative concept of clamping and measuring relevant values has been developed (Fig. 13.7).

During the running experiment, the active user is able to interact with the test by pausing, continuing (4), or terminating it at an early stage. During the experiment, real-time test data (5) and a corresponding real-time graph (6) are provided for the user. For instant comparison of different materials and/or tests, already existing graphs can be loaded (7), based on data fed into PeTEX database. The database is enlarged continuously with results from tele-operated experiments as well as from other in-house experiments for further investigation and comparison.

Once the experiment has been finished, the active user is provided with the data package. It consists of the produced raw test data as ASCII files, the image of the diagram and the appendant coordinates, the live stream and the high definition video, recorded near the specimen. The results of the experiment are therefore available

1. As graphical interpretation of load vs. elongation.
2. As tables containing preprocessed data.
3. As raw ASCII code and can be used for further and independent analyses.

During the initial project stage, the UTT setup has been equipped manually. Today, the UTT process is fully automated and controllable via an interface integrated to Moodle (Fig. 13.8) can be accessed separately as well. In order to comprehensively interact stepwise with the tele-operated UTT, experiment input options for adjusting parameters (e.g., geometrical parameters or test-velocity) are available to the user as well as features to receive continuously real-time feedback from the test stand.

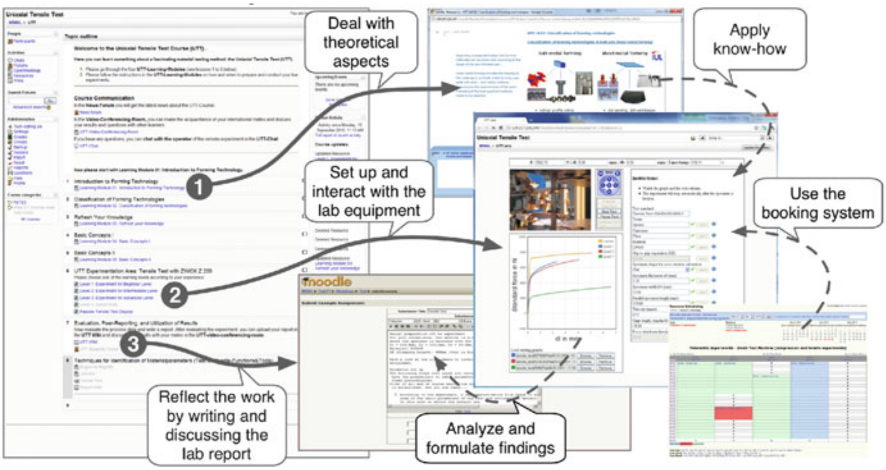

Fig. 13.8 Main window of the e-learning environment based on Moodle. The background shows the interactive LernBar learning module (1), the Moodle window for conducting the experiments (2), and the window with Moodle tools for peer-reviewing (3). The *openmeeting* plug-in is also installed to allow for convenient video-conferencing, both within the entire learning-community and in the domain-specific courses

In PeTEX@Work, the socio-technical integration of the depicted tele-operated human experiment interaction facility is conceptualized as a competence development activity which is described in the following.

Socio-Technical Design for Online Learning: Competence Development as CSCL Walkthrough at Work

PeTEX@Work conceptualizes learning as a competence development activity. Competency is achieved by pedagogically structuring the learning environment into distinct knowledge-oriented, skill-oriented, and performance-oriented learning outcomes so that they can provide the basis for learning activities (see Feisel & Rosa, 2005). The development of competences is designed as a "walk" through modularized learning objects (Fig. 13.9), such as instructions, active learning sequences, like exploring the tele-operated experiments, and performance activities like collaboration, doing portfolio work, etc.

Figure 13.9 shows the socio-technical structure of the various modularized activities in the learning environment:

- The green bar represents the learning community area where social software components for course communication, user-generated content, and resource sharing have been integrated, e.g. a video-conferencing tool with screen-sharing functions, the Moodle tools for peer-reviewing with the integrated "workshop", and forums, blogs, wikis, chat-channels, etc.
- The yellow bar represents the backbone of instruction, integrating the interactive learning modules. These comprise the necessary theoretical foundations of the three experimental test beds.

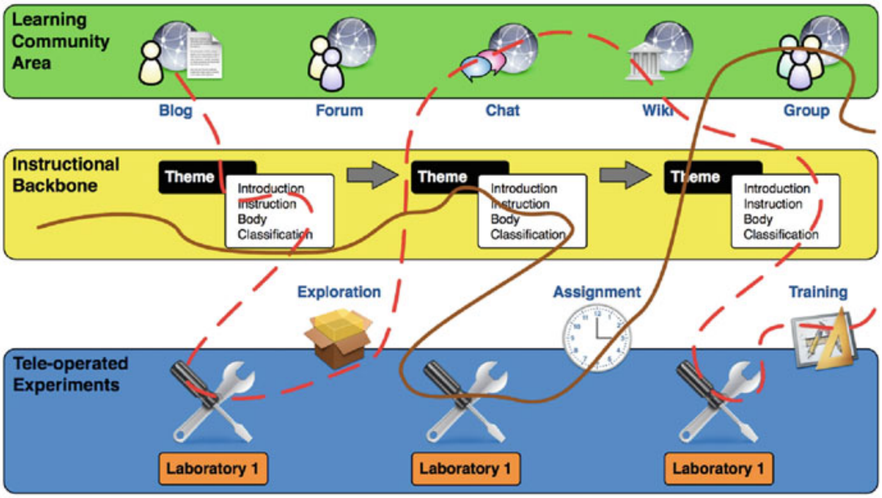

Fig. 13.9 Learning walkthrough; the two different lines symbolize paths of two different learners. For example, learner one (*red interrupted line*) starts the walkthrough in the learning community area by reading a blog from a colleague about unexplainable results of a testing experiment with some new material (1). Starting to become curious by the colleagues postings, s/he initially wants to know more about the basic theoretical concepts behind the experiment, thus, s/he walks into the instructional backbone and gets a first theoretical input from a WBT module (2). Then s/he runs an initial tele-operated experiment and explores some basic functionalities of material testing (3). As the learner has some questions about the process, s/he walks back into the community area to ask via the chat, if anybody has more information about the observed effects (4). Discussing the problem in the chat, somebody remembers the Wiki page with descriptions of novel anomalous material behavior cases, permanently collected by the community (5). The Wiki entry redirects the learner's walkthrough again in the backbone of instruction to an advanced WBT module about methodological problems of data evaluation (6). With this new experience-based knowledge, the learner becomes inquisitive to start an initial training sequel of experiments, eager to learn more about restrictions of successful material testing and the way of solving those problems (7). After completing his experiments, the learner would have the chance to evaluate his results and start writing his report for a final discussion and examination

- The blue bar represents the three remotely accessed experimental test beds, and the related interactive software interfaces.

The learners "walk" through these modularized learning activities, exploring research questions, conducting tele-operated experimentations, finding answers, making interpretations (discovery learning), and, finally, discussing results with peers and writing a report (final assessment).

This framework facilitates the configuration of walkthroughs as specific training sequences for different levels, from beginner to advanced levels. The latter, more complex self-directed exploratory- and problem-based learning walkthroughs will have comprehensive means of navigating through the entire environment, with the opportunity to interact with all learning objects and to find solutions for complex problems.

For the current prototype stage, PeTEX has defined three progressive scaffolding levels:

1. Instruction-based approach: The beginner-level students will receive a scripted guideline as scaffold for "walking" through the learning environment and for carrying out a predefined experiment.
2. Problem-based learning: Intermediate-level learners will have wider opportunities to define test bed settings and will have to solve a subject-specific real-world scenario where learning objects and experiments have to be applied in a self-directed way.
3. Research-based learning: Advanced level learners will have to propose their own research questions and carry out their own experiments.

An extended concept is the support of linking research in disciplines with students' learning, also known as "research-mode learning" (Jenkins, Breen, & Lindsay, 2007). Research-based learning is an active process in which a learner finds out and constructs his own opinion (see above). It means that learners explore something (e.g., hypotheses, ideas, and results) without knowing or having been given a solution by the teachers. Learners interact with the community of learners by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments. However, such an approach does not mean unguided learning. This concept encourages the learner to do experiments and to uncover relationships, for example, testing materials with tensile tests. Learners get the opportunity to discover unexpected things by following various learning paths. This approach mirrors the advanced learning level (see Table 13.1).

In contrast to the advanced and intermediate level, beginners need a more structured scaffolding support by the learning environment. Scaffolding helps the learners to learn step by step according to their previous experiences. This support for the beginners is characterized by more instructions and more tasks given by the teachers compared to the other target groups (beginner level, see Table 13.1). The following main elements occur:

- (*Before the experiments*) Regarding the learner's level, s/he walks differently *through* the teaching material, learning objects and in particular learning activities (phase of individual learning).
- Prepare and conduct remote experiments in production engineering and
- (*After the experiments*) the learner writes a report about the experimentation and its results, using Moodle to upload the report online (phase of learning in groups).

An initial learning step for beginners, for example, is to go through one of the learning modules (M) of the three partners—milling and milling machines (MaMM), the UTT, or friction stir welding (FSW). Second, learners prepare the design and conduction of the experiment. The third learning step is the assessment. The learner gets a documented file from the telemetric experiment, writes a report and matches the results with her/his expectations about the experiment and theoretical assumptions. The report is one of the most important learning steps since the learner reflects what s/he has learned. Finally, teachers as well as other learners write a review (using a guideline or guided questions), and the learner gets the opportunity to revise the report. In case of successful assessment, s/he gets a certificate.

PeTEX@Work: Lessons Learned

By means of a 2-year research-based design process (including modeling, development, implementation, and improvement), we constructed a socio-technical-educational prototype as a proof of concept and formatively evaluated pedagogical and technical aspects of our implementation.

The research-based experimental learning model used for evaluation is the product of seven evaluation workshops that iterated on the model in light of data from our study (in detail: Jahnke et al., 2009, 2010). The evaluation results from external experts were generally good. One important result is that the external experts, including students and teachers as well as experts from e-learning and pedagogical research centers validated the online learning model. A positive outcome is that the socio-technical prototype can be used almost intuitively. This is revealed through the evaluation results, which utilized a Thinking-Aloud-Method including video records, screen-recordings, and participant observation, conducted in project month 19 with students (Fig. 13.10). But the evaluation also showed that students overestimated the attractiveness of experiments. The word "experiment" promotes different expectations and learners expect different things (what can cause problems regarding the learner's motivation). In particular, students need an understanding and clearer idea of what "experimental learning" is, and which possibilities as well as expectations (from teachers) are connected with PeTEX.

Fig. 13.10 Students are conducting the remotely accessible friction stir welding experiment within the PeTEX-Lab during the usability-testing workshop in month 19

A weak point of the learning environment concerning CSCL at Work is that Moodle seems to advance a teacher-centered design. Accordingly, Moodle, as designed, is relatively poor for supporting a self-organized community based much more student-centered learning approaches. To this end, the social interaction modes within the prototype will be enhanced in the future to push community and group learning by integrating an e-portfolio system. Thus, we should have a closer look at the near future development ideas that can inspire CSCL at Work by PeTEX@Work.

Next Design Steps: Integrating Mahoodle into PeTEX@Work

E-portfolios are based on the general idea of an artist's portfolio that collects work and presents representative work to others in order to illustrate competence. This collection and presentation activity supports a reflective learning process (Breuer, 2009, p. 155). E-portfolios support the same, but they are made online and provide the collection of different kind of data like texts, tables, photos, videos, and audio data (Reichert, 2011, pp. 94–96).

By creating such an e-portfolio the learner can document his own learning and research process and starts reflecting on the experiments he conducts during his research learning (Reinmann & Sippel, 2011, p. 189). He can present experiments and their results, show photos from the test setup, explain his thoughts on the research, discuss new and open questions, and so on. Because other persons can be invited to see the collection in the portfolio, it can be said that it is not only a way of documenting the learning process but as well it is a way of communicating it. That means that learners, who conduct experiments in the PeTEX system and fill their e-portfolios, can get into contact via the portfolio software. They can see what others are especially interested in, start discussing it, give comments and help each other in case of a problem during the experimental learning process. Through this process a specialized community on remote laboratories emerges within the PeTEX context (May, Terkowsky, Haertel, & Pleul, 2012; Terkowsky, May, Haertel, & Pleul, 2012).

Portfolio's in the context of PeTEX@Work could act as a lifelong system to document and share individual competences from the university and professional life. This should be explained by an example in three steps:

1. An engineering student starts working with the PeTEX system at university. He uses the system in order to document his experiments. During his studies, he conducts different experiments, collects his entire research documentation in his e-portfolio, and reflects on his own way of learning. The learner can invite the teacher to evaluate his learning behavior. This can be seen as the main use of e-portfolios at university.
2. Because the PeTEX system also addresses workplace learning, the e-portfolios can be seen as a bridge from university to professional life. Depending on the

concrete use of the e-portfolios by the student, he can use his portfolios to present himself to potential employers.

3. Once employed at a company, the former student, now an employee may continue to collect artifacts from various accomplishments in a portfolio. By doing so, the employee continues the reflective learning processes instilled through PeTEX@Work in a university setting. His e-portfolio grows and with every year it turns out to be a comprehensive, iterative presentation of his professional life and his competencies.

We especially see opportunities for small- and medium-sized companies to use the system to enhance technological skills in their workforce by doing research with the PeTEX@Work hardware. In addition, they can use the e-portfolios to implement a system for the documentation and measurement of the employees' skills and competences. This could be supported by the lifelong use of e-portfolios.

Conclusion

In this chapter, we illustrate how learning-integrated work can be designed and improved as PeTEX@Work for online engineering education. The case of web-based remote labs shows that an actual laboratory test bed for experiments *can* be transformed into a web-mediated socio-technical system to foster individual and collaborative learning for different target groups from industry to academia. The project team designed a prototype that holistically integrated a technical platform for CSCL at Work, based on "Moodle", by connecting didactic methods into socio-technical situations of higher education and workplace contexts. The designed learning system includes distributed tele-operated experimentation facilities, educational content, and socio-technical requirements for an international online learning community.

It will be a future task to develop and integrate new tele-operated experiments, grounded on the research-based experimental learning concept of PeTEX@Work *in the making* as part of the highly innovative and comprehensive research and design project ELLI–Excellent Teaching and Learning in Engineering Education—funded by the German Federal Ministry of Education and Research with 11.3 Mio € (duration 10/2011 to 09/2016). However, we just have started and thus have to tackle interesting and motivating new challenges in the novel field of CSCL at Work by doing research in settings where the answer to a problem is not known.

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Chapter 14
Information Seeking and Collaborative Knowledge Creation: Exploring Collaborative Learning in Customer Service Work and Software Product Development

Anders I. Mørch

Introduction: Challenges for CSCL at Work

Challenges for computer-supported collaborative learning (CSCL)@Work are formulated as dilemmas, leading to research questions and opportunities for resolving them. Dilemmas reveal tensions and disturbances that require development and learning; they can help to advance the current state of knowledge (Engeström, 2001). In addition, dilemmas reveal problems for which there are no fixed answers (Fischer, 2003). This could be because the situations in which the problems occur are poorly understood or because there are multiple, alternative solutions.

In this chapter, two general dilemmas are addressed. One is organizational and concerns the gap between work and learning and the other the lack of a conceptual framework for integrating individual and collaborate learning. I claim the two challenges are deeply rooted both in CSCL and e-learning at work (ELW) given the large body of previous research attempting to resolve them. Previous efforts have branched computer-mediated learning into many subareas. This chapter argues that the time is ripe to address them afresh with the advent of new perspectives like CSCL at Work (this volume), new technologies like social media (Kaplan & Haenlein, 2010), and emerging practices like cultures of participation (Fischer, 2011; Jenkins, 2009). I report from our efforts at exploring the challenges in two case studies: one involves customer service work in an oil company and the other involves collaborative knowledge creation in a software house, and I propose a set of research questions for the emerging field of CSCL at Work.

First dilemma—learning and work: Educational institutions have been criticized for being preoccupied with theories and not being sufficiently in contact with the world of business, corporate finance, engineering, health care, marketing,

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manufacturing, national policy, public service, and so forth. The complaint is that university students have general and subject-specific competency but lack the skills necessary for applying the knowledge in different settings. To bridge this gap between theory and practice, educational institutions have adopted instructional methods modeled after problem solving in the professional world. These methods are problem-based learning, project-based learning, and case-based learning to name a few. The basic idea is that students will gain a deeper understanding of a knowledge domain if they engage in a practice-like process in the domain, generating their own problems, proposing tentative answers, and searching for deepening knowledge collaboratively. This is a common teaching method in professional degree programs in engineering, medicine, law, etc. throughout the world.

The adoption of new models from other domains is not unique to educational institutions. Early adopters and trendsetters in society emerge from the creative class of knowledge workers like university graduates (Florida, 2002). Their proficiency with new technology creates a pressure for many companies to adopt new participative learning practices. Furthermore, educational institutions will adopt best practices from each other. An example of relevance for this study is the educational reforms in Scandinavia in the early 1970s that introduced collaborative learning (e.g., group work), open schools (adaptive classrooms), and techniques to stimulate creativity. These are, arguably, distinctive features of the Scandinavian school system. Most recently, educators in Denmark have exported the "Scandinavian model" to schools in China in a joint effort to experiment with the integration of collaborative and individual learning in order to develop an educational model that is better fit for each country and for a global society (Gräs, 2011). It is too early to speculate about what results this initiative will bring, but it exemplifies an important trend that is addressed in this chapter: namely, experimental efforts to combine practices that previously have been thought of as incommensurable or difficult to combine. This leads to the next dilemma for CSCL at Work.

Second dilemma—collaborative and individual learning: In Sfard's (1998) influential survey of theories of learning, she introduces two metaphors of learning to distinguish among them, *acquisition* and *participation.* This is roughly equivalent to the distinction of individual and collaborative learning, respectively. The acquisition metaphor entails that learning means to gain possession of some commodity, transmitted from a teacher to a learner during instruction, where the aim is development of concepts and acquisition of knowledge (Sfard, 1998). According to the participation metaphor, the context for learning is important, in particular social interaction and community building. The ability to communicate in the language of the community is essential to learning according to this metaphor (Sfard, 1998). The duality of the metaphors, together with the slightly negative connotation associated with them, indicates that they refer to fragmented knowledge. How to achieve the synergy of individual and collaborative learning is an issue that has received much debate in the learning sciences and particularity in CSCL (Stahl, Koschmann, & Suthers, 2006). Broadly speaking, there are two main positions on the issue: the "cognitive" and the "social." Their difference hinges on how the duality is balanced and how each position is given weight and prioritized. The social position holds that learning is mediated by dialog (spoken interaction). The cognitive position treats the social as a background weakly connected to learning. It is focused on internalization as a process of perception, thought, and reasoning.

To transcend the dichotomy represented by the two positions, they must be combined in synergistic ways. Three approaches are viable: (1) start from the "social plane" and reach inward (Vygotsky, 1978), (2) start from the "cognitive system" and extend outward (Simon, 1996), or (3) identify common objects on the intersection of the two planes and make the objects building blocks for further development (translation, transformation, expansion, etc.). Spoken language is on the interface: audible in speech and silent in thought (Rommetveit, 1992; Wertsch, 1991), as well as the other tools that allow us to use, modify, and extend knowledge objects and physical things in our immediate surroundings.

Two initiatives in the CSCL community towards a synergy following the first approach are briefly presented. Enyedy and Hoadley (2006) propose two types of computer interfaces: one a communication interface for participation learning and the other an information interface for acquisition learning. An inquiry model they refer to as "progressive discourse" is described as "individuals take up what is said by others, compare it to their own understanding, and respond to these ideas, pushing the collective discourse forward, and at the same time extending one's own thinking" (Enyedy & Hoadley, 2006, p. 416). Enyedy and Hoadley have focused more on supporting collective discourse (participation learning) than extending one's own thinking, and the interfaces they propose have much in common with group inquiry environments like future learning environment (FLE) (Leinonen, Virtanen, Hakkarainen, & Kligyte, 2002). In the Knowledge Practices Laboratory (KP-Lab) project (Moen, Mørch, & Paavola, 2012), various techniques have been proposed to integrate Sfard's two metaphors in novel ways, including developing new kinds of interfaces, proposing new concepts, and studying practice transformation in educational institutions and workplaces. The notion of "trialogical," coined by Paavola and Hakkarainen (2005) as a third approach to learning, refers to the integration of monologue (as in acquisition) and dialogue (as in participation). The dialogical subprocess is the sum of individuals' contribution to collaborative knowledge creation (i.e., communication taking place while developing a shared artifact together and negotiating what the common goal should be). Monologue means the internalization of the common knowledge collaboratively created, in an effort to extend one's own thinking. The results of a trialogical process are shared knowledge objects and concrete artifacts (Moen et al., 2012).

Review of Related Work

In popular press and some policy documents, CSCL and e-learning sometimes are treated as the same (online distance education). Elsewhere, CSCL has been misunderstood and called a specific methodology (a subcategory) of e-learning (Stahl et al., 2006). In this chapter, I focus on the differences of CSCL and e-learning. Broadly speaking, and according to the challenges just raised, CSCL is about collaborative learning applied in educational settings, whereas ELW is about computer support for individual learning applied in workplace settings. However, this comparison is very rough and will be considerably elaborated below, according to goals, perspectives, computer support, and research methods.

Computer-Supported Collaborative Learning

Learning in CSCL is characterized by knowledge sharing and knowledge creation in groups, which are often modeled as inquiry (Bereiter, Scardamalia, Cassells, & Hewitt, 1997; Hakkarainen, 2003; Stahl, 2006). The setting for CSCL can range from online communities in a virtual world (like *Second Life*) or an inquiry environment for classrooms (like *Knowledge Forum*) (Bereiter et al., 1997) to two or more people located around the same computer to solve a mathematics problem (Stahl, 2006). It is the knowledge that is created together by the members in the group, and the shared meaning making process that leads up to it that are the main objects of study for CSCL researchers. The individual learning that may be required to participate in a collaborative learning activity and that may occur as a result are typically not part of CSCL research because "CSCL locates learning in meaning negotiation carried out in the social world rather than in the individuals' heads" (Stahl et al., 2006, p. 9). However, the relationship between individual and collaborative learning is debated in the CSCL community because the two types of learning are closely intertwined. The debate has been associated with the multiple interpretations of Vygotsky's social learning theory and the integration of collaboration and learning in social learning activities.

Vygotsky (1978) proposed the "law of genetic development," in which he claimed that learning occurs on two planes: first the social plane and then the individual. Furthermore, he proposed the idea that there is a transformation between the two planes (iterative and incremental) carried out in productive dialogs among peers and more knowledgeable persons and mediated by cultural artifacts (Wertsch, 1991). Unfortunately, Vygotsky was not able to complete the research he set out to do in his own lifetime. He outlined the critical issues, formulated hypotheses, and discussed tentative answers by comparing and refuting contemporary research (prior to 1934). His students (e.g., Leontiev and Luria) researched the two planes more rigorously in their own terms, but they did not manage to reconnect the two branches of psychological research. A reason for this could be the grand challenge associated with bridging social activity and individual (neuropsychological) learning, each having its own set of research methods and reference systems (theories, models, etc.).

Arnseth and Ludvigsen (2006) have identified and discussed the similarities and differences between two approaches to CSCL according to research approaches, which they refer to as *systematic* and *dialogical*. The systematic approach in CSCL aims to identify independent collaboration variables (e.g., group size, composition, nature of common task, type of mediating artifact) and to find out if there are interdependencies and effects on individual learning (Dillenbourg, Baker, Blaye, & O'Malley, 1996). The unit of analysis is the individual learner. Acquisition and transfer are two key processes. The dialogic approach in CSCL is based on the idea that learning is a socially organized activity. The unit of analysis is a group of individuals interacting to accomplish a shared learning objective. Key processes are interaction, social context, and cultural mediation (by various tools, including ICT) (Ludvigsen & Mørch, 2010; Rommetveit, 1992; Stahl, 2006; Wertsch, 1991). It is through talk and interaction with others that understanding is measured with the dialogical approach. Common research methods following the dialogical approach are ethnographic research, ethnomethodology, and discourse and interaction analysis (e.g., Jordan & Henderson, 1995).

Design research in CSCL ranges from pedagogical interventions in classrooms using methods like design experiments (Collins, Joseph, & Bielaczyc, 2004; Krange & Ludvigsen, 2009) to various means of scaffolding collaborative knowledge creation and knowledge sharing with computer support, such as organizing collaboration by CSCL scripts (Fischer, Mandl, Haake, & Kollar, 2007; Sobreira & Tchounikine, 2012), critiquing and advice giving (Fischer, Lemke, Mastaglio, & Morch, 1991; Mørch, Jondahl, & Dolonen, 2005), multiple representations and visualizations (Suthers & Hundhausen, 2003; Furberg, Kluge & Ludvigsen, 2013), and complex monitoring and interaction analysis with the use of AI techniques (Hoppe, Ogata, & Soller, 2007). Comparing user interaction data with desired models of collaboration like those defined in scientific inquiry can generate these forms of automated feedback. Examples of scientific (research like) inquiry models in CSCL are knowledge building (Bereiter et al., 1997; Law, 2002; Stahl, 2006), progressive inquiry (Hakkarainen, 2003), and progressive discourse (Enyedy & Hoadley, 2006). The pedagogical interface agents developed in the DoCTA project in Norway (Mørch et al., 2005) were designed to support progressive inquiry in FLE (Leinonen et al., 2002). The feedback from these agents was formulated as advice for how students could be more active in the knowledge-building forum and how to add new notes (contributions) based on the notes already posted. Computer-based critics integrated with design environments (Fischer et al., 1991) have inspired the pedagogical agents in FLE.

In sum, the role of software (including the AI work) in all the work reported above is to support, not replace, humans in collaborative knowledge creation processes. Of the CSCL research reported to this date, most of it has been carried out in or in close proximity to educational institutions, and there is a discrepancy between a small number of core researchers and a large body of international researchers thinly spread out (Kienle & Wessner, 2005), and to the best of my knowledge, there are few studies of CSCL reported in workplace learning journals.

e-Learning at Work

The research area of ELW is fragmented and reported in many journals and magazines. The current review takes a bird eye's view of this research and supplements it with more detailed studies in the implementation of e-learning in specific organizations. Cheng, Wang, Mørch, Chen, and Kinshuk (2003) have conducted a thematic analysis of 736 published articles in 23 journals, accepting papers on "workplace e-learning" in the period from 2000 to 2010. The methods employed were bibliometric techniques and keyword visualization (co-word analysis, hierarchic clustering, network diagramming). Elsevier's Scopus database was chosen as the data source (all documents were electronically available). The corpus was obtained by a search with the keywords "e-learning" and "distance learning" in the database. The resulting dataset of 736 articles were clustered based on the articles' keywords, through a series of data processing steps, including constructing a keyword co-occurrence matrix. After operating on this matrix to reduce and group it, the analysis yielded six clusters of keywords, which were labeled into six topics by the authors: (1) distance education, (2) e-learning and knowledge management, (3) adult education, (4) multilevel blended learning, (5) on-the-job training support, and (6) technology adoption and impact. Other general findings from the literature on ELW are that it is predominantly focused on technology and cost savings (Servage, 2005) and that it often suffers from poor application of scientific knowledge from organization studies and learning theories (Tynjälä & Häkkinen, 2005).

A detailed case study of one organization's implementation of a suite of e-learning applications was carried out as part of a PhD dissertation in Norway (Netteland, 2008) and reported in the literature (Netteland, Wasson, & Mørch, 2007). Netteland has studied the implementation process of e-learning in a large telecom company in Norway over a period of 4 years. The Company's HR department had a vision of organizational learning captured by the slogan "empower the single employee to take responsibility for the company's development and growth" (Netteland et al., 2007). This is a simplification of an application of the organizational learning theory of Wenger (2000) referred to as *social learning systems*. In a social learning system, employees are the central actors. *Engagement*, *imagination*, and *alignment* are three terms used to differentiate among the types of participation in a social learning system (Wenger, 2000). Engagement is learning that is close to the task at hand, and alignment is learning that is associated with the shared goals of the company. Imagination is learning associated with representations of the local situation for the purpose of reflection and self-regulation. Netteland (2008) has identified a resistance met by the HR department when implementing the organizational learning vision during the e-learning adoption process. Her study identified six challenges (tensions or disturbances) for e-learning in this type of environment, three of which are specific to the adoption process: (1) management control, (2) technical infrastructure for learning, and (3) execution of implementation tasks and three of which are broader in scope: (1) information sharing (lack of information sharing hinders critical mass of users), (2) allocation of time (time for e-learning must be available during everyday work), and (3) relevance to work and previous knowledge (otherwise employees will not be motivated or see the benefit of e-learning, and seek out other means for getting access to required information). It is worth noting that the participation approach to learning (Sfard, 1998; Wenger, 2000) failed in this organization as the e-learning system was not compatible with the participation metaphor. The e-learning applications introduced in the company were designed according to the acquisition metaphor (Netteland, 2008).

In a study of using a collaborative learning environment in workplace learning, Wang (2011) has addressed challenges associated with the technical infrastructure of e-learning and found that the organization failed because the e-learning environment took into account neither organizational goals (alignment) nor individual needs (engagement), leading to a predominantly technology-driven organizational implementation. Lack of relevance to work is another recurring issue that has been reported in related work. Fischer has coined the term "learning on demand" (Fischer, 1991) to propose a solution to a problem of how to "making information relevant to the task at hand" (Fischer, 1991; Fischer et al., 1991). According to Fischer (1991) and Mørch, Engen, and Åsand (2004), learning on demand can be approached by a better integration of computer-supported learning with the work tools employees rely on in their daily work. When learning at work is treated as an extension of daily work rather than an activity to be done elsewhere, e-learning applications can be designed based on workplace studies and enabled in specific situations requiring learning or delivered as chunks of information compatible with employee performance and preferences (Mørch & Engen, 2008).

Summary, Comparison, and Contrast

The brief survey of two areas of computer-mediated learning shows that there are indeed major differences between CSCL and ELW. The main challenge for CSCL is to provide integrated support for individual and collaborative learning, and a secondary challenge is to provide a better integration of learning and work, as very few CSCL studies have been carried out in workplace settings. On the other hand, ELW practitioners have ignored the complexity of supporting both organizations and individual employees, opting instead for a simplified technology-driven approach. In ELW, the main challenge is therefore better integration of e-learning in daily work, and the secondary challenge is to provide better support for collaborative and individual learning.

Emerging, common themes in CSCL and ELW are web browsers and social networking technology as platforms for social learning environments. Moreover, both CSCL and ELW have strived towards better scientific foundation for its research. This is generally accepted (but not agreed upon) in CSCL and an emerging theme in ELW. Two themes that do not seem to have much in common are technology adoption and research methods. The introduction of a new learning technology in a business environment is sometimes a costly endeavor that may last several years. Models and methods to support the adoption process are diffusion of innovation (Rogers, 2003), participatory design (Mørch et al., 2004), and evolutionary application development (Mørch, Nygård, & Ludvigsen, 2009). On the other hand, when a new learning technology is introduced in a classroom, it is often profiled as a "design experiment," a relatively short-lived innovation (weeks to months). The aim of a design experiment is bring new research informed by theory into use rather than sustaining an innovation over time (e.g., after the research projects have ended). Finally, research methods in CSCL tend to be more rigorous than those used in ELW, and the research conferences on CSCL and the related areas of the learning sciences are more prestigious than those on ELW.

Two Case Studies in CSCL at Work

I will now report from two case studies carried out in our research group, ICT and Learning at Work, during the past 10 years. The aim is to identify opportunities for CSCL at Work by proposing solutions to the challenges introduced above. The first case is from a 3-year Norwegian project, Learning at Work (LAP in Norwegian), carried out between 2001 and 2004. This project was organized as a consortium of two companies in the service sector (oil company and accounting firm), the Federation of Norwegian Commercial and Service Enterprises, and three research institutes (one being the University of Oslo). The project had the aim to develop methods for "learning on demand" (Fischer, 1991) in customer service work, and therefore addresses the challenge of integrating work and learning. The second case is an empirical study of the interaction of end-user development (EUD) and professional software development (PSD) in a Norwegian software house. It was part of a large European project called Knowledge Practices Laboratory (KP-Lab) carried out between 2006 and 2011. The common theme explored in this project is collaborative knowledge creation (Moen et al., 2012; Paavola & Hakkarainen, 2005), which resulted in a set of tools and a model of collaborative learning based on the trialogical approach (Paavola & Hakkarainen, 2005). The main challenge addressed in this project is to transcend the dichotomy of learning, described by the two metaphors of learning, acquisition and participation, proposed by Sfard (1998). Each case is organized into four subsections: context, methods, findings, and discussion.

Information Seeking in Customer Service Work

Context: A goal of the LAP project was to introduce web-based learning resources in two companies. One of the companies is the gasoline station division of an oil company (hereafter called ServiceCompany), which is the case reported here. The need for learning at work in service work is evident, as skills for performance when serving customers are high. Gasoline stations in Norway are effectively small supermarkets and fast food snack bars, in addition to being outlets for automobile products and gasoline. The employees in these multipurpose service centers are faced with a large inventory that contains many different products and services they need to know about. Staff members are often young and inexperienced, but there are older employees with few skills in using computers. The combination of

Fig. 14.1 *Left*: Playing a work-oriented script with the aid of a mock-up to resolve a breakdown (customer waiting in line is helping himself by consulting a semi-mobile information display). *Right*: Mock-up with post-it notes and hand drawing to simulate functionality of handheld device

high demands on quality of customer interaction, the rise in the number of products and services an employee needs to know about to successfully perform, the widespread adoption of mobile and ubiquitous computing devices, and a broad learner group have given rise to new demands on workplace learning.

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

Methods: A research team from our university participated in the design and organizational implementation of the new web-based learning resource, "web portal" or just "portal" for short (Mørch et al., 2004; Mørch & Skaanes, 2010). The research question we set out to address was (1) how does the portal integrate with existing ways of seeking information in everyday work? and (2) how can we conceptualize learning at work in terms of primary work? During the early phases of the project, we made extensive use of participatory design techniques to involve future users (employees) in the process of designing their future workplace. It started with learning scenarios and mock-ups that were incorporated to envision the integration of work and learning (Fig. 14.1). The final result was the field deployment of a web portal at 230 service stations. To reach the final result, six versions of the system were made and four were tested with end users. The first version is depicted in Fig. 14.1. It is a mock up of a portable information display created in a participatory design workshop with representatives of the end users (Mørch et al., 2004), and the

INFORMATION-SEEKING METHODS BEFORE THE PORTAL (N=34)

Method	%
Ask a colleague	81
Paper catalogs	58
Staff meetings	50
Call a colleague	38
Post-it notes	19
Call another station	19
Product sheets	19

Fig. 14.2 *Left*: The latest (fourth) prototype of ServiceCompany's web portal is integrated with the cash register, as two keyboards sharing the same screen ad computer. *Right*: Information seeking preferences before the portal was installed, and alternative means to find information when the answer is not known when interacting with customers at the ServiceCompany

final one was a solution integrated with the cash register created by the ServiceCompany and shown in Fig. 14.2 (Mørch & Skaanes, 2010).

The portal adoption process lasted for 14 months and 230 service stations were involved. The data we report on was collected between the third and sixth month of the adoption process, during which the portal had been installed at 25 stations. We collected data from multiple sources: field observations, online questionnaires, and interviews. A mixed methods approach was used to triangulate the data. The questionnaire was sent to the 25 stations. The items in the questionnaire concerned information-seeking strategies employed during daily work as this was judged to be an important method for integrating work and learning, and 34 respondents completed the survey.

The majority of the respondents were attendants in the age group 20–29 (three station managers and one regional manager were older). The average number of years working for the company was three. The use of the system was not mandated during this period, but the station managers encouraged the attendants to use it.

Findings: The new web portal was implemented more or less in competition with already well-functioning technologies for interpersonal communication; before the introduction of the portal, the attendants had to make use of a range of resources for accessing information to support their work. We asked the employees at several stations how they would get access to the relevant information if none of the self-help strategies applied. A representative answer was "We just pick up the telephone and call a nearby ServiceCompany station." Results from the survey showed that 81 % of the respondents reported that asking a colleague was the most useful approach when seeking information. Other frequently used resources of information were paper catalogs (58 %) and staff meetings (50 %). Paper catalogs are vendor-specific product manuals containing automobile parts and assembly instructions. The staff meeting was a weekly forum for information exchange where questions could be asked. During these meetings, the attendants would be informed about the introduction of new products. In addition, 38 % of the respondents said that they would call a colleague at home if he or she encountered problems that no one present could answer. The station manager and the assistant manager were the two people most likely to be contacted in this way (Mørch & Skaanes, 2010). The table in Fig. 14.2 gives an overview of the information seeking methods the attendants made use of, ranked according to frequency of use.

After the portal was introduced, 46 % of the respondents said that they stopped using one or more of the older methods. The remaining 54 % of the respondents said that they continued to use the older methods despite the availability of the portal, and several employees preferred to use the paper catalogs instead of the computerized display in order to find the required information. According to several of the attendants, it was important to have alternative means for accessing information during work. However, there are management plans to terminate the production of those methods that are too costly to produce and those that serve only one function.

Discussion: The findings are discussed in terms of learning on demand (Fischer, 1991), social learning systems (Wenger, 2000), and "secondary work," a new concept for work-integrated learning related to articulation work (Strauss, 1988).

As the web portal went through several rounds of revision, we saw a shift in the station attendants' view of the portal, from a performance support system for small, geographically dispersed groups toward a participation tool for communication and information sharing for the entire company. This was an aim of the ServiceCompany and evident to us (researchers) after the third prototype was installed, i.e., that the company wanted a shared portal for the entire organization. The end result could be seen in two different ways: (1) as a (partially completed) web-based learning environment supporting workplace learning according to the learning-on-demand strategy (Fischer, 1991) and (2) as a centralized information-sharing system emerging as a new form of work-integrated organizational learning. From an organizational learning point of view (Wenger, 2000), we saw a shift from local engagement to an alignment with the company's overall profile and shared values. The hands-on, work-oriented material of the mock-ups and role-playing sessions (see Fig. 14.1) created a close connection with the operations of the first prototype, thus resulting in a higher level of engagement than we have seen with the third and fourth prototypes. On the other hand, the third and fourth prototypes have more durability due to corporate backing (see Fig. 14.2).

When analyzing the work in the service stations, we could group the work into three categories: (1) primary work, (2) secondary work, and (3) gap closing (Mørch & Skaanes, 2010). Secondary work and gap closing are our main concerns here as they provide a vocabulary for conceptualizing work-integrated learning. Primary work refers to the main tasks to be accomplished during a workday, and these tasks are often written in a work description. Secondary work supports and augments primary work and comes to the foreground when the work is analyzed in detail or is otherwise disrupted and becomes an object of reflection. Secondary work is therefore a kind of articulation work (Strauss, 1988), but differ in its focus on information seeking behavior. The boundary between primary work and secondary work is not fixed, but dynamically changing and porous. The border changes when secondary work is taken up in primary work and when old work routines dissolve.

In the ServiceCompany, primary work is serving customers and ordering out-of-stock items, alternating between a counter with cash register and a back office with a desktop computer. This work is periodically updated to reflect the demands of society in terms of customer needs and to promote a certain image of ServiceCompany to the outside world about its priorities. Secondary work is often the source for updates to primary work because it is more responsive to new innovations and less rigid than explicit work descriptions. *Information seeking* was identified to be the main secondary work method. It was used to find required information to carry out primary work tasks. Furthermore, access to information to answer everyday questions has increased as a result of the ServiceCompany's continual effort to expand into other market segments (small goods retailing and hot food catering). The attendants must continually adopt the new methods and practices introduced with new business areas whenever the older ones become unavailable for further use.

The challenge explored is the gap between work and workplace learning. The research questions raised in the study were (1) how does the portal integrate with existing ways of seeking information at work and (2) how can we conceptualize learning at work in terms of primary work? First, the portal provides access to required information by web search, but only about half of the participants in our study preferred it to the existing methods; in other words, it has not been fully integrated into daily work practices in the ServiceCompany. The employees rely on other information-seeking methods that they are already familiar with (e.g., contacting colleagues within and across service stations). In this regard, we provide new insight into the use of multiple information-seeking strategies in everyday work. Web search with the portal is one of several cultural tools to seek and access information.

Second, the study identifies web-based information seeking as a type of secondary work. Although information seeking is already supported by existing (noncomputerized) methods, the new web portal was preferred by half of the users we surveyed. In this regard, it seems a promising approach to bridge the gap between primary work and secondary work to accomplish required tasks. Gap closing work and learning by web-based information seeking means to organize work so that accessing information with a computer becomes a natural, non-disruptive part of everyday work (Mørch & Skaanes, 2010). The learning scenario that served as one of the inputs for the design of the web portal was informed by the theory of learning on demand (Fischer, 1991).

However, there is a limit to gap closing work and learning. As mentioned earlier, the portal had been through a series of iterations before it was integrated with the cash register. The version immediately preceding it was a laptop with a similar user interface, but placed at the end of the cash register counter. Based on an evaluation of this configuration, it was concluded that its adoption as combined work and learning system was unsuccessful (Mørch & Skaanes, 2010). The portal was barely used during this stage of development, and one reason for this was that it was located too far away from where the "action" (primary work) took place. The developers of the latest (fifth) version of the portal learned from this and brought the portal closer to the cash register. This resolved the problem, but with the unanticipated consequence of bringing the portal "too near" to where the action is. Based on observation and interviews, it became clear that some of the attendants avoided the portal because it could interfere with the operation of the cash register. They were concerned that the cash register would stop working if they crashed the portal. The two systems were running on the same computer (with separate screens and keyboards). This was an unacceptable solution to the attendants, since primary work is more important to accomplish, even though avoiding the portal could lead to suboptimal customer services. The lesson we have learned from this is that when secondary work interferes with primary work, the employees often switch to another secondary work strategy and resort to (sometimes sub optimal) alternatives. All of the existing information-seeking seemed to follow the same pattern: "nearby without interfering." The heuristic suggests that the cash register and the information/web-search display should be near enough to each other to allow for easy access from one to the other but not too close that they infer with each other's internal workings.

Collaborative Knowledge Creation in Software Product Development

Context: In the KP-Lab project, several application domains for knowledge creation were studied, but only a few were in a business environment. The setting for this case is a small software house manufacturing project-planning tools (Mørch et al., 2009; Mørch & Andersen, 2010). The company develops and sells its project planning software in the Nordic oil and gas industry and provides consultancy services, training, and support for the users of these tools. The researchers from InterMedia were invited into the company to give advice on their knowledge management practices for customer relations.

The company is known for their customer-initiated product development approach—that is, for close interaction with customers to develop tailor-made solutions (Andersen & Mørch, 2009; Nygård & Mørch, 2007). Customers are requested and encouraged to report usability problems and innovative uses; and some of the most skilled users also assist in end-user development (EUD) of the company's products. The developers offer communication and information sharing tools for customer interaction, which has been stimulated through long-term relationships (maintenance contracts) and user forums. The main meeting ground is an annual showcase in which customers are invited to communicate with the company's employees.

Methods: Understanding the transitions from specific (adaptation) development to general (product line) development and back again have been one of our research questions (Mørch et al., 2009). One of the objectives became to construct a model of "mutual development" between customers and professional developers as seen from an EUD perspective—i.e., how there is a mutual dependency between end-user developers and professional developers with regards to proposing and making improvements to the products, mediated by the company's software products and communication and information sharing tools (Andersen & Mørch, 2009). These communication and information sharing tools started with the telephone, then were supplemented by email, later extending to a Helpdesk interface, then a Customer Relationship Management (CRM) system, and, most recently, a Web 2.0 prototype created by the research team (Mørch & Andersen, 2010). The background for the Web prototype was to design a portal to organize the rapid growth of information and to improve the communication within the company and towards its customers.

We used a qualitative approach as part of a case study. Methods employed were open-ended interviews, focus groups, and participant observations. Moreover, we used audio and video recorders to gather the data (Derry et al. 2010). We followed a grounded theory approach to categorize data (open coding and template matching), iterating between data and preliminary categories in multiple rounds. The empirical material consists of interview data and a video-recorded meeting with key stakeholders (developers and users).

Findings: When we interviewed the respondents (developers and customers), they related historical events connected to some external organizations the company does business with, in particular an oil company and an engineering company. Some of these events led to major changes in the company's product portfolio, including the creation of two new products, Planner and Microsoft Project Extension (MPX). However, most of the external events led to minor changes, producing only gradual improvements and continuation of existing products. Figure 14.3 shows a schematic overview of the major events that have influenced product line development in the company (Mørch et al., 2009).

The interview extract below illustrates a developer's view of user participation in adaptation of one of the company's products. The extract is from an interview with the head of support in the company, who is also involved in sales, development, and management. The interviewer focuses her questions around how user participation is initiated in practice, and the respondent refers to one of the products to exemplify user participation.

Interviewer	Are there any customers that have participated in the development of your products?
Respondent	[…]Statoil (oil company in Fig. 14.3) is an example. When we delivered version 3 of Planner, Statoil was a major initiator of the development. Much of what we incorporate in our products comes from our customers
Interviewer	How do you receive customer requests, how is the process accomplished?
Respondent	Customers send us a wish list for new functionality or modifications to existing functionality. During development, if (the request for new functionality) seems reasonable, e.g., if others are asking for it, if it is an area we should look closer into and maybe look at in a broader perspective. For example, if you are writing reports and (someone) wants new functionality, we include it because we are already in there (altering the report-module in the product). This enables late requests to be taken into account, assuming it doesn't have side effects requiring changes to many of the other modules in the product

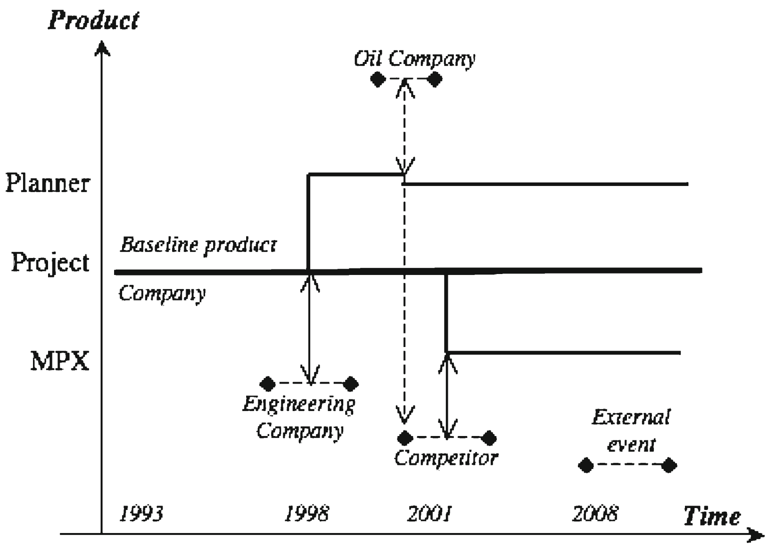

Fig. 14.3 Software product line development in the company. It depicts a family of project planning software starting with Project, which spawned two subsequent products, Planner (improved GUI) and MPX (Windows application), partially influenced by external events

The interviewer asks the respondent how customers have participated in development activity. The respondent explains how one of their main customers is an active contributor to new ideas for development, and he exemplifies this by referring to one specific version of the project management tool Planner (see Fig. 14.3). He later generalizes this ("Much of what we incorporate in our products comes from our customers"). The interviewer goes on to ask how improvement requests are received. The critical factors dealing with request processing include whether or not the request is judged to be important for the developers' current activity, how much extra work is required to incorporate it, and to what extent it is restricted to a well-defined area in the software code. This indicates two levels of development (customer and company): each with its own time scale and change rhythms. The discrepancy among the levels is best reconciled when specific requests for change align with the company's internal development cycles.

Discussion: We identified the subprocesses of the product development process studied and ended up with the following five categories (subprocesses) of customer-initiated product development (abbreviated here, see Andersen & Mørch, 2009).

- *Adaptation*: This is when a customer requests an improvement to an existing product and the company chooses to fulfill that request, which becomes an adaptation just for this customer. Sometimes, the customer has to pay for this, sometimes not.
- *Generalization*: This occurs when a new version of an existing product is released and is available to more than just one customer.

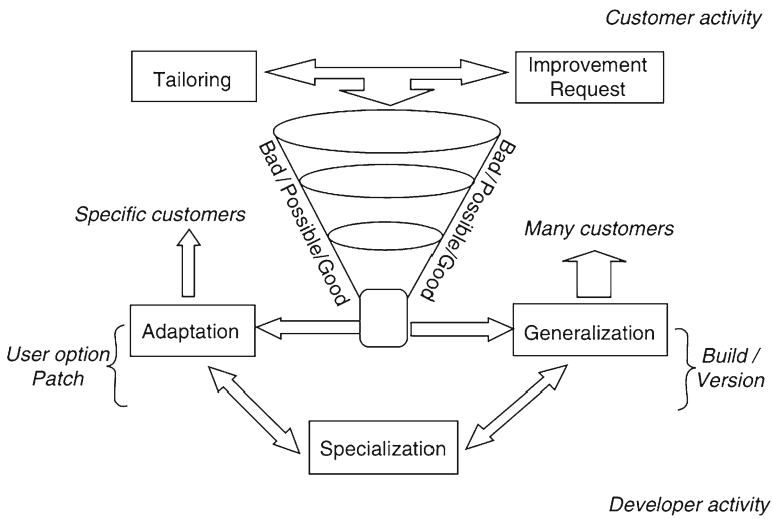

Fig. 14.4 Model of mutual development in collaborative knowledge creation where the customer and developer activities coevolve. The *arrows* indicate dependencies

- *Improvement Request*: This is when customers make a request from the company for extra functionality, or to report bugs and usability problems, which are viewed from the customers' perspectives.
- *Specialization*: This is when the professional developers at the company create in-house builds. This could potentially result in new features, but most often it entails removing bugs, reorganizing program modules, and perfecting the product when time allows.
- *Tailoring*: This is about active end-users (customizers, super users, local developers) who make adaptations on their own.

We justified these various stages using data extracts and analysis (Andersen & Mørch, 2009; Mørch et al., 2009), one of which is shown above. Our findings are summarized in Fig. 14.4, our first attempt to construct a model that integrates professional development and EUD. There is an implicit classification scheme of improvement requests that helps to filter a user contribution. When received by the company, it will first be classified as good, possible, or bad (Andersen & Mørch, 2009). A good suggestion is accepted as is. A possible suggestion must be accompanied with payment, and a bad suggestion is rejected outright.

The overall (integrated) development process is an elaboration of specialization (refinement), adaptation (domain specification), and generalization (one too many instances), starting with a stable (nonoptimal) version that is gradually improved by uptakes of locally developed extensions, user options, and patches. These are initiated and/or informed by customers through improvement requests and end-user tailoring. Those user contributions that are good or possible (i.e., paid for) will be part of the new builds. When multiple builds become unwieldy (i.e., too many different sites to coordinate), the system is rebuilt in-house. The new system may be introduced as a new version (released) if it will benefit the company and not jeopardize existing customer contacts. The interaction between the stages is bidirectional since new versions may lead to new local development and improvement requests, which repeat the process.

The challenge explored in this case is the integration of individual and collaborative learning in computer-mediated workplace learning. The main research question raised was to understand the transitions from specific (end-user) development to general (professional) software development. This was addressed by unpacking the collaborative knowledge creation process between developers and users of a project planning tool suite and its support systems, and based on interviews with the key stakeholders. The result is a model of mutual development depicted in Fig. 14.4.

Critical to the success of this approach is the use of boundary objects (Star, 1990), in particular end-user modifiable objects in the interface between the collaborative and individual learning environments, here perceived as the integration of specific (EUD) and general development (PSD). The metaphor of trialogical learning is applied in this case to software products that are adaptable to specific customer sites (by the customer or for the customer by developers). The shared knowledge collaboratively created as a result of this is manifest in the software products themselves and in the record of discussions and negotiations mediated by the company's communication and information sharing systems.

Conclusions and Directions for Further Work

The two cases presented demonstrate examples of organizational learning and knowledge management practices transformed into a collaborative learning and knowledge creation process that extended outside the companies studied (i.e., to involve customers). In each we identified learning as a "side effect" or process in parallel with primary work. This type of learning was conceptualized as "secondary work" (extension of primary work) in the ServiceCompany case, and adaptation and generalization of existing products and practices in the software house case.

More specifically, the first case explored the opportunities for CSCL at Work in the following way: collaboration during information seeking (i.e., with colleagues, during staff meetings, and in interaction with customers). Moreover, in addition to collaboration with colleagues and more experienced people, searching for information in information repositories (catalogs, product sheets, web pages) and interacting with physical objects (post-it notes, tagged products) provide opportunities for learning on demand. In these situations, the envelope for learning is small (customer service work does not leave much space for learning on demand), and multiple means for information seeking being in place is essential. When one means does not work, the attendant seeks out one of the alternatives. This is partly a result of the fact that secondary work is not mandated by one method. Therefore, information seeking must cater to different users' needs and preferences, which varied according to age group and computer proficiency in the company we studied.

The second case explored CSCL at Work in the form of enabling active users (customers of a software house) to contribute to the expansion of the product line and organizational learning of the company. As the company develops software products for the open market, it benefits from feedback from its customers. These include improvement requests and local adaptations. The company followed up those suggestions that were judged to be good (e.g., an innovative new feature of general applicability) or regarded as possible to do (e.g., an adaptation for a specific customer). The case demonstrated trialogical learning in a business context, an approach to CSCL developed in the KP lab project (Moen et al., 2012). Collaborative learning is attributed to the knowledge collaboratively created in productive user-developer interactions when improving upon project-planning software. The locally adapted version of a shared product provides a model of individual learning for the end users.

Based on the work presented, open issues for further work include:

- Develop domain-specific inquiry models for different business domains.
- Creating a model of technology adoption that accounts for participatory design, EUD, and application evolution with the diffusion of innovation model.
- Transform design-based research into a methodology for continuous assessment to sustain workplace learning innovations beyond the research project.
- Explore opportunities for cultures of participation in workplace communities (e.g., identify cases and carry our empirical studies).
- Continue to explore the potential of social media to serve as a platform for CSCL at Work technology. Our current efforts towards this are to evaluate the potential of *Second Life* for training military officers in intercultural communication (for service abroad) and integrating *Facebook* with existing e-learning applications for training in the (supermarket) retail business.
- Identify and describe a third type of work, "reflective practice," positioned between secondary work and education, to improve the gap closing of work and learning.
- Continue to invent new teaching methods and courses for educational institutions adopted from problem solving in the professions (PBL, inquiry, etc.) to make education more responsive to the needs of working life requirements, such as training in "critical thinking."
- Identify and study intermediate stages between collaborative learning and individual learning.
- Carry out research with methods other than interview and questionnaire to capture the more fine-grained aspects of user data in workplace learning (e.g., interaction analysis, thinking aloud protocols, social network analysis).
- Provide design-inspired models of the non-visible stages of the (internal) learning process, which builds on boundary objects in collaborative learning.
- Design computer-based boundary objects that are truly plastic (i.e., end-user modifiable and extensible) for the purposes of translation, transformation, and expansion, drawing on previous research in EUD and Activity theory.

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Part V
Sum Up (Also for Practitioners)

Chapter 15
CSCL@Work for Practitioners

Sean P. Goggins, Isa Jahnke, and Volker Wulf

Introduction

Any person who is part of a traditional or virtual organization must learn new skills routinely. The chapters in this book demonstrate that much of what you will try to learn for yourself in the modern workplace cannot be found in a book, or on the Internet. Information and knowledge are jumbled together with social connection and experience. Often you will need to acquire the acumen to apply skills, tools, and approaches that were invented very recently, and for which there is little if any documentation. In such cases, you will likely be collaborating with a group of people—formally or informally—and it is quite likely the people who help you the most will not work in the same organization that you do.

You may be a practitioner looking to advance your own skills with limited resources, a team leader hoping to help your group obtain a competitive internal advantage, or a manager with responsibility for advancing your organization in a competitive global environment. This chapter has something for each of you. It is divided into three sections. The first section is a practitioner's guide to considering the social, technical, and pedagogical dimensions of collaborative workplace

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learning. This is a step back from the detailed chapters you have already read (or might someday read). The second section is intended for workplace learning designers, and lays out a set of principles for designing workplace learning in three parts. First, consider learning in unexpected places; second, think of learning as a connecting activity that reaches beyond your present organization's boundaries; and third, use collaborative workplace learning to drive change.

A Practitioner's Guide to Advancing Practice from this Book

You are likely a regular participant in collaborative or social computing. Facebook, Twitter, and other participatory mass media are routinely sites for information encountering (Erdelez, 1997) and collaborative information seeking (Reddy & Spence, 2008). Gurzick and White (Chap. 14) describe how these platforms are becoming part of how collaborative learning occurs in the workplace. It is important to recognize that CSCL at Work is happening whether you plan for it, design it, or encourage it. We all have our own networks, and yours is likely a frequent source of insight for you. This chapter is focused on making CSCL at Work a planned and managed part of both individual and organizational learning strategies, using the chapters throughout the rest of the book as guideposts for more specific information and insight. The other chapters are detailed stories of what works. This chapter is a series of waypoints for making the parts of this book relevant to you real where you work.

Learning Embedded in That Which Looks Fun: Social Interaction

Common education approaches in early life learning do not model collaborative learning skills, which is a problem. There are a number of alternative, social places where learning does take place. Massive online games and social media provide two examples.

King (Chap. 13) describes the use of massively multiplayer online games (MMOs) as a place for learning how to adapt and collaborate fluidly in the context of a workplace. King contrasts traditional classroom notions of learning, which continue to be principally collocated with the virtual, jazzlike environment found in MMOs. Collaboration, learning, and enculturation take place in these environments not as a preordained pedagogical outcome but through problem solving and information seeking. People participate in MMOs as a recreational activity, but many develop important, socio-technical workplace skills through the experience.

Gurzick and White (Chap. 14) explain how people in the workplace who have questions that cannot be answered with knowledge from other people or information systems within the workplace use Facebook to tap into their personal networks. Social media is sometimes regarded as a time-wasting activity. It can also be a rich resource for gaining needed information and knowledge that is not known within an organization's boundaries. One of our premises is that learning is a social activity (Bandura, 1997; Carroll, Rosson, & Zhou, 2005). In this context, social media can be viewed in a new way. You likely rely on your own personal network. How do you connect with your network today?

Fischer (Chap. 3) frames the problem of learning in contemporary organizations as "solving problems where the answer is not known." This includes knowledge not known to the individual or available to the individual from resources within an organization's boundaries. Social and technical environments outside of your traditional workplace become sites for developing the answers that are *not known*, experimenting with ill-defined problem spaces, and mixing aspects of our lives considered *fun* with the performance of work.

Technology Design and Workplace Learning: Beyond Warehouses and Sociality

Some knowledge is difficult to get from a personal network, particularly if you work in an organization with highly specialized knowledge. The challenge of needing to solve problems where the answer is not known likely is the same for you—but in specialized work the answer may *truly* not be known, inside or outside the organization. In these kinds of cases, specialized collaborative workplace learning technologies may be required. Three chapters in the book, by Terkowsky et al., Lund et al., and Mørch, provide two examples of specialized socio-technical work environments for collaborative learning. Mørch frames the larger challenge of designing technology for learning, and presents software design case studies that could help you frame CSCL at Work design.

You may have an impression of the role of technology design and learning that was informed by two contrasting perspectives, both of which hold in some organizational contexts. The first is called "technological determinism" by academics, and it's the notion that people think human behavior can be directed through technology. The second is an inertial view of technology use that describes how popular systems become more popular, and unpopular ones languish. You have likely witnessed both anti-patterns in your experience. A third way leverages Scandinavian design principles focused on participation. In fact, participatory design that engages workers in the process of building systems is one of the great contributions of Scandinavian culture to the ideas behind CSCL at Work.

Both the Lund et al. and Terkowsky et al. chapters describe novel workplace learning environments focused on the production of manufactured products. Terkowsky et al.'s chapter describes CSCL at Work design in a manufacturing environment. In the manufacturing case it proves critical to understand the intersection of technological design with learning capacity in the individual and group. When beginning to learn a new manufacturing technique, CSCL at Work might take a more instructional form in the manufacturing environment. As the worker's skill advances, you will notice how this case study focuses on specific, complex problems and then on approaching the manufacturing task through CSCL at Work as a form of research. In manufacturing, like other endeavors where the answer to a problem is not known in an organization, you will find benefit from technology design and practice that recognizes when this happens in a workplace learning context.

Product design, described by Lund et al., recognizes that there are many unknown answers to design problems, and that product design is a collaborative discipline. So much is unknown, and measurements of what the right answer is are so subjective that learning the design process is viewed as a significant contribution of the CSCL at Work approach. You might consider the extent to which the type of work you are doing is "production" oriented or "design" oriented, and reflect on these two chapters in tandem.

Mørch provides a complementary examination of CSCL at Work design by walking you through what is known about individual and collaborative workplace learning. Thinking about how reliable and useful the information used to evaluate a particular workplace learning situation might occur to you instinctively, Mørch's chapter will help you to work through this input to your CSCL at Work technology design more systematically.

Making Learning Explicit: Collaborative Pedagogy for the Workplace

If you find learning in unusual places and choose to design technology focused on sharing information and helping people learn in the workplace, you are only part way to the envisioned, practical CSCL at Work. Learning, it turns out, must also be designed—for example, collaborative reflections need to be enabled and supported, see Chap. 7 by Prilla et al. Teachers and researchers call this "pedagogy," and it is an intimidating, multisyllabic word. Like many words used in narrow disciplines, it serves a purpose of distinguishing those within a discipline from those who are not. In the case of this book, we use it because it is specific, and we ask you to look past its other purposes toward this goal—we simply suggest that opportunistic workplace learning and technology to enable workplace learning must be combined with lightweight plans for learning to occur. Just as a sports team calls plays or a software or medical team explicitly coordinate their work to accomplish their goals, you will fare better if you think about how learning might occur in the organization where you work. You will not be able to script learning as a screenplay, but you can improve the odds.

This volume provides a number of examples in different disciplines that outline how such learning might occur. Hartswood et al. (Chap. 8) describe a specific case of workplace learning design in mammography. Hokstad et al. (Chap. 10), Kienle (Chap. 11) and Prilla et al. (Chap. 9) describe specific examples for designing reflection and facilitation into CSCL at Work environments. Mumford (Chap. 6) connects workplace learning, organizational learning, and experiences from university courses in a way that will aid you in communicating about the relevance, validity, and utility of CSCL at Work efforts within your organization. As a reader of this book, you are no doubt familiar with individual and organizational resistance to new ideas. Mumford helps you frame your elevator pitch within your organization.

Three Principles for Collaborative Workplace Learning Design

Examples like those presented in this book inspire us; but we find it difficult to directly apply examples from cases in our own work. The chapters presented in this volume generate a myriad of ideas for future studies that advance CSCL at Work practice. Yet, you will not find them useful as recipes in practice any more than we do as recipes for future research. Adaptation is critical, and you will find it more straightforward to apply a set of principles on a day-to-day basis; well, at least we do, and we assume you are similarly motivated—or you likely would not have read this far.

In this section we briefly explain three core principles for CSCL at Work practice. We do not consider them exhaustive or even detailed. The needed details will come from the intersection of these high-level principles and a specific context—yours or ours. First, look for learning in unusual and unexpected places. Second, foster connections outside your organization—this may prove difficult for some organizations, but our research and the research of others suggest that innovation is best fostered through idea sharing. Third, acknowledge that CSCL at Work is intended for fostering change. Organizations and individuals do not undertake something new in the absence of inspiration or necessity; if you are interested in CSCL at Work, it is highly probable that you are motivated by enabling successful, effective, and emotionally untumultuous change.

Learning in Unusual and Unexpected Places

You likely have people in your organization who already use public discussion forums to ask questions, find information, and learn different perspectives that help them learn and add more value to the organization you are a part of. Find and share these spaces.

Fostering Transformational Connections: Reaching Beyond Your Organization

Connection is easier than it once was; but connections are also different. Instead of a handful of deep connections, you and those you work with likely already maintain a large, weakly connected network of personal and professional relationships.

Before social media, the most outgoing, socially capable members of any organization were uniquely privileged by their capacity to maintain a strong network based on these weak ties (Granovetter, 1973). With social media, the opportunity and ease for connection making are growing.

These new kinds of connections take three forms (there may be others) that can aid your organization in developing CSCL at Work approaches that extend beyond organizational boundaries. First, there are connections you and others within your organization make in the physical world; these kinds of connections can now be easily sustained with social media connections. Questions asked by organization members using these networks may be answered through their personal, weak tie networks. Second, connections can be made solely online. This is what happens when you participate in a discussion board, and open-source project or other technology where people share information and help each other out. Github is emerging as a place for software and documents to be sustained using this kind of lightweight collaboration. Third, there are connections that extend organizations into less structured, virtual organization space. Getting help through an open-source forum or open-sourcing software product development are two ways this occurs with software. Recently the German Government even put all the laws in the Bundestag on Github. How people define organizational affiliations is changing in fundamental ways, and is enabling both new kinds of collaborative organizational learning and new kinds of organizations.

CSCL at Work to Drive Change: Building Worker-Centered Change Plans

Learning in the workplace is a powerful tool for supporting organizational change. CSCL at Work is an approach to enabling change that focuses on the individual, worker perspective. You may not be motivated to adapt your job or reshape the work you do through a focus on how it affects an organization you are part of; in fact, changing of individual roles within an organization is often perceived as a threat. Learning, however, is now widely recognized as a long-term competitive advantage in many fields. Making learning a more natural part of workplace collaboration helps individual organization members perceive change differently.

When planning for change, you might consider the extent to which new skills, knowledge, or information will be required in the workforce. You can also think about the extent to which supporting individual member objectives will serve to advance those goals. CSCL at Work is not a silver bullet for supporting organization, but the perspective the chapters in this book provide is not reflected in literature on change management, knowledge management, or other disciplines. Through this book, you have an opportunity to deliver a new perspective within your organization—enhancing your own value!

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