Cultural-historical psychology as a basis for learning to use CSCW systems

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I hereby certify that all material, which is not my own work in this dissertation, has been identified and that no work is included for which a degree has already been conferred on me.

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Abstract

Computer-Supported Cooperative Work (CSCW) is a growing field, which aims at facilitating, by means of technology, coordination and communication between people, working together. One problem within the area is that users often have problems learning the systems. Activity theory, a theoretical framework often used within CSCW, includes theories of learning, which however, have received relatively little attention within CSCW. Activity theory, as developed by Leont'ev, stems from Vygotsky's cultural-historical theory, and has been further developed by Gal'perin. In this thesis the theories of learning in the works of Vygotsky, Leont'ev, and Gal'perin in particular, have been applied to CSCW in order to investigate the contribution these theories can make to support learning within CSCW. Several conclusions are drawn from the theories analysed in this thesis. To begin with, learning should take place in social settings. Learners also need to be motivated to learn and need to be oriented in the learning task before performing the action to be learned. They need to be guided by a teacher, who asks guiding questions during the learning process. It is of importance that the learner performs the action to be learned him- or herself and describes, both verbally and quietly, what he or she is doing. During the performance of the action, the learner should manipulate material or materialised objects. The conclusions from the analysis are summarised in a number of guiding principles for CSCW system training that may provide a theoretical starting point for taking a closer look at learning problems pointed out within CSCW.

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1. Introduction

Today, there is a growing interest in Computer-Supported Cooperative Work (CSCW) (Olson & Olson, 2003). CSCW aims at facilitating cooperation and communication between people working in groups (Olson & Olson, 2003). Sometimes CSCW is seen as a subfield of Human-Computer Interaction (HCI) (see, e.g., Preece, Rogers, Sharp, Benyon, Holland & Carey, 1994), a cross-disciplinary field engaged in the study and practice of usable technology (Carroll, 2002). The field aims at understanding and creating technology, which is easy and effective to use. The users should also want to use the technology and feel satisfied with it (Carroll, 2002). If the term “human” in HCI can be replaced by “humans”, it is natural to regard CSCW as a part of HCI. However, some authors claim that CSCW today is a field in itself (see, e.g., Dix, Finlay, Abowd & Beale, 2004). Differences between the areas have also been pointed out, e.g., within HCI focus is on bringing psychology and computing together, whereas CSCW focuses on bringing sociology and computing together (Dix et al., 2004).

CSCW became a formal field of study in 1984 (Olson & Olson, 2003). Different authors have different views of what kind of systems should be regarded as CSCW technology (Grudin, 1994a). Therefore, there is no coherent definition of CSCW. There are not only differences between authors, but also between different parts of the world. In the United States focus is on small groups (less than, approximately, three or four participants), whereas CSCW in Europe has its focus on larger project groups (approximately six or more participants) (Grudin, 1994a). There are also different ways of categorising CSCW systems (Dix et al., 2004). The most common way is to use a matrix and categorise CSCW technology along two dimensions: time and geographical location (Grudin, 1994a). Hence, there are synchronous/ collocated systems (e.g., meeting support), synchronous/ remote systems (e.g., videoconferences), asynchronous/ collocated systems (e.g., argumentation tools), and asynchronous/ remote systems (e.g., email). Other ways of categorising CSCW technology are by their supporting function, and the degree of sharing of information (Dix et al., 2004).

There are many advantages with CSCW, e.g., communication, which would not be possible without CSCW can be made possible, and the use of CSCW can be economically beneficial (Olson & Olson, 2003). However, there are also unsolved problems within CSCW. One of the problems concerns learning (Blumenthal, 1995; Wulf, 1997).

> When introducing groupware into organizations it often happens that users have problems to understand the way certain functions operate. This is especially the case, if users are rather inexperienced in using networked technology… (Wulf, 1997, p. 14)

Because of the difficulties of learning and understanding CSCW systems, and their functions, CSCW systems are often incorrectly used and do not support communication and coordination between participants in the way they are intended to. It appears as only little research has been carried out concerning how to learn CSCW systems. Venkatesh (2000) let prospective users of a CSCW system play a game, before using the CSCW system, in order to increase the users' motivation. The result shows that the user became more motivated to use the system. However, the study focused on motivation, not on how to learn to use the system itself and its functions. Research concerning learning has been conducted for other kinds of systems, e.g., management information systems, but the research often does not seem to address how to learn the system, but rather to discuss related factors, e.g., instruction material (e.g., Olfman & Mandviwalla, 1994). The learning situation is also different between single user applications and CSCW systems, since learners affect each other during learning of CSCW systems.

Tannenbaum (1990) claimed that user training is a critical factor for user acceptance. According to Venkatesh (2000) until 1996 organisations spent as much as $20B each year on computer-related education. However, in 1982 only 10% of all education led to an altering in the behaviour of users (Georgenson, 1982), and the number still seems to be valid (cf. e.g., Venkatesh, 2000). Hence, more effective education is necessary (Facteau, Dobbins, Rusell, Ladd & Kudisch, 1995). This is especially true for learning of CSCW systems, because:

> …[i]n groupware it is much more difficult [than in single user applications] to explore the effects of the activation of a function, because they can not be fully perceived at the interface of the activator. (Wulf, 1997, p. 14)

Venkatesh (2000, p. 993) stated that "…more effective training methods are necessary and this is particularly true in a telework environment…". This is in line with Wulf (1997, p. 14), who claimed "Thus, we have to think of new ways to support users in exploring a groupware's functionality."

Consequently, there is a need for a theoretical approach within CSCW, which includes theories of learning. Today, there are a number of theoretical approaches used within CSCW (Halverson, 2002), e.g., distributed cognition (Hutchins, 1995), and ethnography (Kristoffersen & Ljungberg, 1999), but learning aspects seem to have been, at least to a great extent, neglected. In addition, unfortunately sometimes work in CSCW lacks theoretical grounding all together. Above all, this is evident from the number of articles concerning CSCW, which do not mention theoretical foundations at all. Not all of the theoretical approaches used include theories of learning, but one approach, which does, is activity theory. Most parts of activity theory are widely used within CSCW, but the theories of learning do not seem to have been applied to CSCW at all. Activity theory has been used for describing, and understanding an organisation as well as the work, and technology used in the organisation (Blackler, 1995), but also for other purposes. Barthelmess and Anderson (2002) focused on three levels of activity (coordinated, cooperative, and co-constructive), and identified strengths, and weaknesses in process-centred software development environments (PCSDEs) at each of these levels. Clases and Wehner (2002) developed models for an activity theory analysis of problems surrounding knowledge management software for cooperative environments. Collins, Shukla, and Redmiles (2002) carried out a case study of the development of requirements for evolving a knowledge management software system, which was supposed to be used within a customer support group within a large organisation. They used open ended interviews, and the activity system model was used to structure the interview data. Fjeld, Lauche, Bichsel, Voorhorst, Kreuger, and Rautergerg (2002) developed design guidelines based on iterative evaluation and improvement of an augmented reality hardware and software system. The guidelines are linked to the authors' interpretation of activity theory. Spasser (2002) made an activity theory analysis to reveal specific conflicts, and tensions between different communities of stakeholders in the process of developing a web-based project coordination and publishing environment. Miettinen and Hasu (2002) studied the activity of innovation and their result highlights tensions and conflicts arising from cultural historical differences in the communities. Korpela, Mursu, and Soriyan (2002) used an activity theoretical framework for software development to examine tensions among multiple communities of stakeholders. By means of a hypothetical example they illustrated how the activity theoretical framework can be used within software development projects. Despite the wide use of activity theory within CSCW, research concerning activity theoretical learning aspects does not appear to have been conducted. The theories of learning seem to have been overlooked. Blumenthal (1995, p.7) claimed that "…the effect of internalization (learning) on users have been examined in only a very limited fashion".

Activity theory has its roots in Vygotsky's cultural-historical theory (Grigorenko, 2000), which stated that the development of higher mental functions requires social interactions between individuals. It is in the social settings that individuals expand their capabilities and learn (Vygotsky, 1978). Knowledge first exists at an interpsychological plane before it become internalised and becomes intrapsychological (Haenen, 1996). Vygotsky introduced the concept of the *Zone of Proximal Development*, which is the distance between the level of knowledge that can be reached by an individual him- or herself and the level of knowledge reached by the individual under a teacher's guidance (Vygotsky, 1978). During assistance, or scaffolding from the teacher, the learner's level of development heightens (Shepardson, 1999). Vygotsky also emphasised the importance of tools (Grigorenko, 2000). There are both psychological, e.g., language, and technical tools, e.g., a thermometer. Through the use of tools individuals develop and expand, since they, by means of tools are able to look at phenomena from different perspectives (Vygotsky, 1978).

Leont'ev developed Vygotsky's cultural-historical theory further into the *activity theory* (Haenen, 1996). According to Leont'ev (1981), social interactions cannot be seen as the source of development, instead its source is human activity. All activities are cooperative. They are directed towards an object, which is transformed into a desired outcome during the activity (Kuutti, 1996). Activities are mediated by tools (Kaptelinin, 1995). An activity itself consists of actions, which in turn consist of operations (Hasan & Gould, 2001). Operations are unconsciously and fluently performed, whereas actions are consciously executed (Kuutti, 1996). During learning, as practice proceeds, actions become operations (Leont'ev, 1981).

Activity theory was further developed by Gal'perin (Haenen, 1996). Instead of focusing on activities, Gal'perin put emphasis on actions. He tried to understand how an action is transformed from an external to internal form, i.e., how an action is learned (Gal'perin, 1969). He concluded that this transformation is carried out in a stepwise manner (Gal'perin, 1989). He also identified four prerequisites of the formation of mental actions: *the learning motive* (the learner must be motivated to learn), *the orienting basis* (the learner must be oriented and gain an understanding of the action to be learned before performing the action), *the four parameters of an action* (the action must develop in a certain direction determined by some properties), and *the stepwise procedure* (a number of stages are gone through in the formation of a mental action) (Haenen, 1996). The first three prerequisites constitute the fourth. The stepwise procedure consists of six stages: the motivational stage, the orienting stage, the material or materialised stage, the stage of overt speech, the stage of covert speech, and, finally, the mental stage (Gal'perin, 1989). Hence, first the learner must be motivated to learn, then oriented in the task before performing the action. First the action should be performed by means of material or materialised objects, then by means of overt and covert speech respectively. Finally, the action has become a full-fledged mental action (Gal'perin, 1992b). Even though there is a prevailing use of theoretical approaches within CSCW, and an increasing use of activity theory, and its different strands, learning aspects do not seem to have been taken into consideration. Gal'perin's research program, which is founded on activity theory, and specifically focuses on learning, does not appear to have been applied at all within CSCW.

To sum up, CSCW aims at supporting cooperation and communication between people working in groups (Olson & Olson, 2003). However, CSCW tools often become a problem in organisations, since the users have difficulties understanding and learning them (Wulf, 1997). Users have problems understanding the actions performed in the system, and their consequences, since the consequences cannot always be perceived by the actor. In consequence, CSCW tools are wrongly used and do not support users as they are intended to do. Therefore, there is a need for more effective education (Grudin, 1994; Venkatesh, 2000; Wulf, 1997). There are several approaches of learning, among others activity theory. Activity theory is a theoretical framework, which has been pointed out as a possible foundation of CSCW (Blackler, 1995). Activity theory offers a framework, which analyses the role of the technology in an organisation, and the work from a collaboration, and cooperation perspective. Most parts of activity theory are already used within CSCW. However, while activity theory includes learning, it seems that the importance of supporting learning has been overlooked within CSCW, and hence, activity theoretical learning aspects have not been taken into consideration. Furthermore, Gal'perin's development of activity theory, especially focusing on learning, does not seem to have been applied within CSCW at all.

Hence, there is a demand for effective education within CSCW. Theoretical approaches of learning are required. Large parts of activity theory are already applied to CSCW. Therefore, the possibility of also applying the aspects of learning within activity theory to CSCW should also be investigated. Gal'perin's development of activity seems to be of special interest, since it focus on learning, and, in particular how to learn actions and their consequences.

Subsequently, the aim of the thesis is, first of all, ***to investigate the contribution that the cultural-historical theory, activity theory, and Gal’perin’s work in particular, can make to support learning within CSCW.*** A second aim is ***to develop guiding principles of learning applicable in the area of CSCW*** based on the analysis of the different theoretical approaches.

In order to achieve the aims, the area of CSCW, especially learning problems, will be analysed, as well as theories of learning within the cultural-historical school, in particular Gal'perin's research program. The applicability of Vygotsky's, and Leont'ev's cultural-historical theories in general, and Gal'perin's research program in particular will be evaluated.

The purpose of this thesis is to take a first step towards a closer look at learning, and learning problems within CSCW. Very few sources are available on this subject and it appears as almost no research has been conducted concerning learning within CSCW. Based on the very few sources, which mention learning problems, it does not seem that the problems of learning and understanding only concern one kind of system, or a certain type of functions. Therefore, this thesis focuses on learning in general, as a starting point for further investigations concerning learning. The cultural-historical learning theories will be introduced in CSCW, and general guiding principles for learning actions in a system, and their functions, will be specified

Since, in particular users, who do not have any experience of CSCW, have problems learning to use CSCW systems, and since almost no research appears to have been conducted concerning learning, focus in this thesis is on first-time users. Other kinds of learners may have different needs. Therefore, research concerning other kinds of learners is also needed. However, this thesis is limited to only include the perspective of novices.

The thesis is structured as follows: In Chapter 2 an overview of the area of CSCW is presented. The chapter gives an overview of the field and presents the problems concerning learning. Chapter 3 includes a presentation of the need for, and choices of, theoretical frameworks. In the following three chapters, Chapters 4-6, Vygotsky's cultural-historical theory, Leont'ev's activity theory and Gal'perin's research program are described. Subsections include major properties of each theory, as well as some critique of them. Chapter 7 includes a summary of the previous chapters. In Chapter 8 the application of the learning theories on CSCW is presented. The chapter also describes the guiding principles for learning of CSCW systems that have been identified. Finally, conclusions and a discussion are presented in Chapter 9.

2. Groupware and Computer-Supported Cooperative Work

More and more organisations take an interest in groupware and Computer-Supported Cooperative Work (CSCW) (Olson & Olson, 2003). CSCW aims at facilitating and supporting the cooperation between people in groups. However there are also problems with CSCW. Groupware is software designed to be included in a network, which aims at supporting group activities of organisations (Olson & Olson, 2003). The technology can be used for communication, cooperation, coordination and problem solving. The term groupware is usually used to denote technology, which is founded on modern computer networks (Olson & Olson, 2003).

Hence, CSCW includes both aspects concerning humans and technology. In this thesis, technical aspects, e.g., use of platforms, will be left out, since they usually do not have a direct affect on learning. This chapter begins with a description of the history of CSCW (Section 2.1). In Section 2.2 definitions of CSCW and groupware are presented. Research and development contexts are explained in Section 2.3. Different ways of categorising CSCW-systems and examples of systems are described in Section 2.4. In Section 2.5 advantages and issues with CSCW are presented. The chapter concludes with a summary (Section 2.6).

2.1. History

In 1984 CSCW became a formal field of study (Olson & Olson, 2003). Paul Cashman and Irene Greif arranged a workshop with people from diverse disciplines (Grudin, 1994a). The participants had in common an interest for how people cooperate and how technology can support the cooperation. The term “Computer-Supported Cooperative Work” (CSCW) was coined. The first conference took place in the United States in 1984. However, the interest for CSCW was also great in Europe and Asia (Grudin, 1994a).

Other areas and disciplines paved the way for CSCW. In the end of World War II Vannever Bush presented an idea of something similar to today’s World Wide Web

(Bush, 1945, in Olson & Olson, 2003). In the mid 1960s, tasks, such as, printing payroll checks, were rendered into requirements which ended in successful mainframe systems (Grudin, 1994a). In the mid 1970s, the approach “Office Automation” was grounded. It aimed at supporting groups by means of minicomputers. The area of Office Automation strived to extend successful single user applications, e.g., word processors and spreadsheets, to support cooperation. It included many groupware elements. As examples email and document sharing can be mentioned (Ellis & Nutt, 1980). However, the area faced difficulties understanding system requirements, and consequently, ran out of steam (Grudin, 1994a).

An understanding of how people work together in groups and how they are affected by technology was required. Some engineers pointed out the importance for such knowledge (Grudin, 1994a). Douglas Engelbart, for instance, presented ideas about key groupware components, e.g., support for real time, face-to-face meetings, and audio and video conferencing (Engelbart & English, 1968, in Olson & Olson, 2003). Some members of the field of Management Information System also emphasised knowledge about cooperation (Grudin, 1994a). However, designers and developers engaged in early efforts to develop group support systems did not care about this knowledge. CSCW started as a way to bridge the gap between knowledge about technical aspects and knowledge possessed by, e.g., economists, social psychologists, anthropologists, organisational theorists, and educators (Grudin, 1994a). The World Wide Web have been of importance for the development of the field of CSCW (Schatz & Hardin, 1994). (For a more inclusive summary of early historical trends, see Greif, 1988).

2.2. Definitions of CSCW and groupware

Different authors have differing views on what should be included in the notions of groupware and CSCW (for a discussion, see Grudin, 1994a). Therefore, no coherent definitions of these terms exist. Different authors construct their own definitions. Many definitions are general and vague. In this thesis the definitions of groupware and CSCW created by Olson and Olson (2003) will be used. In this thesis it is not essential to clarify what specific systems are denoted as CSCW, rather it is more important to have an easily comprehensible definition. Olson and Olson (2003, p. 584) define groupware as “software designed to run over a network in support of the activities of a group or organisation” and describes CSCW as “[t]he broad study of the development and use of groupware”. However, maybe a network is not a necessary feature. There may be computer supported cooperative work, which is not founded on network, such as people discussing a design solution, by means of a computer, and a projector showing the viewing screen of the computer on projection screen . Within CSCW focus is on computer-supported cooperative work, but also on areas such as competences and social behaviour. Knowledge about network technology and how technical aspects affect user experiences is also required (Olson & Olson, 2003). In this thesis, purely technical aspects will not be considered, since they usually do not directly affect learning. The affect of technical aspect on user experiences, on the other hand, will, in part, be included.

The term Computer-Supported Cooperative Work has been criticised for being too long. Some authors use the term Computer-Supported Collaboration instead. The term CSCW has also been criticised for including “collaborative work”, which, according to the critics is a goal, rather than a reality. The term Workgroup computing has also been suggested. However, it changes the focus from group work to the technology and “restricts it to small organizational units” (Grudin, 1994a, p. 2). The same is valid for the term groupware, which was used by Peter and Trudy Johnson-Lenz and adopted by the CSCW community. Today, conferences in both groupware and CSCW are organised. Conferences in groupware have a more technological focus, whereas conferences in CSCW concerns, for instance, the nature of workplaces and organisations (Grudin, 1994a).

2.3. Research and development contexts

The development of computer systems has different foci in different areas, as illustrated in Figure 1. Every ring represents one focus and the principal “customer” or “user” of the resulting technology.

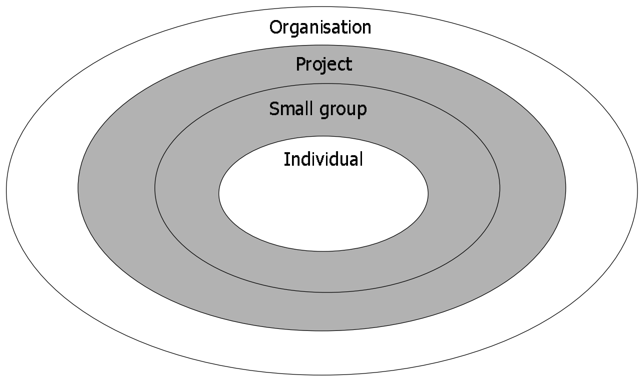

Figure 1: Different foci of computer system development (modified from Grudin, 1994a).

Until recently, almost all attention has been given to the outer and inner rings (Grudin, 1994a). The outer ring represents systems which aim at supporting organisations, e.g., mainframe and minicomputer systems. Tasks such as transaction processing and order control are supported by the systems (Grudin, 1994a). The inner ring represents applications which are supposed to be used by individual users. Typical applications are, e.g., spreadsheets and word processors. The two rings in between concern large projects and small groups. These areas have become a major concern for CSCW (Grudin, 1994a). The products developed in these areas are groupware. Groupware, such as meeting rooms and workflow automation systems, are common within the area of large projects. This type of groupware is only useful for six or more participants. In small groups, desktop conferencing and collaborative writing applications are often useful. To be efficient, these types of groupware require less than three or four participants (Grudin, 1994a).

However, Figure 1 is a simplification and only represents central tendencies. CSCW is a complicated area, which is hard to define. Individuals, groups, projects and organisations are interrelated and intertwined (Grudin, 1994a). Therefore, CSCW cannot be restricted to one or two rings.

The different groups represented in Figure 1 use the same terms in different ways, e.g., the terms “user” and “implication” have different meanings in the inner and outer rings. The different groups also have different foci. In the area of small groups attention is often paid to communication, whereas focus in the area of organisational systems often is coordination (Grudin, 1994a). Because of these different foci, participants may have different needs during learning of CSCW systems. It has been suggested that problems in CSCW are due to conflicts between technical and social aspects (e.g. Ackerman, 2000). However, according to Grudin (1994a), the real source of conflicts is between the different groups represented in Figure 1.

The perspectives on CSCW in the United States and Europe differ (Grudin, 1994a). In the United States, CSCW gatherings have focused primarily on small groups, whereas focus in Europe has been on the project level (cf. Figure 1). In this thesis, both project groups and small groups will be included in the term CSCW. Asian research and development in CSCW is also becoming more salient (Grudin, 1994a). According to Grudin (1994a) another difference between the United States and Europe is that research and development are more intertwined in the United States than in Europe, where more research is government sponsored.

2.4. Categories

CSCW applications can be categorised in several ways. In this section three ways are described: time/geographical location matrix, supporting function, and sharing. Examples of CSCW-systems illustrating the different types of categories are also presented.

2.4.1. Matrix

A common way of categorising is by using a matrix (originally created by DeSanctis & Gallupe, 1987 in Grudin, 1994b; Dix, Finlay, Abowd & Beale, 2004; Olson & Olson, 2003). CSCW applications then are categorised along two main dimensions (Table 1) (Scrivener & Clark, 1994). The first dimension is time, i.e., whether the users of CSCW technology work together at the same time or at different times. The second dimension is geographic location, which elucidates whether the users are at the same or different places. The axes have been given different names by different authors (e.g., Dix et al., 2004; Grudin, 1994b; Viller, 1991). The signification, however, is the same. Since the settings and ways of communication differ significantly between the four cells in the matrix, it can be assumed that the needs in learning differ between the cells.

Table 1: Time/geographic location matrix

Time / **Geographical Location**	Synchronous	Asynchronous
Collocated	Electronic brainstorming	Shared documents
Remote	Videoconferences, chat	Email, work flow

Groupware has been designed for all of the cells in the matrix. In Table 1 examples of CSCW applications illustrating the cells are presented. Many of the first systems, e.g., email and videoconferences, aimed at overcoming the problems of distance (Dix et al., 2004). More recently, systems for supporting face-to-face meetings and other collocated cooperation have been designed. Examples of different CSCW systems are described below. The examples are structured in accordance with the time/geographic location matrix, in the following order: “synchronous/collocated”, “synchronous/remote”, “asynchronous/collocated” and “asynchronous/remote”. The summary of applications does not aim to be exhaustive, but rather seeks to illustrate the variety of kinds of tools that have emerged to support human collaborative activities over networked systems.

Synchronous/collocated; There are different types of tools for supporting the meeting process and the objects that are used during a meeting (Olson & Olson, 2003). Some tools give emphasis to structuring the meeting process and include support for brainstorming and voting. *Group Decision Support Systems* (GDSSs) support decisions that should be made jointly by a number of individuals. GDSSs can help and facilitate decision making by, e.g., guiding the decision makers through a series of steps, such as brainstorming and evaluation of proposals. Evaluation of GDSSs shows that the proposals suggested and the decisions made are of higher quality than proposals and decisions without support. Despite this, evaluations also show that the decision makers feel unsatisfied with the meetings. The meetings also take longer time (Olson & Olson, 2003). However, there are also evaluations showing the opposite (Kraemer & King, 1988). Participants can feel that the meeting is going well, but the decisions made are poorer than the decisions that would be made by the participants individually (Kraemer & King, 1988). Another type of meeting support is less structured. The applications support groups by giving access for working on the same document or drawing. The systems allow the participants to make changes simultaneously or in parallel (Olson & Olson, 2003) (further discussed in section 2.4.3). A third type of meeting support is electronic white boards (Olson & Olson, 2003). They allow input from pens, just as usual white boards. Electronic white boards are powerful, since all participants can see the changes being made. However, to be efficiently used, a person with experience of the tool has to be present at the meeting (Olson & Olson, 2003).

Synchronous/remote; Real time meetings between remote individuals are hard to support (Olson & Olson, 2003). The most commonly used technology for supporting remote meetings are *video conferences*. Even if good technology for supporting sound and video over internet protocols exists, it is time consuming and difficult to establish such connections. There are a number of factors affecting the success of videoconferences. The quality of sound is one factor. Video is another. Video can give clues about who is talking, whose turn it is next (Veinott, Olson, Olson & Fu, 1999), and provide information about gestures and facial expressions (Pendergast & Hayne, 1999). However, there are also problems with videos. A disadvantage is that videoconferences often lack the natural dialogue, which is conducted during a face-to-face communication or phone call (Olson & Olson, 2003). Gestures and facial expressions can also be difficult to perceive during videoconferences. Eye contact is also an important social clue during communication, which is hard to capture in videoconferences (Olson & Olson, 2003). The sharing of objects is another factor of importance for the success of videoconferences (Olson & Olson, 2003). The participants may need to see, e.g., the same agenda or to-do-list. Traditional videoconferencing technology provides object sharing through an object camera. There are also technologies, which provide digital information to be shared through shared screens. However, the participants tend to be unsatisfied with the process and outcome when using shared objects in videoconferences (Olson & Olson, 2003). *Chat systems* can be seen as instant email (Olson & Olson, 2003). Participants can write messages to each other and when the message is sent, it will immediately be viewed on the screen of the receiver. Previous comments will be saved, so that the participants can keep track of the main thread. An outgrowth of chat systems is “instant messaging”. ICQ, Microsoft’s Messaging System, and Jabbar are examples of such systems. By means of instant messaging, participants can see which of his or her co-workers or friends also are online (Olson & Olson, 2003).

Asynchronous/collocated; One example of asynchronous/collocated systems is *argumentations tools*, which can be beneficial for decision makers (Dix et al., 2004). Different decision makers record their decisions and arguments for making the decision in the system, so that future decision makers can modify or learn from the decisions. Usually, decision makers use the tool one at a time. There are argumentation tools, which support remote collaboration, but argumentation tools are typically used by groups within the same office (Dix et al., 2004).

Asynchronous/remote; *Email* is the most commonly used CSCW application (Olson & Olson, 2003). Even a relatively simple email system includes a number of functions besides the basic functions, e.g., the possibility to forward email, creating email groups, and to attach files. Research shows that the use of email changes the social pattern in a group. For instance, alterations take place concerning who are talking to whom and the tone and interpretation of what is being said (Sproull & Kiesler, 1991). Thanks to the widespread use of email, it is easy to send a message to several persons. However, some individuals get more than hundred emails a day and can be subjected to an information overload (Olson & Olson, 2003). *Workflow systems* are systems, which support "coordinated asynchronous (usually sequential) steps of activities among team members working on a particular task" (Olson & Olson, 2003, p. 589). For instance, a workflow system can pass a travel reimbursement voucher round, from the traveller to the bank, via the approving party and the accounts payable. It is not only the workflow that is supported. Usually, a register of who did what, and when, is also kept (Olson & Olson, 2003). A *group calendar* is an online calendar, in which a group member can see his or her own and other group members' schedules. Group calendars can be beneficial, e.g., when a group member needs to know when another group member will return from a meeting (Olson & Olson, 2003).

The time/geographical location matrix has been widely used, is easy to understand and facilitates communication (Grudin, 1994a). However, it gives a simplified view of CSCW systems. Recently, groupware supporting several cells has been created and a transition between the cells has emerged (Dix et al., 2004). These systems do not fall into one or another of the categories in the matrix. For some systems, e.g., email systems, it does not matter if the users work at the same time or not, which also complicates the classification. However, it has been suggested that systems with a single shared database is considered to be synchronous, i.e., "people working together … know they are working together" (Dix et al., 2004, p. 692). Extended versions of the matrix to overcome some of the problems have been created (see e.g., Grudin, 1994a; Dix et al., 2004). Problems with systems, which support just one cell, have also been noted. Most work includes both communication and coordination. Applications, which support one cell, but neglect another tend to be useful for a narrow task, but not for the overall activity, of which the task is a subpart. Therefore "any time, any place" support has been called for.

2.4.2. Supporting function

Implicit in the term CSCW is that there are two or more participants who are working together. They also interact with different tools. Some of them are physically shared, some of them are not. Common for all of the tools is that they are shared "in the sense that they contribute to the cooperative purpose" (Dix et al., 2004, p. 666). One of the aims of communication is to establish a common understanding of the task the participants are working on. Figure 2 illustrates different relations between participants and tools during cooperation.

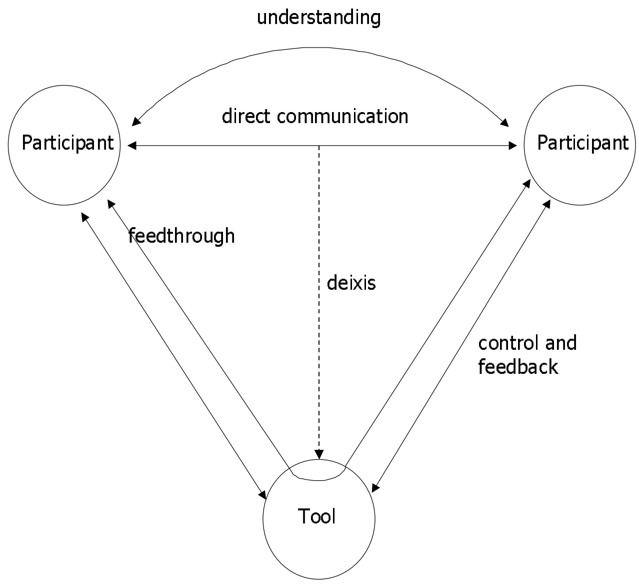

Figure 2: Framework of cooperative work (modified from Dix et al., 2004).

One of the relations between participants is *direct communication.* Direct communication can help participants to establish a *common understanding*. Participants can *control and get feedback* from the tool used. The participants can also see and understand what the other participant(s) are doing through the tool (*feedthrough*). Users can also communicate about tools (usually about the artefacts used as a part of the task) (*deixis*). These relations between participants and tools can be supported by CSCW technology.

The previous section described how CSCW applications can be categorised according to a time/geographical location matrix. CSCW applications can also be categorised by their supporting functions. Dix et al. (2004, p. 667) distinguish three supporting functions of CSCW systems:

> **computer-mediated communication** supporting the direct communication between participants [see the arrows with the text *direct communication*, and *deixis* in Figure 2];
>
> **meeting and decision support systems** capturing common understanding [see the arrow with the text *understanding* in Figure 2];
>
> **shared applications and artifacts** supporting the participants' interaction with shared work objects – the *artifacts of work* [see the arrows with the texts *control and feedback*, and *feedthrough* in Figure 2].

CSCW systems, which support direct communication between participants (the arrows *direct communication* and *deixis* in Figure 2*)* are labelled *computer-mediated communication* (CMC) (Dix et al., 2004). It is an important part of CSCW, since good communication can facilitate and improve cooperation. There are a number of CSCW applications for supporting direct communication, e.g., email, bulletin boards, instant messaging systems and video based systems (Dix et al., 2004).

To be able to work together and communicate in a good and efficient way, the participants must have a common understanding of the task they are to perform and generate ideas (Dix et al., 2004). Participants need a *meeting and decision support system.* In some working activities a common understanding of the task and generation of ideas are not the purpose itself, but a subordinated activity. However, in other activities, generating ideas and understanding is the primary activity, e.g., in design tasks and in research environments. Dix et al., (2004, p. 679) discuss three types of systems, which support the generation and recording of ideas (the arrow *understanding* in Figure 2):

> **Argumentation tools** which record the arguments used to arrive at a decision and support principally *asynchronous co-located* design teams.

> **Meeting rooms** which support face-to-face groups (*synchronous co-located*) in brainstorming and management meetings.
>
> **Sharing drawing surfaces** which can be used for *synchronous remote* design meetings.

There are also CSCW applications which support *the sharing of the working domain* itself (the arrow *feedback and control*, and *feedthrough* in Figure 2) (Dix et al., 2004). Participants can share computers, applications on the computers, and the documents they work with. CSCW applications such as shared PCs, shared windows systems, shared editors, and co-authoring systems belong to this category. The needs during learning may differ between the different categories, since they support different activities.

2.4.3. Shared information

A third way of classifying CSCW systems is by the degree of sharing of information. CSCW systems differ as to the degree of sharing they allow. Determining factors for sharing are the size of an object chunk and the frequency of update (Dix et al., 2004). Regarding the size of an object chunk, some systems allow participants to edit the same sentence or word at the same time, whereas other systems have locks, which imply that only one participant can use the system at the time. Systems also differ concerning frequency of update. Some systems show participants' updates immediately, whereas others show the updates when the participant has finished the editing chunk. Frequent updates are most common (Dix et al., 2004).

The degree of sharing can be assumed not to affect learning needs. The degree of sharing of a system implies a certain frequency of updates and a certain size of an object chunk. However, the functions to be learned depend on the type of system. Therefore, learning needs seem to depend on the kind of CSCW system and its functions, rather than the degree of sharing.

2.5. Advantages and issues

There are a number of advantages with CSCW technology. CSCW technology facilitates communication and can make it faster and clearer (Olson & Olson, 2003).

By means of CSCW technology communication can take place, which would not otherwise be possible (Dix et al., 2004). Problem solving in groups can be facilitated. In addition, CSCW technology make new ways of communicating possible, e.g., anonymous brainstorming (Olson & Olson, 2003). CSCW can also be economically advantageous (Kraemer & King, 1988).

Despite these advantages, a number of unsolved problems still need further consideration. Grudin (1988; 1994b) pointed out a number of issues. Grudin (1994b) stated that there is a disparity in work and benefit. CSCW systems can require more work from the participants. The individuals, who put in a great deal of work, are not always those who gain benefit from the system. Another problem is what Grudin (1994b, p. 5) called “critical mass and prisoner’s dilemma problems”. For a CSCW system to be useful, the number of participants has to exceed a certain number. CSCW applications can also fail because no one benefits from them. Grudin also discussed the problem of disruption of social processes. Social, political, and motivational factors can be violated or threatened by the activity related to the use of groupware. Exception handling and improvisation are distinctive traits of much cooperative work. However, these traits are not always supported by CSCW applications. Problems concerning infrequent use also exist. All features of groupware are not frequently used, but they must still be accessible to the participants. However, in reality, this is not always true. Infrequently used features must be integrated with more frequently used features. Grudin also mentioned that the difficulty of evaluating groupware is often underestimated. The results from evaluations are also hard to generalise, which entails impediments of learning from experience.

Ackerman (2000) emphasised the importance of incentives for the use CSCW. He pointed out that users must be motivated to use CSCW systems, otherwise the systems will be unaccepted and idled. According to Ackerman, even small costs in collaborating must be compensated for. The issue of motivation needs further investigation. Grudin (1994b) also pointed out issues concerning the acceptance of groupware. A number of strategies for reaching system acceptance have been addressed, e.g., customer support and documentation development. However, these strategies can fail, due to a poor introduction of the system. According to Grudin, groupware has to be introduced very carefully. One aspect of groupware introduction is learning. It is important that the users learn the system properly (Grudin, 1994b). When introducing CSCW technology in organisations it is common that users have difficulties understanding the functions of the system and their meanings (Wulf, 1997). Consequently the CSCW tools are incorrectly used and do not provide the support they are intended to. Learning problems are especially common among users without network technology experience. Blumenthal (1995), Facteau, Dobbins, Rusell, Ladd & Kuddish (1995 in Venkatesh, 2000), Venkatesh (2000), and Wulf (1997) claimed that there is a need for investigating how users can be supported during learning CSCW systems. The learning aspect seems to have been, at least to a great extent, overlooked.

According to Olson & Olson (2003), *trust* is a factor of importance in the use of CSCW applications. Studies have shown that co-workers trust their collocated fellow workers more than their remote colleagues. However, if a remote team has a face-to-face meeting before the remote collaboration, they will trust each other more. Technical factors can also affect trust. For instance, delays and choppiness in video over internet can produce cues, which can be associated with lying (Olson & Olson, 2003). These aspects need further investigations. It can be assumed that trust is also important for learning CSCW systems, since learning to use systems, which support remote collaboration, includes communication with other participants via the system.

Another important factor within CSCW is *awareness*. In real life, people have a feeling for what other people do and have done (Dix et al., 2004). For instance, persons working at the same office can when they are walking along a corridor, see which co-workers are in, and who are out (Olson & Olson, 2003). Remote co-workers can not gain this kind of awareness. Different kinds of technical solutions have been presented, e.g., systems, which give the user the possibility to see the colleagues five seconds each on the screen by means of cameras and systems, which take on-the-spot accounts of the co-workers. The systems have differed in success depending on the consequences concerning privacy (Olson & Olson, 2003). This is an issue that requires further consideration. Since awareness is an important factor for collaboration and communication it can be assumed to be an important factor for learning as well.

2.6. Summary of CSCW

It has been stated that CSCW systems, which aim at supporting group activities, will become widespread and familiar (Olson & Olson, 2003). CSCW became a formal field of study in the 1980s and the interest for CSCW has increased ever since. There are a number of different CSCW systems, which give users support in different ways. Often, systems are categorised according to a time/geographical location matrix, but there are also other ways of categorising CSCW technology, e.g., by their supporting function, or the degree of sharing they allow. There are a lot of advantages with CSCW, e.g., the use of CSCW can be economically beneficial and it can make communication faster, and clearer. However, there are also problems with CSCW applications, e.g., there is a disparity in benefit and work, there are difficulties of evaluating CSCW systems, and there is a need for knowledge about how to motivate users of CSCW technology. Another problem, which is of special interest in this thesis, is that users often have difficulties learning the systems. The aspect of learning seems to have been largely overlooked within CSCW.

3. The need of theoretical frameworks for CSCW

There is no complete approach ready for use to support the social problems and questions of behaviour which arise with CSCW (Blackler, 1995). There are big differences between face-to-face communication and computer-aided communication, in which individuals are separated concerning time and place. To be able to support such communication the area of CSCW needs to rely on empirical studies and a theoretical framework is required, which can be the foundation for CSCW (Blackler, 1995). A number of theoretical constructs are used within CSCW (Halverson, 2002). The approaches used comprise conceptual frameworks, theories and descriptive methods. Besides, a number of hybrid forms exist. Approaches, such as activity theory (e.g., Engeström, 1987; Kuutti, 1996; Nardi, 1996), distributed cognition (e.g., Hutchins, 1995), ethnomethodology (Kristoffersen & Ljungberg, 1999; O'Neill & Martin, 2003), situated action (Suchman, 1987), and conversation analysis (Bowers, Pycock & O'Brien, 1996; Walker, 1997) are commonly used within CSCW. Usually, the approaches are used for describing or studying CSCW settings and the system in use in these settings. Few of the approaches usually used within CSCW include means to support a design process. Therefore, CSCW often makes use of other methods to support design issues, e.g., participatory design, and user centred design (Halverson, 2002).

The approaches used are not created with a view of supporting CSCW (Halverson, 2002). Activity theory and distributed cognition, for instance, are first and foremost theories about cognition. Introducing approaches from other fields within CSCW may pose a risk. Theoretical objects can be brought into focus, which are not appropriate for CSCW.

Leont'ev's activity theory, which has its roots in Vygotsky's work, is one of many theories used within CSCW. The interest for activity theory within CSCW increased during the 1990s (e.g., Bødker, 1991; Engeström, 1987; Nardi, 1996; Raeithel & Velichkovsky, 1995). Activity theory can offer a framework that analyses the role of technology in an organisation and the work, from a perspective of cooperation. It is well suited for supporting CSCW since it gives an understanding of social processes, which includes the relation between technology and social interaction, group dynamics and organisational problems (Blackler, 1995). Activity theory has become widely used within CSCW. Activity theory also includes theories of learning. However, the theories of learning do not seem to have been applied to CSCW, even though, generally speaking, almost all other aspect of activity theory are used within CSCW. Because of the problems of learning within CSCW, there is a need for learning theories. Subsequently, it seems proper to apply also the activity theoretical aspects of learning to CSCW to investigate how they can support learning.

Gal'perin developed activity theory further into a research program with a learning focus. Activity theory, and Gal'perin's less widespread research program in particular, may be useful for the support of learning within CSCW. In order to understand Gal'perin's research program we will take a look at its origins and development. Subsequently, the next two chapters describe Vygotsky's cultural-historical theory, and Leont'ev's activity theory. The following chapter (Chapter 6) describes Gal'perin's systematic formation of concepts, and thoughts. The descriptions of the theories are not exhaustive, but rather descriptions with a bias towards learning. In Chapter 7 a summary of CSCW, and the learning theories are presented. The learning theories are then applied to CSCW (Chapter 8) in order to see how they can contribute to the issue of learning problems within CSCW. Within the chapters about the learning theories examples related to CSCW will be given. For the sake of simplicity, these examples concern less complicated tasks, such as sending an email.

4. The cultural-historical theory

Some of the basic ideas within Leont'ev's activity theory and Gal'perin's systematic formation of concepts and thoughts have their origin in Vygotsky's cultural-historical theory. In the 1920s Leont'ev worked together with Vygotsky. However, he disagreed with Vygotsky about some issues and in 1930 Leont'ev and Vygotsky split up. Leont'ev became the head of Khar'kov school and created activity theory. Activity theory was also further developed by Gal'perin, who was also a member of the Khar'kov school. Gal'perin and Leont'ev were on variance about some questions. Gal'perin left Leont'ev and developed the research program systematic formation of concepts and thoughts, which has a learning focus. Gal'perin was not only influenced by Leont'ev, but also by Vygotsky. The relations between Vygotsky, Leont'ev, and Gal'perin are illustrated in Figure 3.

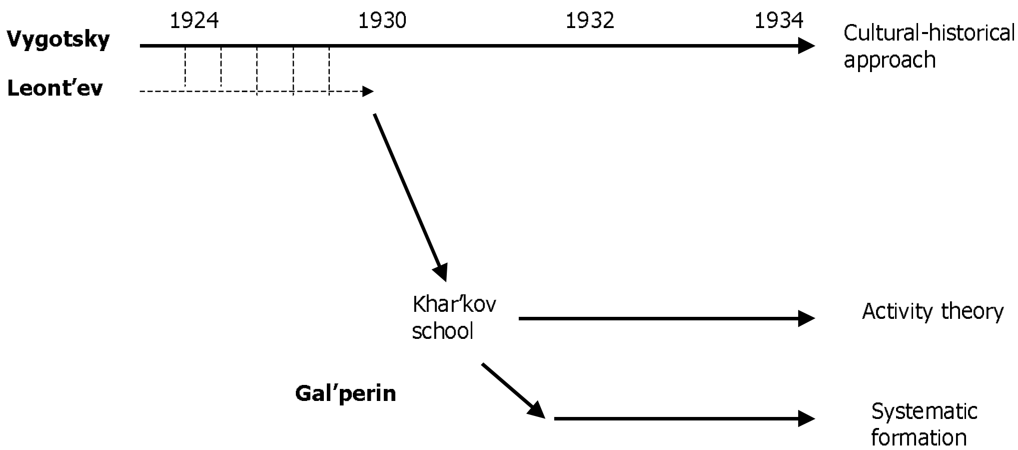

Figure 3: The relation between Vygotsky, Leont'ev and Gal'perin (modified from Haenen, 1996).

Consequently, to be able to gain an understanding of activity theory and the systematic formation of concepts and thoughts, an understanding of the cultural-historical theory is required. In this chapter, a brief summary of Vygotsky's theories from a learning perspective will therefore be given.

Vygotsky, unlike Leont'ev and Gal'perin, put a great emphasis on signs, symbols and speech. Despite the fact that Leont'ev and Gal'perin did not agree with Vygotsky about the importance of speech and signs, the summary of Vygotsky's learning theories in this chapter has a speech focus, since the summary would be deceptive if the speech perspective was left out.

As already mentioned, all aspects of the cultural-historical theory cannot be explained in this thesis. According to Moll (1990) the key elements of cultural-historical theory are:

> … (1) social activity and cultural practice as a source of thinking; (2) mediation in human psychological functioning; (3) that pedagogy is central to development; and (4) the inseparability of the individual from the social. (Shepardson, 1999, p. 622)

In this thesis the focus is on learning. Shepardson (1999) describes Vygotsky's theory of learning through four aspects: the social interactional nature of learning, interplay between psychological and technical tools, verbal interactions as mediated activity, and everyday and scientific concepts (cf. the concepts Grigorenko (2000) considered the most central in Vygotsky's theory of learning).

Section 4.1 includes a description of the background of the cultural-historical theory. In Section 4.2 the distinction between higher and lower mental functions is explained. The four aspects of learning (distinguished by Shepardson) are described in Sections 4.3-4.6. In Section 4.7 critique of the theory is presented. The chapter is concluded with a summary (Section 4.8).

4.1. Background

> After the 1917 Revolution, Soviet psychology had to face the task of reconstructing psychology on the basis of dialectic materialism. This was a scientific challenge, because the works of Marx, Engels and Lenin do not contain straightforward guidelines for solving the problems of a Marxist psychology. (Haenen, 1996, p. 69)

Vygotsky translated the Marxist-Leninist concept of man into a psychological theory: the cultural-historical theory (Rosa & Montero, 1990). The term psychic activity thereby got a totally new meaning. The cultural-historical and instrumental aspects are of special importance for the new meaning.

The cultural-historical aspect is the foundation of Vygotsky's approach (Haenen, 1996). It is intimately connected with the social life of a man. To be able to understand the human mind, the cultural-historical processes of human social life must be taken into account (Wertsch, 1990). The human mind can not be understood in isolation. Instead the mind should be seen as the outcome of the cultural-historical experience, which is a part of the society (Haenen, 1996).

The instrumental aspect is also of great importance in Vygotsky's theory (Haenen, 1996). The concept has its origin in the assumption that human mind is determined by the social life. The human mind is mediated by psychological tools and signs, symbols and language. These tools are instruments which make it possible to reach higher mental functions, such as reasoning and memorising. This view of psychology implied a new angle of approach of the human mind (Haenen, 1996).

There are strong interrelations between the cultural-historical aspect and the instrumental aspect (Haenen, 1996). To be fully understood the concepts must be studied together. The two concepts are different in the way that "cultural-historical" concerns social interaction whereas "instrumental" has to do with psychological activity. The concept of internalisation (further discussed in section 4.3.1) can be seen as a link between the cultural-historical and instrumental aspects (Haenen, 1996). It is through internalisation that humans reach higher mental functions or behaviour.

4.2. Lower and higher psychological functions

During the 1920s and 1930s it was common to categorise behaviour into higher and lower forms (Haenen, 1996). Lower forms of behaviour can be shown both by man and animal. The lower forms are constituted by elementary sensori-motor functions. Lower psychological functions can be explained in terms of stimulus – response (Haenen, 1996). The difference between higher and lower mental functions can be explained through the difference in the structure of the stimuli-response relation of each of them (Vygotsky, 1978).

By means of extrinsic stimuli human can ”control their behavior from the outside” (Vygotsky, 1978, p. 40) and thereby reach higher mental functions, e.g. language and memory (Días, Neal & Amaya-Williams, 1990). Hence, higher mental functions are mediated by some mediators. Tools and human speech are the most important cultural mediators (further discussed in section 4.4). The mediation is illustrated in Figure 4. Higher mental functions are not just extensions of the natural (biological) ones (Grigorenko, 2000), but qualitatively new formations originating on the basis of biological functions as a result of the child’s development in an acculturated environment.

> [H]igher form[s] of intellectual activity, is not a quantitative overgrowth of the lower associative activity, but a qualitatively new type. Unlike the lower forms, which are characterized by the *immediacy of intellectual processes, this new activity is mediated by signs.* (Vygotsky, 1934/1986, p. 109)

According to Wertsch (1985) mediation is Vygotsky’s most important contribution. When learning to use CSCW systems, learners are mediated by tools, such as the systems and speech. First, speech is used between the teacher and the learners, mediating the learning activity. After learning has taken place, speech (or language) is used as a communicating means between participants of the CSCW system, mediating the activity of, for instance discussing a design solution. Higher mental functions, e.g., reasoning and memory, are required during the learning process and use of CSCW systems.

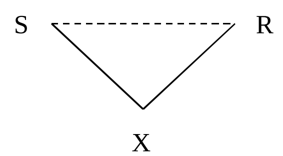

Figure 4: A mediated act (redrawn from Vygotsky, 1978)

Higher psychological functions can only be comprehended through the study of their genesis, i.e., their development (Haenen, 1996). All phases in their lifecycle must be taken into account. Knowledge about the historical factors of the functions is a prerequisite to understanding the functions (Haenen, 1996).

Leont'ev and Luria worked together with Vygotsky. The three of them were called the 'troika' of Soviet psychology (Haenen, 1996). At the request of Vygotsky, Leont'ev and Luria investigated, among other things, psychological tools mediating higher psychological functions and the assimilation of the tools during ontogenesis. Leont'ev conducted researches concerning the area of memory, using "functional method of double stimulation", developed by Vygotsky and Luria. In the study nursery school children, pupils in the fifth and sixth grade (ten to twelve years old) and adults participated. There were two types of stimuli. The subject would remember nonsense syllables and meaningful words. In the first experiment words were read out to the subjects, which they would remember. In the second experiment the subjects had pictures in front of them and were assigned the task of choosing one picture when hearing a word. The picture reflecting the word uttered should be chosen, since the purpose of the picture was to help the subject remember the word. The result showed that nursery school children were not helped by the auxiliary pictures. The pupils of the fifth and sixth grade remembered twice as many words by means of the pictures. The performance of the adults was not affected by the pictures (Haenen, 1996).

The differences between the groups depend on differences in the development of psychological functions (Haenen, 1996). The young children's memory is still a function of biological origin, tied to the process of growth and maturation. The memory is a "natural, unmediated, lower psychological function" (Haenen, 1996, p 74). School children can take advantage of the use of pictures. By means of the use of picture there is a transition from memory as a lower to higher psychological function. Memory is at this stage still externally mediated. It now has a cultural-historical origin, but makes use of external means. In adults memory is full-fledged. External means have been internalised. Instead of being externally mediated, memory is internally mediated (Haenen, 1996).

The study has been widely criticised, e.g., for overlooking operations of short duration, and for revealing only the macrostructure of the cognitive processes (see, e.g., Zinchenko & Gordon, 1981). Despite this, the study was of importance. Leont’ev was the first to study memory within the cultural-historical theory. The study can also be seen as Leont’ev’s first move toward the concept of activity, although he did not use the term activity at the time, since the term was not used within the cultural-historical theory (Haenen, 1996).

Memory was categorised as a higher psychological function (Haenen, 1996). Since children’s memory is mediated by reasoning, a new function was considered emerging in the course of a child’s development. Vygotsky regarded thinking and memory interrelated. Together thinking and memory constituted a new complex function, a psychological system, which is illustrated in Figure 5. Before then, changing the structure of separated functions had been the essential thing about socio- and ontogenesis. Now, the factor considered determining socio- and ontogenesis was instead the formation of new psychological systems that incorporate these functions (Haenen, 1996).

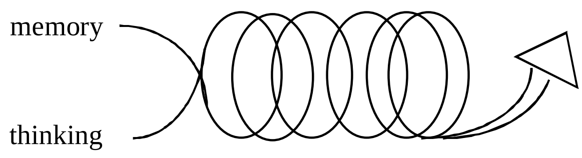

Figure 5: Memory and thinking as an interrelated process

Because of the change of view, a new methodological framework was needed (Haenen, 1996). Psychological systems should be treated like unitary wholes, developed through the interlacing of higher psychological functions. In October 1930 Vygotsky held a talk devoted to the topic of psychological systems. The talk is often considered the beginning of the second phase in the development of Vygotsky’s theory, the “interfunctional” phase (Haenen, 1996). From Vygotsky's perspective, the use and learning of CSCW systems involve several interrelated mental processes, such as thinking, memory, and perception, in order to, for instance, understand and remember how different functions of the system work.

4.3. The social interactional nature of learning

The acquiring of higher mental functions always takes place in a social context, “It is through others that we develop into ourselves” (Vygotsky, 1960/1981, p. 161). According to Vygotsky, individuals are born in a society with a culture and a history (Haenen, 1996). Through the relationship with parents, other adults, and peers children experience the world. From the perspective of CSCW, the social and cultural context can differ between parts of the world, but also between different organisations. CSCW users develop during interaction and cooperation with other individuals. For instance, the members of one organisation often use the same concepts and terms. It is important that the learners of a CSCW system learn the same concept, so that they can communicate in a good way with each other.

Children’s psychological functions emerge from the social interaction with other individuals and objects.

> Before these functions become an integral part of personality, they manifest themselves in the ‘outer’ world as interactions between the child and the people around him. They emerge in the social context and are gradually transformed ‘inwardly’. (Haenen, 1996, p. 72)

Although the social environment is of great importance in the formation of a child’s intrapsychological plane, this does not imply that the physical environment is unimportant or insignificant (Wertsch & Stone, 1985).

Vygotsky also stated that:

> … any higher mental function necessarily goes through an external stage [in its development before becoming a mental function] because it is initially a social function (Vygotsky, 1960/1981, p. 162).

The transformation from external to internal functions is called internalisation. In the next section the concept of internalisation is explained in more detail.

4.3.1. Internalisation

Internalisation can be seen as one of the bedrocks of Vygotsky's cultural-historical approach (Haenen, 1996). The term internalisation received a lot of attention by Vygotsky's contemporaries. A number of Russian psychologists have developed the concept of internalisation further (e.g., Gal'perin, see Chapter 6; Davydov & Radzikhovsky, 1985; Kozulin, 1990 in Grigorenko, 2000).

In accordance with the assumption about internalisation, functions in individuals' development make their appearance twice (Grigorenko, 2000). First, functions appear at the social, or interpsychological, level, i.e., during interaction between individuals. Then, functions appear at a psychological, or intrapsychological, level, within the child. This is central in the cultural-historical theory (Haenen, 1996). The intrapsychological structure is not just a copy of the external social plane, but a formation or reconstruction of the interpsychological plane (Vygotsky, 1960/1981).

> Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category. (Vygotsky, 1960/1981, p. 163)

This is also valid for adults (cf. e.g., Berger, 2004; Kikas, 2003). Hence, from this theoretical view, during learning to use CSCW systems, knowledge first occurs at an interpsychological plane between individuals, before the knowledge becomes internalised and intrapsychological. The learners internalise external knowledge about the system in order to be able to externalise knowledge and thoughts to other participants in the CSCW activity.

Since every function appears twice, Luria stated stat humans live in a double world (Haenen, 1996). As a consequence, consciousness can not be uniquely analysable. Consciousness "…is the process of constantly constructing and resolving the differences between a world 'as given' and a 'mediated' image of the world" (Cole, 1985, in Haenen, 1994, p. 72). An example of this view is Vygotsky's examination of the internalisation process. Because of the importance of the concept of internalisation, several studies of the phenomenon were carried out. Among other investigations, Vygotsky examined children's pointing to objects. He was of the opinion that three stages are gone through during the development of this gesture (Vygotsky, 1960/1981). First, the gesture is just an attempt by the child to grasp an object with its fingers and therefore the child makes grasping movements with his hand. This grasping movement is then interpreted by adults as an indicatory gesture. Hence, the adults act in accordance with this interpretation. Finally, the child starts using the grasping movements as a communicative gesture directed to other individuals. The grasping movement has been transformed into a deictic gesture. In the transformation process of grasping movement to pointing, external movements are internally reconstructed by the child (Vygotsky, 1960/1981). The movements become psychological tools, which can be used in the communication with other individuals.

This transformation is in accordance with Vygotsky's "general genetic law" for the assimilation of psychological tools (Haenen, 1996). First, the child is unable to make use of the tools as a means to organise mental activity. In the social interaction with adults, the child is provided with the tool as an external object. By gradual stages, the child learns to use this external object as a psychological tool. The tool is transformed inwardly, i.e., internalised (Haenen, 1996).

Within the context of CSCW, learners, which are presumably adults, have already acquired several psychological tools, such as speech, which are used to understand and internalise new knowledge. There are also new psychological tools which can be internalised, e.g., a method or procedure.

To sum up, Vygotsky's idea about the social interactional nature of learning includes:

> … (1) the formation of the internal, intrapsychological plane trough interpsychological activity; (2) an external reality that exists only in a social interactional context; (3) the use of external signs, primarily words, as the mechanism for the formation of the intrapsychological plane; and (4) the "quasi-social" nature of the intrapsychological plane, that is the intrapsychological plane is not just a copy of the interpsychological plane. (Shepardson, 1999, p. 626)

Consequently, participation in social activities is a prerequisite of learning. Vygotsky claimed that it is through cooperation with more knowledgeable individuals in a society that competence develops (Blackler, 1995). In the case of verbal interaction for instance, scientific concepts first exist between the student and a more knowledgeable individual (scientific and everyday concepts are further explained in section 4.6). Then the student internalises the concepts which then become a part of the individual activity (Shepardson, 1999). By participating in interpsychological activity the child acquires a framework for seeing, talking and thinking about scientific concepts and phenomena. Through internalisation speech becomes a psychological tool for seeing, talking, acting, and thinking. In the next section, individuals' internalisation of knowledge in cooperation with more skilled individuals is explained in more detail.

4.3.2. The zone of proximal development

Western psychologists have paid a lot of attention to measures of individual performances and intelligence (Blackler, 1995). According to Vygotsky, measures of performance of an individual in cooperation with another, more competent, individual should instead be in focus, since it is during cooperation individuals develop and expand their capabilities. Hence, in this perspective, to learn how to use CSCW-systems, the learner must be engaged in social activities. Subsequently, learners are engaged in a social activity in order to learn the system, so that they later can be engaged in the social activity of CSCW and acquire other knowledge.

Vygotsky introduced the concept of the "zone of proximal development" (ZPD), which, according to Vygotsky (1978), is:

> … the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (p.86)

The ZPD can be viewed as a social interface, in which the encounter between the child's and the adult's behaviour and thinking takes place (Grigorenko, 2000). The concept of the ZPD is illustrated in Figure 6.

As is evident from the quotation above, Vygotsky emphasised the importance of cooperation with more knowledgeable individuals, i.e., someone who has a better understanding or higher ability level than the learner, with respect to a particular task, process, or concept. It does not necessarily have to be an adult (Tudge, 1990). A peer can also support the learner in the learning process. Accordingly, within CSCW, during learning how to use CSCW systems, the learner needs guidance from a more skilled person. According to Galloway (2001), the more knowledgeable person does not have to be a human being at all. An electronic performance system, programmed with more knowledge than the learner possesses, could be the more knowledgeable "individual". However, it is questionable if there is a social interaction between the learner and the teacher in that case.

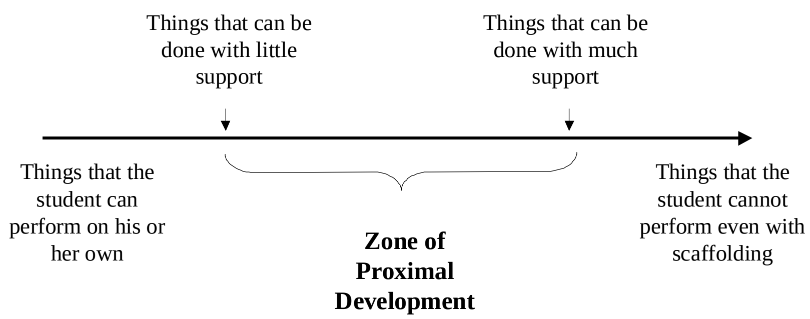

Figure 6: The zone of proximal development (modified from Galloway, 2001).

Once a student has managed to achieve a particular task, by means of appropriate assistance (scaffolding), the student will be able to complete the task on his or her own, without scaffolding (Galloway, 2001). As the student learns, the ZPD will shift to the right on the axis (Figure 6).

4.4. Interplay between psychological and technical tools

According to Vygotsky, the formation of the intrapsychological plane is mediated by tools. There are both psychological and technical tools, or, in Vygotsky's (1978) terms, signs and tools. The logical relationship between psychological tools (signs) and technical tools (tools) are illustrated in Figure 7.

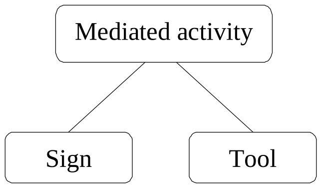

Figure 7: Logical relationship between the use of signs and tools (redrawn from Vygotsky, 1978).

Psychological tools are acquired through social interaction, they are appropriated and have become an internal activity (Grigorenko, 2000). Different cultures use different psychological tools (Kozulin, 2003). They are not invented nor discovered by individuals independent of the social interaction (Shepardson, 1999). When a child has appropriated a psychological tool, the tool becomes a framework, through which the child can see phenomena. However, not all psychological tools are mastered by the child, and not all children master all tools to the same degree. Shepardson (1999) stated that children learning science must appropriate psychological tools as a way of:

> … (1) seeing phenomena; (2) talking about phenomena (engaging in scientific discourse); (3) guiding and structuring activity; and (4) thinking about phenomena. (p. 629)

Technical tools, on the other hand, are phenomena oriented, i.e., they are means to physically acting upon phenomena (Shepardson, 1999). By means of technical tools an individual can stimulate a change in a phenomenon, thereby completing a task (Vygotsky, 1978). Technical tools, such as a microscope or a thermometer, enable individuals to look at phenomena from different perspectives (Davydov & Radzikhovskii, 1990). By means of tools different physical characteristics can be shown. The possibility to change phenomena is necessary for children learning science. By changing, extending, or enhancing the observations of phenomena, children are provided with different points of reference of phenomena (Shepardson, 1999). Hence, psychological tools (or signs) are internally oriented, while technical tools (or tools) are externally oriented.

> The tool's function is to serve as the conductor of human influence on the object of activity; it is *externally* oriented; it must lead to changes in objects. It is a means by which human external activity is aimed at mastering, and triumphing over, nature. The sign, on the other hand, changes nothing in the object of a psychological operation. It is a means of internal activity aimed at mastering oneself; the sign is *internally* oriented. These activities are so different from each other that the nature of the means they use cannot be the same in both cases. (Vygotsky, 1978, p. 55)

During learning how to use CSCW systems technical tools, such as the system, or a model of the system, and psychological tools, such as, a method, or a procedure, can be used. The tools become a means to change objects, understand phenomena, and see things from different perspectives.

According to Shepardson (1999), in Vygotsky's theory, the importance of interplay between psychological and technical tools in the formation of the intrapsychological plane is not clearly expressed. However, Shepardson (1999) claimed that interplay between the two different kinds of tools is central in a child's learning process:

> While technical tools provide children access to phenomena from different perspectives, it is only through psychological tools that children come to see the phenomena from the different perspectives. (p. 629)

Hence, learning science involves shifting perspective and learning to see phenomena from different perspectives. Psychological tools that are appropriated through social interaction provide the access to a new frame of reference (Rogoff, 1990). According to Vygotsky, one of the most important psychological tools is language.

4.5. Verbal interactions as mediated activity

Following Vygotsky, it is not just the social interaction that is leading to the child's development (Haenen, 1996). The child takes control over the means used in the interaction, which is also of great importance to the child's development. The main means in the transmission of social experience from an adult to a child is speech (Lee, 1985; Vygotsky & Luria, 1994) and in particular word meaning, and concepts (Wertsch & Stone, 1985). Vygotsky claimed that through investigating a child's concept formation and comprehension of words, it is possible to get knowledge about the development of a child's consciousness (Haenen, 1996).

According to Vygotsky, the function of speech is first to establish a point of reference between the teacher and the learner (Shepardson, 1999). Then, speech becomes a means, by which the teacher mediates the learner's thoughts. The learner also appropriates speech as a psychological tool, which can be used for representing thoughts (Vygotsky, 1986). In other words, children internalise social speech, which becomes a means to formulate and reformulate children's intrapsychological structures (Vygotsky & Luria, 1994). During learning of CSCW systems, the learning is mediated by speech. The learner, who is presumably an adult, has already acquired speech as a psychological tool, but can during communication with the teacher learn new terms, related to CSCW. Thanks to new concepts the learner can understand and learn the system. Later, when the system has been learned, the users can communicate with each other via the system, and, through the interaction acquire new knowledge of the subject of communication. To be able to have an effective communication, the learners must learn the same concepts and terms.

Verbal interaction does not only facilitate children's activities (Gallimore & Tharp, 1990), but shapes and defines them (Vygotsky & Luria, 1994). It becomes a tool which influences the way children see, act, talk, and think about scientific phenomena. When a child is confronted with an unfamiliar situation, egocentric speech often resembles social speech, in the way that it has a communicative function (Shepardson, 1999).

Since social speech becomes a psychological tool for thinking through appropriation, children's speech for thinking is dependent upon the verbal communication with teachers and peers.

> [T]he emergence of inner speech is based on external speech. Originally, for a child, speech represents a means of communication between people, it manifests itself as a social function, in its social role. But gradually a child learns how to use speech to serve himself, his internal processes. Now speech becomes not just a means of communication with other people, but also a means for the child's own inner thinking processes. (Vygotsky, 1994, p. 353)

In Vygotsky's view, the three stages of internalisation (see section 4.3.1) are also applicable to speech (Haenen, 1996). First, there is a direct correspondence between a word and its meaning. To the child, a word is just an attribute of an object. In the second stage, in the social interaction between a child and an adult, the adult uses the word as a means for communicating with the child. In the last stage, the child understands the meaning of the word. The word becomes a psychological tool.

To sum up this subsection, according to cultural-historical theory, participation in verbal interaction with more knowledgeable individuals is a prerequisite for learning science. During verbal interaction the child's intrapsychological structure is formed, by means of speech, which functions as a mediator. First, speech mediates the way of seeing and acting, then as a way of talking and thinking about scientific phenomena.

The concepts used in verbal interaction can be categorised as everyday and scientific concept. In the next section the difference between the two types is explained.

4.6. Everyday and scientific concepts

Vygotsky categorised children's concepts into two categories, depending on the context, in which they are created. The categories are everyday and scientific concepts respectively (Goodman & Goodman, 1990; Shepardson, 1999). Everyday concepts, or spontaneous concepts, which they also are called, are created outside formal school settings, when children interact with other individuals and gain experiences through their activities. Scientific concepts, on the other hand, are created through interactions and experiences in formal school settings. They are also referred to as nonspontaneous concepts (Shepardson, 1999). Vygotsky assumed that the ways of learning was completely different between formal school settings and outside formal school settings. However, it can be questioned if the settings and ways of learning differ as much as Vygotsky stated.

Everyday concepts are perceptually bound (Panofsky, John-Steiner & Blackwell, 1990), i.e., they have a direct relation to the phenomena and the physical appearances and characteristics of the phenomena, which are experienced through everyday activities (Shepardson, 1999). Hence, they are bounded to the immediate experience of the phenomena and they lack a system of generality. On the contrary, scientific concepts do not have a direct perceptual relation to the phenomena. Instead, they are defined in a generalised manner, i.e., “in a relationship between other concepts” (Shepardson, 1999, p. 634). They are tied to the phenomena through mediation by previously defined concepts (both everyday and scientific concepts). The two types of concepts change each other; scientific concepts change everyday concepts and everyday concepts alter scientific concepts. These changes imply an alteration of the entire conceptual system (Shepardson, 1999). Within the context of CSCW, learners may have both everyday and scientific concepts related to CSCW which alters each other. Before learning they may have an everyday concept of, for instance, a computer network. During learning they appropriate the scientific concept of the same term.

According to Vygotsky, concepts are first formed as “concept-in-itself” (sign – object relation), then as “concepts-for-others” (socially) and, finally, as “concepts for-myself” (individual, intrapsychological) (Vygotsky, 1986, p 124).

During children’s learning, everyday concepts become more general. Scientific concepts, on the other hand, move downward towards the phenomena and become more specific (Shepardson, 1999). Everyday concepts therefore form the formation of the intrapsychological plane. When children will learn science, they must be introduced to scientific concepts, to appropriate a tool for looking at phenomena in different ways, and they must be engaged in an activity, which brings the scientific and everyday concepts together (Shepardson, 1999). In the case of learning to use CSCW systems, the learners acquires new scientific concepts, related to CSCW. Presumably, they have already everyday concepts of certain CSCW terms, which can be further developed in the course of learning scientific concepts.

4.7. Critique

Vygotsky's view of the importance of speech has been strongly criticised by e.g., Luria, Leont’ev and Gal’perin (Haenen, 1996). Gal’perin stated that in Vygotsky’s point of view, word meanings are seen as building blocks. Combined, the building blocks form consciousness. This means that word meaning is the smallest unit of analysis and can exist by itself. Also Wertsch (1985) shares Gal'perin's opinion. Vygotsky had set up some general theoretical requirements, which he assigned to word meaning, although, according to the critics, word meaning does not fulfil the requirements (Haenen, 1996).

Gal'perin also emphasised another problem (Haenen, 1996). Vygotsky claimed that consciousness has its origin in the external world, and that humans internalise external tools during their development. According to Gal'perin, the conclusion that consciousness originally is externally grounded provides no foundation for analysing the process of internalisation. The question that must be answered is how social interaction is transformed inwardly. Gal'perin claimed that Vygotsky's theories do not include an answer to this question. The theory is therefore unfinished. In Gal'perin's point of view, Vygotsky's theory was seen as the beginning of a new way of looking at, and prosecuting psychology, but the significance of internalisation was just potential, since the theory had no answer to how internalisation is brought about (Haenen, 1996).

As mentioned earlier, also Leont'ev disagreed with Vygotsky's about some of his ideas. Around 1930 Leont'ev developed the concept of activity within the cultural-historical theory and started a new ground in psychology, separated from Vygotsky's theory (Haenen, 1996), i.e., activity theory.

4.8. Summary of the cultural-historical theory

Vygotsky translated the Marxists-Leninist concept of man into a psychological theory. He differentiated between higher and lower forms of psychological functions. Higher forms are characteristic for humans. Higher mental function is reached by means of psychological and technical tools. To be able to understand mental capabilities an understanding of tools must be obtained. Vygotsky also emphasised the importance of social interaction. He stated that ”any higher mental function necessarily goes through an external stage [in its development before becoming a mental function] because it is initially a social function” (Vygotsky, 1960/1981, p. 162). Individuals internalise knowledge, etc., which first occurs at the interpsychological plane. It is through cooperation with more skilled persons that individuals develop. Vygotsky introduced the concept of the ZPD, which is the distance between an individual’s actual developmental level, and the level of potential development. Verbal interaction is important during learning, since the learner is mediated by speech. Vygotsky distinguished between concepts that are learned within formal school settings and outside formal school settings, i.e., scientific concepts, and everyday concepts respectively.

5. Activity theory

Activity theory is an approach, which can offer a framework for CSCW and it is commonly used within the area of HCI and CSCW. Activity theory has been used for a number of different purposes within CSCW. It has been used for meta-level analyses based on theoretical precepts, for describing “native” cooperative phenomena, for describing computer support for cooperative work, for comparing Process Centred Software Development Environments (PCSDE) and for examining activity theory driven information design itself (Halverson, 2002). In addition, models have been developed to extend the theory, or define new phenomena. Some authors have used the theory practically by addressing design. Activity theory has its origin in the work of Vygotsky, but the ideas from the cultural-historical theory have been further developed. In this chapter, a summary of activity theory from a perspective of learning will be presented. First, in Section 5.1 the concept of activity is explained. In Section 5.2 the basic principles of the theory are presented. Section 5.3 concerns the activity system model. In Section 5.4 learning within activity theory is explained. Critique of the theory is presented in Section 5.6. Finally, a summary is presented in Section 5.5.

During the years between 1924 and 1930 Vygotsky, Luria and Leont’ev worked together (Haenen, 1996). In 1930 Vygotsky summarised their joint research and introduced the concept of psychological systems. He was of the opinion that psychological systems were the clue to further development of earlier findings. Leont’ev kept contact with Vygotsky, but differed from Vygotsky concerning some ideas. Leont’ev developed his own perspective in psychology, starting from the Vygotskian framework. He became the head of the Khar’kov school in Soviet psychology (Haenen, 1996).

5.1. The concept of activity

In Vygotsky’s cultural-historical theory, social interaction is the foundation of development of word meaning. Leont’ev also considered social interaction important, but was of the opinion that development cannot be explained in terms of social interaction. He considered Vygotsky's theory too narrow to explain consciousness. It was further considered by Leont'ev that individual object-oriented action mediated by tools and signs was the wrong level of analysis (Haenen, 1996). According to Leont'ev, all human activity[1] is cooperative. Therefore, explaining consciousness in terms of action is insufficient. In spite of these disagreements, the concepts of tool mediation and object orientation are used as main concepts within activity theory. To solve the problems considered by Leont'ev, the concept of activity was introduced in activity theory. Activities were considered the link between subject and object (Leont'ev, 1981).

The gap in Vygotsky's theory, concerning the transmission of social experience from an adult to a child, was first noted by Leont'ev (Haenen, 1996). The trend of events between the initial form of a child's activity and the socially determined activity was only briefly and generally described by Vygotsky. It does not emerge from Vygotsky's theory, which kind of activity, that has to be performed by the child, for an assigned model of social experience to be assimilated and reproduced (Haenen, 1996).

In 1930, Leont'ev moved to Khar'kov and began to practice research, in which the concept of activity was in the centre of attraction (Haenen, 1996). Vygotsky was also invited to Khar'kov, but he never realised the transfer. However, he frequently visited Khar'kov. His contribution to the theorising about psychology in Khar'kov is indistinct. There are obscurities about the relationship between the 'Khar'kovites' and Vygotsky (Haenen, 1996) (for further details, see, e.g., Kozulin, 1996)

Leont'ev summarised the Khar'kovites' critique of Vygotsky's theory in a lecture in 1935 (Haenen, 1996) clarifying the position of the Khar'kov school. The development of speech was the point of departure of the continuous research, since

[1] The Russian term "deiatel'nost" is translated to "activity". However, the term activity is more inclusive and broader than the Russian term (Davydov, 1999).

development of speech was considered central for development of thought and consciousness (Haenen, 1996).

According to Vygotsky, the development of word meaning takes place in the social interaction between a child and an adult (Haenen, 1996). However, the cause of the development cannot be concluded from the social interaction itself. There is a need for investigating what is at the bottom of the social interaction. Following Leont'ev, what is behind social interaction is the child's own activity (Haenen, 1996).

> The historical and the societal nature of the child's psyche consists therefore not in the fact that the child generalizes, but rather in the fact that his or her activity becomes objectively and societally mediated (Leont'ev, 1992, in Haenen, 1996, p. 79).

This hypothesis was an attempt to bridge the gap between societal and individual consciousness. The gap was of major concern in the Khar'kov school (Haenen, 1996).

In many psychological theories, action is used as the unit of analysis (Kuutti, 1996). In Leont'ev's opinion, this is a shortcoming. An action always has a context, and cannot be understood without it. The minimal meaningful context, which must be taken into consideration to understanding actions, according to Leont'ev, is activity (Kuutti, 1996). Leont'ev (1978) gives an excellent example, which explains the importance of studying actions in their context. The example is about primitive hunters. In order to catch game, the hunters group into two parties, with different roles: catchers and bush beaters. The task of the bush beaters is to intimidate the game, so that it runs toward the catchers. If the context of the bush beaters' actions is not taken into consideration, the actions tend to seem to be in conflict with the goal of catching the game. The actions must be seen as a part of the larger system to be considered relevant.

Usually, Leont'ev is considered the founder of activity theory (Kozulin, 1996). Even though Vygotsky's cultural-historical theory is the basis of activity theory, Leont'ev also made his contribution to the theory. Leont'ev noticed some problems with the cultural-historical theory and the formation of activity theory was an attempt to solve these problems (Haenen, 1996). A first draft of the theory was presented in the mid

1940s (Kozulin, 1996). Today, activity theory has developed into different directions and is used in several areas of research all over the world. The different directions are united by the concept of activity (Kuutti, 1996). Kuutti (1996, p. 25) defines activity theory as

> ... a philosophical and cross-disciplinary framework for studying different forms of human practices as development processes, with both individual and social levels interlinked at the same time.

Activity theory is not a theory in a literal sense (Turner & Turner, 2001), but can be viewed as a set of basic principles (Kuutti, 1996), which are described in the next section.

5.2. Basic principles of activity theory

Central concepts in activity theory are hierarchical structure of activity, object orientation, tool mediation, an emphasis on genetic or developmental explanation and internalisation/ externalisation (Kaptelinin, Kuutti & Bannon, 1995). The concepts will be explained below.

5.2.1. Object orientation

An activity is a deed towards an object (Kuutti, 1996). It is the object that differentiates the activities. An object can be manifested in different ways. It can be a material thing, less tangible (e.g., a plan) or not tangible at all (e.g., a common idea). However, there is a requirement, which must be fulfilled; an object must be sharable for manipulation and transformation by the participants of the activity (Kuutti, 1996). During the activity the object is transformed into a desirable outcome. When the outcome is successfully produced, the activity is performed and concluded. During an activity the object and motive of the activity can change, and, hence, give rise to a change of the activity as well (Kuutti, 1996). In the context of learning to use CSCW systems, the object is the incomplete knowledge about how to use the systems. The object is during the activity transformed into a sufficient, or complete, knowledge about the task. All the participants, or learners, of a CSCW system activity share the same object, e.g., not yet complete knowledge of CSCW, or a not yet finished brainstorming session. It is important that all learners share the same motive. Otherwise the participants will try to transform the object in different directions, and hence they participate in different activities instead of the same.

5.2.2. Tool mediation

According to Vygotsky, by means of tools humans can "control their behaviour from the outside" (Vygotsky, 1978, p. 40) and thereby reach higher mental functions (see section 4.2). Leont'ev developed the concept of mediation further within the framework of activity.

In every activity, one or several tools are included, and "A tool can be anything used in the transformation process" (Kuutti, 1996, p. 28). Both material and mental tools exist, e.g., instruments, signs, and procedures (Kuutti, 1996). Tools are carriers of cultural knowledge and social experience (Kaptelinin, 1996). A tool is a prerequisite for the existence of an activity, because the tool has a mediating role. Through mediation, relations between the elements of the activity are established**.** For instance "an instrument mediates between an actor and the object of doing" (Kuutti,1996, p. 26). The relationships between tools, subject and objects are illustrated in Figure 8.

During learning to use a CSCW system, tools, such as the CSCW system, a model, or a procedure can be used. When the learner has learned to use the system, it can be used for mediating another activity than the learning activity, e.g., for communication between members in a project.

At the same time as tools are sources of possibilities, they are also causes of limitations (Kuutti, 1996). A tool establishes a relation between a subject and an object and contains the historically collected experiences. However, the interaction will be from the perspective of the particular tool only, no other perspective of the object will be available to the subject (Kuutti, 1996).

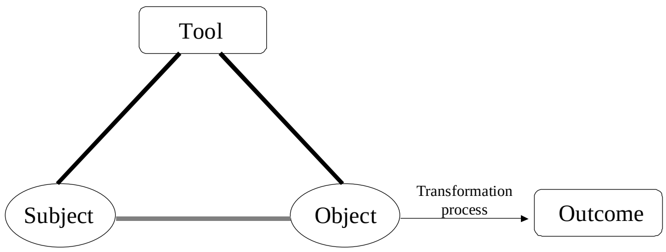

Figure 8: Mediated relationship at the individual level (redrawn from Kuutti, 1996)

The artefact mediating an activity is created and remoulded during the development of the activity. Consequently, the artefact contains historical information about the development of the activity (Kuutti, 1996). The nature of activities is indefinite and they should not be treated as given. Activities depend on and can be controlled by the use of artefacts. A human controls his or her behaviour “not ‘from the inside’, on the basis on biological urges, but ‘from the outside’, using and creating artefacts” (Kuutti, 1996, p. 26). Hence, to fully understand human consciousness, the artefacts mediating human activities must be taken into consideration.

5.2.3. Hierarchical structure of activity

As mentioned above, through activities objects are transformed into desired outcomes. Often, activities are executed in several steps and extend over a long time (Kuutti, 1996). These sub steps are actions. Actions in turn consist of operations. Hence, activity theory embraces a hierarchy of activity with three levels (Hasan & Gould, 2001). The relations between activities, actions and operations are illustrated in Figure 9.

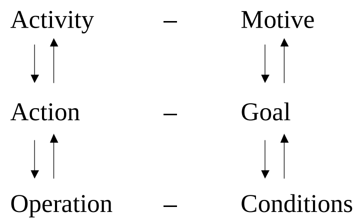

Figure 9: Hierarchy of activity (from Nardi, 1996)

Kuutti (1996) gives as an example the activity of completing a software project. One of the actions constituting the activity is programming a module. Using operating system commands is an operation of the activity. Learning to use CSCW systems can also be an activity. For instance, the activity can be learning to use a meeting support. Actions, such as adding a meeting suggestion, must be learned. The actions consist of operations, such as typing a word in the suggestion sentence. An action could also be waiting for another participant to act.

Activities are constituted by individual actions and networks of actions, related to each other by a common object and motive (Kuutti, 1996). These actions are conscious and have a clear goal (Nardi, 1996). To be fully understood, the activity, of which actions are a part, must be taken into consideration. A certain activity can be composed by different actions in different situations. One and the same actions can also be a part of different activities. The meaning of an action therefore depends on the context (Kuutti, 1996).

Before an action is executed, it is internally mentally planned. During the planning, a model of the execution is created (Nardi, 1996). The planning step is called orientation. The better the model is, the better the performance (Kuutti, 1996). The models are neither rigid nor accurate descriptions of the execution, but incomplete and tentative resources (Suchman, 1987, in Nardi, 1996). In the course of executions of the action, the model is amended. During learning a model is created. It will become more rigid and complete as the learning process progress.

Actions, in turn, are composed by operations, which are well defined habitual routines. Conditions do not have goals, but are "… used as answers to conditions faced during the performing of an action" (Kuutti, 1996, p. 31). At first, an operation is a conscious action (Nardi, 1996). It is made up of two phases: the orienting phase and the execution phase (Kuutti, 1996). When an action has been performed a sufficient number of times, the orienting model has become adequately accurate, so that the orienting phase is not required any more. The action has then become an operation. It can be performed fluently and unconsciously. Simultaneously, a new action is created, which is more extensive, and which includes the new operation (i.e., the former action). The new operation is a subpart of the new action. If the condition of the operation changes, the operation once again becomes an action, since the orienting model must be renewed (Kuutti, 1996).

Operation-action dynamics is characteristic of human development (Kuutti, 1996). During learning operations are created and actions becomes broader. At the same time the performance becomes more fluent. Broadening of actions is a prerequisite of being skilled at something. As an example, driving a car and changing gears can be mentioned. At the beginning, the driver must think of every step in the process of changing gears, e.g., ease the accelerator pedal, disengage the clutch, and move the gear lever to a new position. After practice, the actions are transformed into operations, resulting in a smooth, skilfully performed, action of gear changing. Another example concerns learning to send an email. At first, the learner must concentrate on every step, e.g., pressing the compose-button, typing the email address, typing the message, pressing the attach-button, clicking to find the file, attaching, pressing the send button. When the learning process have progressed, the process of sending an email will be more fluently performed.

Hence, there is no distinct border separating actions and operations. In the same way the bounds between actions and activities are indistinct. Activities can be transformed into actions, and actions can become activities (Kuutti, 1996).

> Thus an activity can lose its motive and become an action, and an action can become an operation when the goal changes. The motive of some activity may become the goal of some integral activity. (Davydov, Zinchenko & Talyzina, 1983, p. 36, in Kuutti, 1996)

The flexibility of the concepts is conducive to the usefulness when describing developmental processes (Kuutti, 1996). Because of the activity's dependence of the subject and object it is a difficult task to determine what an activity is. The activity changes when the subject or object alters (Kuutti, 1996).

When supporting cooperative work, the different levels of the activity hierarchy (cf. section 5.2.3) must be taken into consideration. CSCW can support activities at all levels (Kuutti, 1996[2]). Usually, information technology supports only the lowest level of the activity, i.e., the operation level (Hasan & Gould, 2001). According to Leont'ev (1978), in principle all operations can be automated. Two examples illustrating operation automation by means of computers are automation of administrative data manipulation operations and automation of human calculating operations. When automating human operations, the technology can become a part of the activity, which implies an expansion of the extent of the actions, which can be performed by the individual (Kuutti, 1996). Despite the fact that automation of operations is the most ordinary and accustomed way to support activities, it is not the only way.

The activity level can be supported as well. Computers can enable an activity that would not otherwise be possible. One example is CSCW technology linking together individuals. By means of CSCW, an activity can also have an object, which would be inaccessible without CSCW. Kuutti and Virkkunen (1994, in Kuutti, 1996) recount for a computerised "organisation memory" enabling health care inspectors to handle new, more extensive problems as the object of their activity. The action level can be supported as well. By means of CSCW the action of, e.g., having a meeting can be supported. CSCW can also endorse communicative actions between individuals, i.e.,

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[2] Kuutti talks about information technology in general, but the statements can be considered valid for CSCW as well, since CSCW is a part of information technology.

actions, “directed not toward manipulating or transforming the object, but making the activity ‘run’”(Kuutti, 1996, p. 35).

5.2.4. Internalisation/externalisation

Vygotsky introduced the concepts of internalisation and externalisation (cf. section 4.3.1). These concepts are also key concepts within activity theory. Traditionally, mental processes are viewed as internal activities (Kaptelinin et al., 1995). According to activity theory external and internal activities cannot be separated and studied isolated from each other. A mutual relationship between the two types of activity exists. Within activity theory, the dualistic conception of body, and mind is not accepted; the body and the mind cannot be separated. According to activity theory, the mind has an external and an internal side. The external side cannot exist without the internal one, and vice versa (Kuutti, 1996). Luria stated that cognitive processes

> … are not independent and unchanging ‘abilities’ or ‘functions of human consciousness;’ they are processes occurring in concrete, practical activity and are formed within the limits of this activity. (cited by Stetsenko, 1993, p. 43, in Kuutti, 1996)

The structure of the mental processes of an individual therefore depends on socio-historically formed means and modes, which are transmitted through social interaction (Leont’ev, 1974 in Kuutti, 1996). Hence, activities have a double nature, with an external and an internal side. The subject and the object of an activity have a reciprocal relationship (Kuutti, 1996). The subject is transforming the object. At the same time the properties of the object penetrate the subject and transform him or her. In this internalisation

> … processes often undergo specific transformations – they are generalized, verbalised, abbreviated; most importantly, they can be developed further. This last factor allows them to exceed the limitations of external activity. (Leont’ev, 1981, p. 55)

By transforming an external activity into an internal activity, it is possible to simulate potential activities and anticipate consequences of activities, without a real execution of the activity (Kaptelinin et al., 1995). Internalisation also occurs during learning; humans internalise external, social knowledge. During learning of CSCW, knowledge about, e.g., the procedure of using an argumentation tool, is internalised. Externalisation of activities can also be necessary. As an example, complex calculations can be externally performed with pen and paper. Externalisation can also be essential if an internalised activity, e.g., knowledge about a CSCW system, has to be repaired, or when people are working together in groups and must coordinate their activities (Kaptelinin et al., 1995). When using an argumentation tool, the internalised knowledge about how to use the tool is used, in order to externalise, and add to the system, knowledge about a decision, which can be internalised by other users of the system.

5.2.5. Continuous development

An activity continuously changes and develops; it is not a static or rigorous phenomenon (Kuutti, 1996). Therefore, every activity has its own history. To be able to gain an understanding of a phenomenon, it is essential to understand how the phenomenon has developed into its existing form (Kaptelinin, 1996). “The principle of development gives an opportunity to conduct thorough, scientific analyses of complex phenomena while avoiding mechanistic oversimplifications” (Kaptelinin, 1996, p. 109). Hence, development is not only the object of study, but also a general research methodology (Kaptelinin et al., 1995).

At all levels (operation, action and activity) development takes place (Kuutti, 1996). New actions and operations are created. Actions are transformed into operations and the reverse. Objects and motives can change, which implies a change of the structure of the activity related to it as well (Kuutti, 1996). The activity is also sensitive to changes in the environment. The activity can be affected by other activities, or by other kinds of circumstantial changes (Kuutti, 1996). External elements, which cause imbalance within an element or between elements or developmental phases, are called contradictions. These misfits become apparent as problems, ruptures, breakdowns, and clashes. To solve the contradictions the activity must develop. Since the world constantly changes, activities are always in the process of solving the misfits (Kuutti, 1996). The activity of learning to use a CSCW system can change, e.g., when more participants enter the system, if the system to be learned are upgraded, or if the motive of learning changes. Activities can also change if the objects change. If users of a CSCW system discuss design solutions, the object of the discussion can first be to develop the best solution. During the discussion the object can change to be the most economic solution.

5.3. Activity system model

The basic principles presented above are interconnected. They represent various aspects of the whole activity. Hence, they should be studied together. Within activity theory an activity system model has been created. It shows how different aspects relate to each other. The activity system model (Figure 10) is an extension, made by Engeström (1987) of the model of mediated relationship at the individual level presented in section 5.2.2. According to activity theory, a subject is always part of a community, i.e., a group of people sharing the same object. The model in section 5.2.2 is therefore too simple to be useful. The relations between community and subject and between community and object are mediated by rules and division of labour respectively (Kuutti, 1996). These relationships are illustrated in the activity system model.

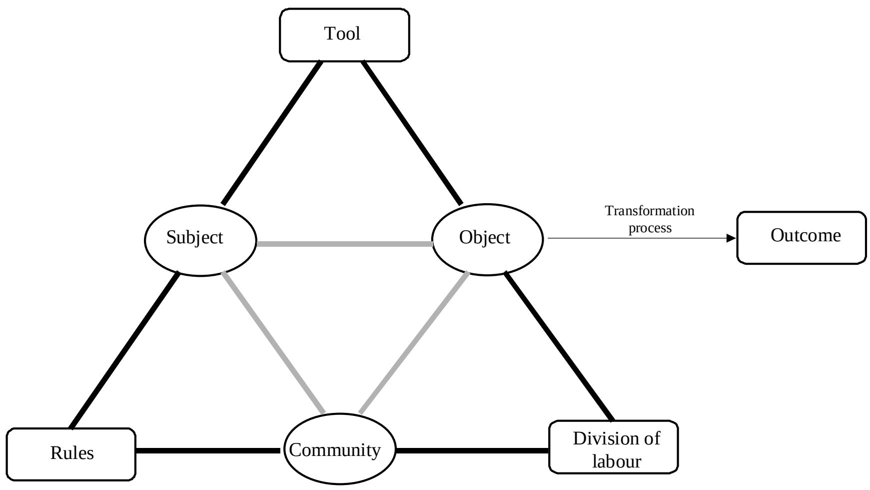

Figure 10: Activity system model (redrawn from Kuutti, 1996)

Hence, there are three mutual relationships, between community, subject and object. There are different mediators, mediating the relationships. As previously stated, tools mediate the relationship between object and subject. The relationship between subject and community is mediated by rules, which "… cover both explicit and implicit norms, conventions and social relations within a community" (Kuutti, 1996, p.28). Division of labour, which is the mediator between community and object refers to "the explicit and implicit organization of a community as related to the transformation process of the object into the outcome" (Kuutti, 1996, p. 28). All mediating concepts are formed and transformed during the development of the activity and they are open to further transformation (Kuutti, 1996).

To clarify the elements of the activity system model, consider a working team given the task of learning a CSCW system as an example. The *object* is the incomplete knowledge about the system. It will later on be transformed into sufficient knowledge (*the outcome*). The team learning to use the system constitutes the *community*. *Division of labour* includes, among other things, working roles and distribution of work. *Rules* prescribe who is a member of the community and embraces explicit rules, e.g., from a parent organisation or a team manager. Implicit rules, such as general working culture, is also comprised. During the learning of the system different *tools* will be used, e.g., procedures, computers and heuristics. Different activities can be proceeding at the same time. Some of the activities might be contradicting. A contemporaneous activity with the learning activity might be a sales activity, of which the goal is to get high profit. The activity of learning to use a CSCW system is then in conflict with the sales activity, since the learning activity is time consuming and make demands on the sales activity.

This activity system model can be compared to the framework of cooperative work (cf. Figure 2 in section 2.4.2) which was previously described. The framework includes connections between participants in the form of direct communication and common understanding. These connections correspond to the connection between individual and community in the activity system model. Both figures have a relation between the tool and the individual or participant. In the framework of cooperative work a relation between participants via the tool (feedthrough) is included, i.e., a participant can form an opinion of the act of another participant by observing the tool. This relation is indirect in the activity system model. The relation between the individual and the tool is explicit, but the relation between the community (i.e., the other participants) and the tool is implicit. However, the community consists of individuals, and hence, there is an indirect relation between the community and the tool. Accordingly, the tool provides a relation between the individual and community. Worthy of note is that within activity theory, the community is viewed as something larger than a number of individuals. A community, or society is a social setting, in which knowledge, etc., occurs before it becomes internalised by individuals (cf. section 4.3). However, the relation between the individual and the collective is not clearly expressed within activity theory (further discussed in section 5.5). The deictic relation in the framework of cooperative work, i.e., the possibility of participants to refer to, and communicate about the tool, can also be found in the activity system model.

To sum up, in this section, the activity system model has been described. It illustrates the relation between tools, individuals, the collective, rules, division of labour, objects and outcomes. Individuals are always a part of a community. It is in the social settings that individuals develop and learn. In the next section, learning will be discussed in more detail.

5.4. Activity theory and learning

According to activity theory, knowledge acquisition can only be understood in relation to the external context. Human development and learning take place in a historical and cultural context, which extends over time and place. Cognition and learning arise through interaction with other individuals. Activity theory provides a framework for studying learning and development. The theory attaches great importance to (Arievitch, 2003b, p. 4):

> … (a) active participation of learners in meaningful and interactive problem solving, (b) learning as a process that occurs not as a purely cognitive reorganization in the individual

mind but emerges within collaborative (shared) activity, and (c) the acquisition of culturally evolved cognitive tools (like different signs, symbols, language, scientific concepts) as the main content of child development.

According to Arievitch (2003b), these items can be reformulated from the perspective of educational aspects and be summarised as follows (p. 4):

- There is no direct way to transmit knowledge from the teacher's head to the mind of the student.
- Students are active co-constructors of knowledge, not passive recipients.
- Students first construct knowledge in shared activity (of meaning making), with material and social support and assistance of others, and then gradually, through language, internalize this activity, which becomes their new knowledge and their new cognitive ability.

Hence, activity theory stresses the role of interaction and cooperation in learning between students and more knowledgeable persons as well as between students themselves. This form of learning is a kind of guided discovery. Vygotsky's concept of "the zone of proximal development"[3] is of significance. During learning, student are given challenging tasks, which should be performed under the guidance of a teacher. The student acquires the appropriate cognitive tools for the task. Accordingly, the aspects of learning within activity theory is different from traditional didactical teaching, which focus more on individual performances. From this perspective, individuals given the task of learning to use a CSCW system should actively investigate and find out information about the system in cooperation with each other, and with a teacher. Cognitive tools, such as speech and concepts can be used, as well as technical tools such as models. New cognitive tools are also acquired in the process of learning.

As mentioned earlier, activity theory has developed into different directions of research. There are some contradictions between the different lines of research. According to Arievitch (2003b) these lines can be divided into two groups, depending

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[3] Arievitch uses the term "*the zone of potential development* " instead of "*the zone of proximal development* ", but the terms refer to the same phenomenon.

on the view on human learning. The first group looks at learning as a fundamentally social process. The second group focuses on the need to account for individual cognitive growth in learners. Naturally, different approaches within one and the same group differ in their treatment of specific mechanisms underpinning learning. Arievitch (2003b) gives an account of two branches within post-Vygotskian psychology, which he finds “most prominent and promising” (p. 6): The North American branch of sociocultural research and the Russian and North European tradition of cultural-historical studies. These branches each focuses on one of the two aspects of learning.

The North American branch focuses on learning as a social process and is mainly concerned with the role of the adult and the forms of the student’s interaction with peers and adults. This branch gives emphasis to the learners participation in collaborative activity, intersubjectivity and educational discourse. Learning is understood as “[the] student’s guided participation in culturally organized activity with a more skilled partner” (Arievitch, 2003b, p. 7). According to the North American branch, it is of importance to study shared activity and individuals’ shared understanding. The cognitive development takes place in social situations, in which individuals interact. Cognitive development cannot be separated from the social environment. Hence, the focus of analysis is sociocultural practices. The direction of the development of the child is determined by the process of guided participation.

The concept of the zone of proximal development has been extended by advocates of this line of research. They stress that the roles of children and their more knowledgeable others are mutually complementary. Both tacit and explicit social interaction in guided participation are considered momentous. During social interaction, the child acquires the skills and understanding in shared thinking, and they become a part of the child’s own internal problem solving. However, the transformation of the structure of the activity during learning is not taken into account in this line of research. Hence, this line of research, within the context of CSCW, would imply a focus on the interaction between the participants of the CSCW technology, learning the system, and the interaction between the learners and the teacher(s) (cf. “community” and the relation between “community” and “subject” in Figure 10, Section 5.3).

The other line of research, the Russian and North European tradition of cultural-historical studies, focuses on the content of instruction and the character of cognitive tools, which the student is acquiring under the guidance of the adult. Emphasis is given to the process of internalisation of cultural tools. It is considered important that the child acquires cognitive tools with the “right” characters, since these characters determine the potential of development. On the other hand, the collaborative aspects of development, central to the other line of research, is not focused upon. Leont’ev’s ideas belongs to the Russian and North European line of research (Gal’perin’s research program, described in chapter 6, has its origin in the work of Leont’ev, and is therefore close to the same line of research).

In this approach, different teaching – learning procedures have been set up and evaluated to investigate the process of how students acquire knowledge. Different characters of the teaching – learning process give rise to different qualities of the student’s mental activity. The whole process of learning is emphasised, i.e., all steps in the process of transformation from the material form of an activity to the mental form. The main concern is to “clarify the conditions under which the student comes to be able to perform a new action or a system of actions mentally and independently” (Arievitch, 2003b, p.10). The task of the teacher is to provide the student with quality assistance. In the context of CSCW, this line of research would imply a focus on how the learners acquire knowledge about the CSCW system to be learned, as well as on the internalisation of cognitive tools needed for a correct use of the system (cf. “tool” and the relation between “tool” and “subject” in Figure 10, Section5.3).

Arievitch stated that the two lines of research mentioned are independent of each other, but not incompatible. Instead, they are two “quite compatible and complementary sets of principles” (Arievitch, 2003b, p. 11). In Arievitch (2003b) point of view, the two approaches could be integrated and in that way greatly enhance the potential of sociocultural psychology. The approaches are also compatible with theories stating that it is of importance not only to learn facts, but also how to use the knowledge.

5.5. Critique of activity theory

Activity theory has been criticised for circular reasoning, since “the phenomena of activity were ‘explained’ through the principle of activity” (Kozulin, 1996, p. 118) (further discussed in section 6.1). This appears to still be a problem within activity theory.

According to Davydov (1999), the relations between collective and individual activity as well as between collective and individual subject are not clearly specified. Davydov (1999, p. 44) stated that it is necessary to elucidate “[w]hat are the essential feature of a group, carrying out the joint activity so that this group may be defined as a collective subject”. Only limited attention has been paid to the differences between collective and individual subject. Also Raeithel (1992) raised questions concerning the relation between individual actors and social systems as well as Gal'perin, who argued that the process of internalisation of collective actions to individual actions must be further investigated (further discussed in chapter 6).

Davydov (1999) also discussed other unsolved problems within activity theory. He stated that it is important to understand transformations. A transformation implies a change in an object. However, not every change is a transformation. For a transformation to take place, the object has to change both externally and internally. A thorough study is required. Another problem mentioned by Davydov concerns the problem of defining the general structure of activity. Leont'ev (1978) considered components such as motive, goal, needs, actions, and operations part of the structure of activity. However, Leont'ev did not include means of solving a problem in the structure. According to Davydov, this component should be included as well. Furthermore, Davydov argued that it is unclear how to relate the general structure of activity to psychic processes, e.g., perception, memory and imagination. Moreover, Davydov discussed the problem of how to classify different kinds of activities.

Davydov (1999, p. 46) raised the question “What kind of classification is the principle on, and what is the general system of different types of activity?”. Davydov is also of the opinion that the interrelation between communication and activity is unclear as well as the relation between the biological and social in human existence. Davydov also emphasised bringing representatives from different disciplines concerned with the study of human activity together, e.g., psychologists, sociologists and philosophers. According to Davydov, it is also of importance to investigate the connections between activity theory and other theories. Gal'perin's research program, for instance, concerns the stepwise formation of mental actions (further discussed in the next chapter). It has as its foundation the notion of action, and hence, a close connection to activity theory. Similarities and differences between activity theory and other theories, such as Gal'perin's research program should be investigated.

5.6. Summary

Activity theory has been used for a number of purposes within CSCW, e.g., for meta-level analyses based on theoretical precepts, and for examining activity theory driven information design itself. Activity is a key concept within activity theory. All activities are object oriented. According to Leont’ev, activities consist of actions, which in turn consist of operations. The borders between activities and actions, and between actions and operations are indistinct and can change. The object, towards which the activity is directed can also change. Therefore, activities continuously develop. Tools mediate activities. An individual is always a part of a community. Rules and division of labour mediate the relations between the individual, the object and the community. Consciousness is created by participation in activities. Leont’ev, just as Vygotsky, thought that knowledge is first interpsychological before it becomes intrapsychological. During learning, individuals first construct knowledge in an external, shared activity between people and material objects, before it becomes internalised. Knowledge can also be externalised, e.g., during cooperation, or if it needs to be modified. Hence, social interaction is a prerequisite for learning.

6. Systematic formation of concepts and thought

In this chapter, Gal'perin's research program will be explained. Gal'perin's research program has a learning focus, which makes his approach of special interest for this thesis. First, in Section 6.1 influences on Gal'perin and Gal'perin's extensions of others work is presented. Section 6.2 deals with the cornerstones of Gal'perin's research program. In Section 6.3 the four requisites providing systematic formation of concepts and thoughts are propounded. In Section 6.4 three different teaching strategies are explained. Critique of Gal'perin's research program is presented in Section 6.5. Finally, a summary is presented in Section 6.6.

Gal’perin (1902-1988) avoided calling his approach to psychology a theory (Haenen, 1996). The term theory is misleading, since Gal’perin’s work is not a theory in conventional meaning. A theory, in a conventional sense, can be considered “a set of assumptions underlining specific phenomena and capable of being verified by experiment or evidence” (Haenen, 1996, p.99). Instead of using the term theory to describe his approach, Gal’perin used the term research program. The research program is characterised as an “interface between a theoretical framework and specific psychological phenomena” (Haenen, 1996, p. 99).

As explained by Arievitch (2003a, p. 279), Gal'perin

> … is largely referred to as a purely educational psychologist, the author of concrete instructional technique. (…) In fact, his work is much broader in scope and contains original contributions to fundamental problems of psychology.

Gal'perin never considered himself an educational psychologist. He even questioned

> … a direct transfer of his method of action formation into educational practice. For him, it was first and foremost a research method that allowed going beyond mere observation to achieve construction of psychological processes. (Arievitch, 2003a, p. 281)

However, Gal'perin's research program has been widely used and discussed in educational settings in, for instance, the Netherlands (Wertsch, 2000) and the possibility of using Gal'perin's work in museums and informal science centres has been investigated (Duensing, 2000).

6.1. Influences and extensions

Gal’perin was influenced by a number of researchers and theories: Vygotsky’s cultural-historical theory, Leont’ev’s activity theory, Pavlov’s concept of orienting reflex and Marx’s concept of the ideal (Haenen, 1996). However, the major influence on Gal’perin was the cultural-historical theory. In the post-Revolutionary years, Vygotsky developed Soviet psychology further by focusing on the concept of consciousness. He emphasised the importance of thorough investigation of the concept of consciousness in relation to human behaviour. Vygotsky (1925/1982a, in Haenen, 1996) early claimed that studying consciousness is a prerequisite of investigating any complex problem of human behaviour. His definition of humans as conscious and active beings strongly influenced and became the basis of Soviet psychology (Haenen, 1996). Vygotsky introduced the concept of internalisation, which became a basic assumption within Soviet psychology. When analysing the concept of internalisation Gal’perin raised questions concerning the transformation process from material to ideal, i.e., from non-mental to mental (Arievitch, 2003a).

The phenomenon of internalisation was studied in two different ways (Haenen, 1996). The first way was evolved by Vygotsky, who emphasised the importance of symbolic tools and social relationships. The second way was developed by Leont’ev, who was the second influence on Gal’perin. Vygotsky’s cultural-historical approach was the starting point for Leont'ev and other members of the Khar’kov school (Haenen, 1996). The activity approach developed by the Khar’kovites became the foundation of Soviet psychology. Leont’ev took over the idea of internalisation and integrated it into the concept of activity. Within the Khar’kov group the opinion about Vygotsky’s theory was that Vygotsky did not clearly specify which type of activity the child has to participate in to acquire and mentally reproduce social experiences.

The Khar'kovites introduced the concept of activity (Haenen, 1996). Leont'ev was of the opinion that it was possible to gain access to the human mind by studying the structure of activities. He elaborated his activity theory, in which the concepts of action, operation, goal and motive were in focus (cf. section 5.2.3). These concepts were a part of a "meaningful activity". Later, Leont'ev abridged the term and left out "meaningful", leaving only "activity" (Haenen, 1996). Gal'perin differed from Leont'ev in his opinion (Haenen, 1996). He claimed that leaving out "meaningful" could get serious consequences. Gal'perin stated that the activity as it exists in and for itself is not of interest. What is interesting is activity as it is related to the actor. It is the personal experience of activity that should be in focus (Gal'perin, 1992a). Gal'perin therefore used the term "personalised" activity and later orienting activity (further discussed in section 6.2.2). According to Gal'perin, using only activity instead of meaningful activity could result in devastating consequences for the drawing up of activity as a key concept within Soviet psychology. It could lead to a state, in which activity theory would get stuck, i.e. a deadlock (Haenen, 1996). In 1969, in an informal lecture, Leont'ev recounted that activity theory had met with this problem (Leont'ev, 1990 in Haenen, 1996). In Soviet psychology, the concept of activity was widely accepted (Haenen, 1996). The term was also used in other disciplines, outside psychology. A complete system had been elaborated, in which all main fields and problems of psychology had been redefined in the light of activity. At the same time activity theory had got stuck, since "[t]he phenomena of activity were 'explained' through the principle of activity" (Kozulin, 1996, p. 118; cf. section 5.5).

According to Gal'perin, the question, which remained to be answered, was why mental activity is required in daily life (Haenen, 1996). When the answer is given, an understanding of the process of teaching-learning of mental actions can be provided. Investigations can then be made, of how to make such a process as good as possible. Gal'perin expressed his conviction that "within the framework of Leont'ev's concept of activity, mental activity and the mind itself continued to be inaccessible to objective analysis" (Haenen, 1996, p. 103). According to Gal'perin, the concept of activity used by Leont'ev was too broad to be considered the subject matter of psychology (further discussed in section 6.2.1).

From the 1950s onward, Gal'perin was also influenced by Pavlov's concept of the orienting reflex as extended by Sokolov, and by Marx's concept of the ideal as explained by Ilen'kov (Haenen, 1996). Gal'perin's concept of psychology can be understood as an effort of solving some of the problems discovered within both the cultural-historical theory and activity theory. Gal'perin introduced the concept of orienting activity (further discussed in section 6.2.2), which derives from Pavlov's concept of "orienting reflex". Both Pavlov and Sokolov

> … emphasised that the biological significance of the orienting reflex is obvious, and as such, they paved the way for Gal'perin's concept of orienting activity. They made it clear to him why orienting activity is the basis on which mental functioning is structured. (Haenen, 1996, p. 111)

By including mental elements within the concept of orienting reflex Gal'perin extended the concept to the concept of orienting activity. He presumed that orienting activity provides the foundation of mental functioning (Haenen, 1996).

Gal'perin found the source of orienting activity within Marx's work, which was the fourth influence on Gal'perin (Haenen, 1996). Gal'perin found Ilen'kov's "reading" of Marx interesting. According to Marx, the ideal "is nothing other than the material transposed to the human head and transformed in it" (Marx, 1873/1977, p. 27 in Haenen, 1996). In the early 1950s Gal'perin began the work of linking together the idea of internalisation and the theme found in Marx's writings. Gal'perin stressed that mental activity is derived from concrete material activity and he used Marx's writings as a reference to confirm his own opinion (Haenen, 1996).

Gal'perin defined four basic assumptions of his research program, which can be traced to the four influences on his work, i.e. Vygotsky, Leont'ev, Pavlov and Marx (Haenen, 1996, p. 112):

> 1. Mental activity has to be considered a form of concrete, material, object-bound human activity.
>
> 2. The structure and content of mental activity have to be studied in the course of internalization.

3. The final product of the process of internalization is a mental orienting activity. A person uses this orienting activity as a basis for directing and monitoring further actions in any new problem situation.

4. Therefore, orienting activity is the true subject matter of psychology.

According to Gal'perin, these four basic assumptions can be summarised as follows:

> Psychology is concerned with mental (ideal) orienting activity stemming from material (practical) activity and emerging as the final product in the course of internalization. (Haenen, 1996, p.112)

Therefore, to understand mental orienting activity, the internalisation process in which it develops must be studied. From the perspective of CSCW, actions to be learned are first concrete and material before they become mental, e.g., the procedure to go through to add a suggestion to an electronic brainstorming session may first be instructions on a paper, before it becomes an internalised method. Therefore, how these actions develop from material to mental should be studied.

Thus, Gal'perin was influenced by the work of others and integrated concepts and ideas from other theories in his own research program. He also extended the work of others, especially the work of Vygotsky and Leont'ev. In Vygotsky's cultural-historical theory the two levels of intra- and interpsychological functioning and an indication of their relationship are included. Leont'ev extended Vygotsky's work by adding the concept of activity, which serves the purpose of being a "superstructure". Vygotsky's approach to human development, and the idea of internalisation in particular, was of interest to Gal'perin. He extended the approach by transforming it into a technology of instruction. Gal'perin converted the principle of internalisation into a new methodological maxim. Wertsch agreed that Gal'perin extended Vygotsky's work. However, according to Wertsch (2000), Vygotsky's work is ambivalent and can be divided in two parts: ideas influenced by the concept of abstract rationality and ideas related to German Romantics (for further details, see Wertsch, 2000). Gal'perin only focused on the side of abstract rationality.

Gal'perin also extended Leont'ev's work (Haenen, 1996). Gal'perin emphasised the importance of the personal experience of activities. Therefore, Gal'perin used the term personalised activity instead of just activity. The three-level analysis, developed by Leont'ev, is not an important part of Gal'perin's research program. Instead, Gal'perin's focus was on the intermediated *action* level, which, according to Leont'ev (1981, p. 59), is "the basic 'components' of various human activities (…) that translate them into reality." Actions are most important, since separate actions or a sequence of actions constitute an activity. The transformation from material to ideal actions was of particular interest to Gal'perin (Arievitch, 2003a). By translating the three-level analysis into the realm of actions, Gal'perin extended the activity theory (Haenen, 1996). Leont'ev and Gal'perin also differ in their views of societal components. By means of the concept of activity, Leont'ev made an attempt to explain how societal change affects individual psychological functioning. The societal component is an important part in Leont'ev's work. In Gal'perin's work, on the contrary, the social component is of little significance, which can be explained by his interest in the action-level.

In activity theory, the term operation is used to denote the means by which an action is carried out and the conditions under which an action is performed (cf. section 5.2.3). Operations are viewed as subordinated to actions. Gal'perin also used the term operation. However, he used it in a different way than Leont'ev. Gal'perin viewed operations as components or parts of an action (Gal'perin, 1969). An action is composed by sequences of discrete operations. Hence, it is only the intermediate level of actions, which is of great importance in Gal'perin's research program. Gal'perin was not interested in actions as such, but mental actions.

6.2. Cornerstones of Gal'perin's research program

Gal'perin extended the work of others and developed his own research program. In this section, the cornerstones of his research program are described.

6.2.1. The subject matter of psychology

As stated previously, Gal'perin was influenced by, among others, Vygotsky, and Leont'ev. However, he found their theories too general and all-embracing (Haenen, 1996). According to Gal'perin, no progress whining psychology can be made without a clear definition of the subject matter of psychology. Therefore, defining the subject matter of psychology is the most important task. When a definition exists, the task of psychology and methods to use can be prescribed (Haenen, 1996).

Gal'perin defined the subject matter of psychology in a narrow sense and stated that *orienting activity* was the subject matter (further discussed in section 6.2.2). He reviewed the history of the subject matter of psychology and discriminated three basic concepts, which have been used: the human soul, the phenomena of consciousness and behaviour (Haenen, 1996).

The history of psychology is often considered beginning with the classic Greek philosophers (Haenen, 1996). Contemporary scientific psychology derive its origin from the ancient Greece. The Greek philosophers considered the human soul to be the subject matter of psychology. The notion of human soul was used as the basic explanatory principle of psychology. At the same time it was considered the subject matter of psychology. For centuries, this view was the dominating one. It was not seriously challenged until the sixteenth century. In the sixteenth century, there was a new scientific movement. Francis Bacon claimed that scientific method must be predominately inductive, proceeding from particular events to general conclusions. Psychology began to change to become an empirical science. To fulfil the new requirements on science, the subject matter of psychology had to be redefined. Descartes strongly influenced psychology, with his dualistic view of mind and body. By contrast, Spinoza claimed that mind and body are two different aspects of the same phenomenon. Spinoza had an influence on the "German classical philosophy" and on Soviet psychology. However, Descartes' view was the dominating one within psychology. According to Gal'perin, dualistic views were still common within psychology. In Gal'perin's view, mind-body dualism is devastating to psychology. He, as well as Vygotsky, tried to replace it. In accordance with the dualistic view, the study of body belonged to physiology and the study of mind belonged to psychology. The phenomena of consciousness became the subject matter of psychology. However, it appeared insuperable to gain objective knowledge of these phenomena. Therefore, a new view of the subject matter took over (Haenen, 1996).

In the end of the nineteenth century, behaviourism became the dominant view within Western psychology (Haenen, 1996). Behaviourism was concerned with observable and measurable behaviour. Consciousness could be left out. It was not considered necessary for psychology. The phenomena of consciousness as the subject matter of psychology was replaced by overt behaviour. This view was prevailing until the 1950s. However, behaviourism did not dominate in Soviet psychology. Vygotsky introduced the concept of internalisation and developed his cultural-historical theory, in which this concept could be further developed. However, he did not define the subject matter of psychology. He left this task to others. Around 1950 the Khar’kovites proposed the concept of activity as a means to develop Vygotsky’s theory further and, in particular, the transformation from external activity to internal activity (Haenen, 1996).

Gal’perin’s aim was to solve the problem of the subject matter of psychology and to give psychology a new and objective point of departure. According to Gal’perin, the true subject matter of psychology was orienting activity (Gal'perin, 1992a).

6.2.2. Orienting activity

The term activity originates from the classic German philosophers, e.g., Hegel, Fichte, and Kant (Haenen, 1996; Raeithel, 1992). The term was further developed within Marxism. German philosophers and Marxism were the point of departure for Soviet psychology and Gal’perin. However, Gal’perin developed his own view of the concept of activity (Arievitch, 2003a; Haenen, 1996).

During the Activity Congress 1977, Pushkin emphasised that no clear definition of the term activity existed within Soviet psychology (Haenen, 1996). During the conference, Gal’perin tried to explain his view of the term. Gal’perin was of the opinion that activity shall be studied as it is related to humans. The actor’s experience is important. Therefore, Gal'perin focused on personalised activity. The Khar'kov school followed Vygotsky, but also emphasised the importance of the activity for the development of consciousness. Gal'perin added the semantic marker ”personalised” for two reasons (Gal'perin, 1992a). First, he wanted to make clear the distinction from the activity of the forces of nature. Secondly, he did not want anyone to mistake activity for behaviourists' use of behaviour as a form of human activity (Gal'perin, 1992a).

The term personalised activity is closely related to both subject and object (Haenen, 1996). According to Gal'perin, personalised activity is subject-bound and object-bound. It is subject-bound because a prerequisite of an activity to exist is an actor, who understands and work up the content of the activity. Experiences, motives, goals and abilities are of importance. “In activity man expresses his inner subjective world, he makes his inner world objective” (Haenen, 1996, p. 95). Personalised activity is also object-bounded because of the relationship between activity and its object (Gal'perin, 1992a). Two aspects of the relationship are of importance. First, the activity and its products are interdependent. During an activity, there is a transformation of initial material into a predetermined product. The second aspect refers to reflection or self-consciousness. Activities change the environment and the environment changes the consciousness of a man. Hence, the activity is directed upon itself. In the case of learning within CSCW, the activity is dependent on the learner (the subject), who wants to learn to use a system and who has previous knowledge and experience, which affect his or her ability to learn. The activity of learning to use a CSCW system is also object-bound, since it changes the object, i.e., the incomplete knowledge about the system, into a sufficient knowledge, which leads to a change in the subject, and subsequently, in the activity. If the object and activity change, the other participants will also be affected, since they are a part of the activity.

This view of activity was shared by the Khar'kovites in the 1930s (Haenen, 1996). However, according to Gal'perin, this view gave rise to a number of questions, e.g., what is the relation between the concept of activity and the concept of mind? According to Gal'perin, the psychological content of personalised activity was not established. Gal'perin was of the opinion that the concept of personalised activity was meaningful only if it was "followed by a radical overhaul of the conception of mind" (Gal'perin, 1992a, p. 47). This did not happen. Leont'ev did not clarify what the mind was. Gal'perin found it fatal that the question of mind was not raised.

Through questioning and analysing why humans need psychic activity in daily life and what the function of mind is from a psychological perspective, Gal'perin came to the conclusion that the basic function of the mind was to orient a person's future actions (Haenen, 1996). He introduced the concept of orienting activity. The planning and regulating function of the mind is substantial for humans in new situations, which involves non-standardised tasks. Haenen (1996, p. 96) states that:

> The subject can only cope correctly with this new situation and the task to be performed in it, if the actual action is preceded and prepared by orienting activity. This orienting activity must be accomplished at the level of images and involves sizing up and testing the results and products of 'realistic' and meaningful options.

Through orienting activity, a type of representations of real life situations are created by means of thoughts and images (Haenen, 1996). By the aid of representations humans can plan and foresee their own and others actions. Representations also make it possible to by means of experience anticipate options for a certain situation and selecting actions suitable for the situation. Accordingly, the learner of a CSCW system is guided by earlier experiences relevant for the learning of the system. Before acting in the course of learning, different options are tested mentally, e.g., mentally simulating the consequences of different system commands. The more experienced in using a CSCW system, the better predictions of suitable actions. Knowledge about communication may be revised during learning of a CSCW system, since communication via the system may differ from usual face-to-face communication. The knowledge constituting the representations is internalised during interaction with other learners, and the teacher. According to Gal'perin, orienting activity is possible thanks to mental action, which is described in the next section.

6.2.3. Mental action

Actions can be seen as conscious attempts to change physical and mental objects according to some goal (Haenen, 1996). Both material and mental actions exist. An example of material action is counting by pointing at or touching material objects, i.e., through hands-on manipulation. Objects can also be changed by mental actions, i.e., without any external handling of real objects. The external objects are then replaced by their images. For instance, mathematical calculations can be carried out internally. Mental actions can be described as “conscious attempts to change objects at the level of mental images” (Haenen, 1996, p. 119). From the perspective of CSCW, sending an email to a colleague, can be externally carried out by means of following instructions of the procedure on a paper, or internally carried out, by using internalised knowledge about the procedure.

Thanks to mental actions, humans can predict and visualize the consequences of an action (Gal'perin, 1989). It is therefore possible to “simulate” the action before performing it externally. Mental actions and images are “the main basis of human mental functioning” (Haenen, 1996, p. 120) (cf. section 6.2.2). Mental processes include two components, which must be understood as complementary. The first component is images of the world, i.e., representations, perceptions, ideas, and concepts. The second component is modes of mental actions for handling them, i.e., thinking. In the context of learning to use CSCW, learners have and get mental images of, for instance, what the CSCW system to be learned looks like, how it behaves, and how other participants affect the system.

In Gal’perin’s view, mental actions and mental images cannot be isolated from each other or treated separately (Haenen, 1996). Gal’perin raised the question of how to explain their relationship to each other and to mental “objects”, e.g., representations. He tried to explain mental concepts and images through the relation between material and mental actions. According to Gal’perin, mental actions are internalised and abbreviated forms of external material actions. He came to the conclusion that the structure and content of mental action must be investigated within the process of internalisation of material actions. The final product of this internalisation process is mental actions, which brings forth the formation of images and concepts. Gal'perin's ideas was summarised by Haenen (1996, p. 120): "images and concepts are formed as a result of mental actions, which in turn are internalized and abbreviated material actions". This implies that the formation of every new mental action begins with its material (or materialised) form. Accordingly, learning must include the material or materialised form of a mental action to be learned. Hence, the assumption has educational and instructional relevance.

6.3. Four prerequisites providing systematic formation

When a mental action, or process has been appropriated, it becomes automatic (Gal'perin, 1992b). The structure of such a process cannot be directly observed. It is only possible to observe the final product of learning and mastering the skill (Haenen, 1996). No inferences about the nature, structure and content of the underlying process can be drawn from the final product. Hence, knowledge about the process is mainly obtained through its effects.

Gal'perin took a great interest in Vygotsky's genetic approach. Vygotsky was convinced that the genesis of mental processes should be studied (cf. section 4.3) and stated that "… the basic task of research obviously becomes a reconstruction of each stage in the development of the process: the process must be turned back to its initial stages" (Vygotsky, 1978, p. 62). Vygotsky's genetic approach became a point of departure for Gal'perin. According to Vygotsky, during learning the process of formation is systematically (re)constructed and, hence, the teaching – learning process is important to analyse. In Vygotsky's ZPD (cf. section 4.3.2), the reconstructional role of education is momentous. According to Gal'perin, Vygotsky's development of a method of systematic formation was imperfect, since Vygotsky continued measuring mental development by means of cross sectional and cross cultural comparative methods (Haenen, 1996). Gal'perin's research can be conceived as an attempt to bridge this gap. He extended the idea of ZPD into the notion of the systematic formation, which is a teaching-learning experiment in which mental actions are formed with specific intended properties (Haenen, 2000).

When a learner will acquire a new action, the objective

> … is not simply to form an action, but to form it with specific, prescribed properties. Such a task decisively alters the general strategy of the investigation: instead of studying how an action is formed, another requirement now emerges: to ascertain and, if necessary, to create conditions ensuring that the action will be formed with the prescribed properties. (Gal'perin, 1989 in Haenen, 1996, p. 121)

Hence, Gal'perin tried to understand under which conditions within a certain activity an action, with properties which will provide optimal performance, is established. Therefore, he devoted much of his time to studies of how mental actions come into being. Gal'perin's methodological maxim became "No more observation, only formation!" (Gal'perin, 1966 in Haenen, 1996, p. 121).

In the early 1950s Gal'perin began to investigate mental actions and concepts necessary to appropriate in elementary education (Haenen, 1996). His interest was the changes the teaching-learning process undergoes during the systematic formation of mental actions and concepts. The first investigations was studies of pupils learning addition (Davydov, 1953 in Haenen, 1996) and geometrical concepts (Talyzina, 1955, 1957 in Haenen, 1996). Gal'perin came to the conclusion that there is a set of four interrelated prerequisites, which provides the systematic formation. The first three become integrated components of the fourth prerequisite. The prerequisites are (Haenen, 1996, p. 122):

1. The learning motive;
2. the orienting basis;
3. the [4] properties or parameters of an action;
4. the stepwise procedure aimed at the formation of a full-fledged mental action.

The relation between these prerequisites is illustrated in Figure 11. Each of the four prerequisites will in turn be explained below (section 6.3.1-6.3.4).

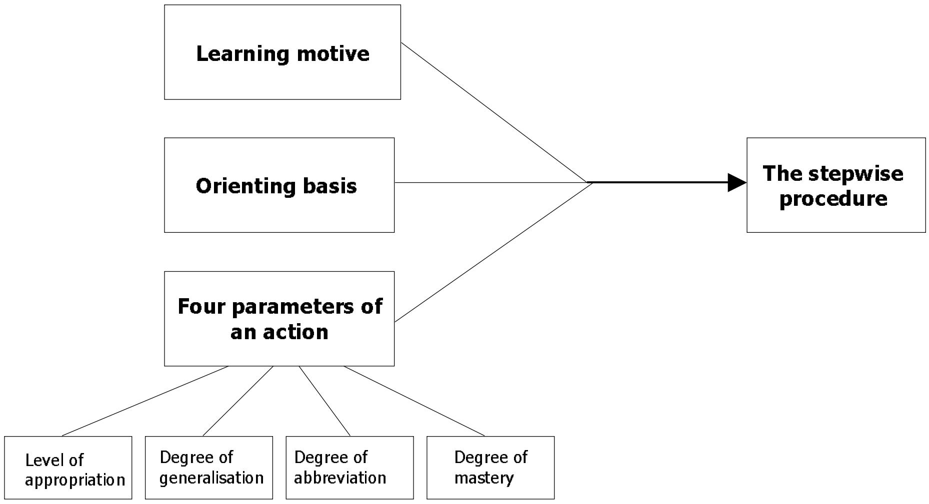

Figure 11: Four prerequisites for the systematic formation of concepts and thought

6.3.1. The learning motive

It is essential for learning that learners are initiated in the learning task in a way that makes them motivated to learn (Haenen, 1996). Unfortunately, Gal'perin did not devote much of his time to study the learning motive. According to Talyzina (1977 in Haenen, 1996), only one study of the learning motive within systematic formation has been carried out (a study by Golu). In the context of CSCW, the learning motive implies that learners must be motivated to learn CSCW systems, and regard the systems as something interesting to investigate, and find out more about. Motivation is of special importance in the context of CSCW, since a lack of motivation in one learner, will affect the other learners as well. The lack of motivation cannot only be infectious, but lack of motivation in one learner will affect the way that learner uses the system, which affects the other, motivated learners. The learner with lack of motivation will not learn the system correctly. The use of the system will therefore be ineffective for all participants, since a good communication between the participants is hindered by the participant, who lacks knowledge about how to use the system.

Haenen (1996) discussed two reasons for why Gal'perin did not take an interest in learning motive. First, Gal'perin's research program represents "a theory of instructions, in which the investigation of learning motivation often has no explicit place" (Haenen, 1996, p. 123). In Soviet psychology, there was a difference between education and instruction. Within the area of education in its narrower sense, the formation of the learner's personality was in focus. The area also include the attitude towards learning. In Gal'perin's research program, education is no central part. Instead the focus is on instructions. Gal'perin stated that if the content of the learning task is correctly taught and acquired, learners will be motivated. Lack of motivation is hence explained through bad instructions. Gal'perin strived to understand how to make instructions as good as possible. However, there is no empirical support for the assumption that good instructions imply motivation to learn. It can be argued that the ignorance of studies of motivations is a shortcoming of the theory. The second reason of why learning motivation did not interested Gal'perin is that Gal'perin's focus was on the action level in the hierarchy of activity. Within the activity theory motivation is theoretically perceived as belonging to the highest level of activity. Davydov (in Haenen, 1996) argued that since Gal'perin focused on the action level, there is no reason for him to take an interest in learning motive, because learning motives do not have their proper place at the action level. Further research concerning learning motivation is needed, since it was (more or less) neglected by Gal'perin.

6.3.2. The orienting basis

According to Gal'perin, appropriation of knowledge and skills must be studied from the perspective of the structure of the learner's action, because appropriation of knowledge is the outcome of actions (Haenen, 1996). Therefore, to Gal'perin, action is the basic unit of analysis.

Within activity theory, actions are conscious acts directed at some goal, which aim to change objects (cf. section 5.2.3). During learning, the learner's repertoire of present actions is improved (Gal'perin, 1989). Gal'perin was convinced that the quality of the repertoire depends on the learner's representation of the goal, the structure and the mediational means to execute a certain action. Gal'perin used the term orienting basis to denote these representations (Gal'perin, 1989). The term is an increasement of the term orienting reflex (cf. section 6.1) (Haenen, 1996). The quality of the execution of an action is, to a large degree, determined by the actor's orienting basis (Gal'perin, 1989). Accordingly, from the perspective of CSCW, for a successful learning of CSCW systems to take place, learners must be guided by good representations of the systems, the goal of the learning process, the means used to perform the action to be learned, e.g., a keyboard, and the structure of the action. The learners must also understand how the different learners are connected. Actions carried out in a CSCW can be hard to understand, since the consequences of the action are not always shown to the actor, but to another participant (for instance when sending an email).

Gal'perin was of the opinion that, to a certain degree, reasoning, rationality and insights are objective characteristics of an action (Haenen, 1996). This assumption was based on an experimental demonstration of apes' reasoning powers, made by Köhler. Köhler stated that in problem solving a single action can only be understood if the whole problem solving process is considered. Köhler (1965, p. 570, in Haenen, 1996) stated that the criterion of insight is ”the appearance of a solution complete with reference to the layout of the entire field.”

Köhler made various experiments to test this notion of learning (Haenen, 1996). In one experiment, Köhler investigated apes putting sticks together, to make them longer, so as to reach food, suspended out of reach. The result shows that the apes test several "hypotheses" before reaching an insightful solution to the problem. The apes seldom tested solutions, which appeared to be accidental in relation to the problem space. Köhler discriminated three phases in the problem solving process. First, the apes learned the relations between the objects involved. Secondly, there is a period of survey. The apes begin to see the situation from a new perspective. This leads to an "Aha-Erlebnis", i.e., a sudden occurrence of the third phase. The third phase is distinguished by the appearance of a complete solution, which manifests itself as an insight. According to Köhler ”for insight to occur, the ape must be exposed to all elements of the problem space. When important elements are hidden from the animal, insightful learning fails to occur“ (Haenen, 1996, p. 126).

Köhler, among others, was a source of inspiration for Gal'perin, when he investigated the development of motor skills (Haenen, 1996). Like Köhler, Gal'perin discovered discontinued improvement in the learning of tool-mediated operations. He also realised the importance of the survey phase for the improvement of motor skills. According to Gal'perin, learners use feedback from their actions to build up representations of problem spaces. These representations are the basis of execution and monitoring of future actions. Gal'perin introduced the concept of orienting basis to denote these representations and their functions. Gal'perin transformed Köhler's idea of insightful learning and introduced it in his own research. Gal'perin (Haenen, 1996, p. 126) argued that

> … insightful learning can occur if the subject (be it animal or a human being) has at his [or her] disposal a complete orienting basis consisting of all the elements of the problem space in question.

Having meditated upon the problem, the learner realises the solution. Within the context of CSCW, individuals learning to use CSCW systems build up representations of the problem space based on, for instance, the response from the system to be learned. These representations are the foundation for future actions with the system. The learner must understand the connections to other participants and how he or she affects them, as well as how they affect him or her. Lack of orientation in one learner will affect all the other learners, in the same way lack of motivation affects all learners.

According to Gal'perin, different actions have different degrees of rationality (Gal'perin, 1992b). The rationality of an action is due to the degree to which the actor's action is motivated by the components of the action, e.g., the goal, the structure, and the means. The components are an orienting part of an action. Gal'perin introduced the term 'Orienting Basis of an Action' (OBA) to denote this orienting part (Gal'perin, 1989). The term "refers to the totality of orienting elements by which the pupil is actually guided when executing an action" (Haenen, 1996, p. 126) (further discussed in section 6.3.2).

6.3.3. The four parameters of an action

Gal'perin's first research concerned mental actions taught and learned in school settings (Haenen, 1996). In the early 1950s, he and his colleagues carried out an experiment on the formation and the structure of elementary actions in arithmetic. Pre-school and first grade children participated in the experiment. Gal'perin and his colleagues gave the children the task of doing sums (addition and subtraction) with numbers between 1 and 10. They investigated whether the children could do the sum with material objects, aloud or internally in the head. They concluded that every action can be classified by several fundamental and characteristic properties. Gal'perin designated these properties 'the parameters of an action', which he considered the third prerequisite for the systematic formation (Haenen, 1996). The four parameters are:

- **Level of appropriation;** According to Gal'perin, an action can be performed at different levels. He distinguished three levels: *The material(ised) level, the verbal level and the mental level* (Gal'perin, 1992b). At the material level, physical objects or material representations are used to perform the action. Material representations are, for instance models, pictures, and diagrams. This level is characterised by the manipulation of material objects (material action) or externalised models of handling them (materialised actions). As an example, the calculation of 2+3 can be mentioned. The task is performed through touching or pointing at material objects. If the objects are removed, the learner cannot perform the assigned task. At the verbal level, the learner speaks aloud when performing the action. The physical objects are not required anymore. Instead the speech helps the learner. At the third, mental level, the learner does not need either material objects or speech. The action is performed internally, in the head of the actor. In the context of learning CSCW systems, learners may at the beginning use a model of the system, or an illustration of the procedure to go through. Later there is no need for the model, or illustration, since speech is used instead. In the end, speech is not required either, because the action can be performed mentally. Then, the learner can fully focus on the activity of communicating with other participant, instead of how the communication is to be carried out. This implies that the communication will be more effective.

- **Degree of generalisation**; This parameter concerns to what degree the learner can distinguish the constant and essential properties of the object of an action from the inessential ones (Gal'perin, 1969). According to Gal'perin, generalising means discerning the properties necessary for the execution of an action. Generalisation is arisen when, from the very beginning, several varieties of the material involved are used while carrying out the learning task (Haenen, 1996). In this way, the learner does not get used to inessential properties. According to Gal'perin, there are different degrees of generalisation. For instance, two learners can perform an addition task at different degrees of generalisation. One of them can add numbers between 1 and 10, but not numbers between 11 and 20. The other can do sums with both numbers between 1 and 10 and numbers between 10 and 20. The second learner performs the action with a higher degree of generalisation. Hence, during learning of CSCW systems, it is important to use, for instance, different models of the system and different illustrations of the procedure to be used, so that the learners do not get used to inessential properties of the action to be learned.

- **Degree of abbreviation or completeness**; The third parameter concerns whether all operations, originally included in the performance of the task is actually executed (Haenen, 1996). At first, all operations of an action will be performed. Later, some of these operations may have been put together and hence, they are fewer. As an example, three different learners can carry out an addition task (e.g., 2+3) in different ways. The first learner may take the first number and then add the second by counting in ones. The second learner may take both numbers as wholes. The third can see the solution directly, and do not need any intermediate steps. Hence, the actions differ in the degree of abbreviation. The third learner's action is more abbreviated than the others'.

Abbreviation often occurs ‘by itself’ and in an uncontrolled way. However, Gal’perin (1969, p. 256) stressed the importance of conscious mastery of abbreviation:

> But we emphasize that only conscious mastery of the abbreviation process can guarantee extensive transfer and the development of new action, a necessity in very difficult conditions. Only conscious development of abbreviation guarantees understanding of the connections between the operations he executes.

Within CSCW, there are also different ways of performing actions. For instance, a learner learning to use an email system can send a message to the receiver in different ways. A message can be send by typing the message in the message field. Another way is to attach a file with the message. The best way depends on the content, the length etc. of the message, but also on the receiver. It is important to have in mind what the receiver is supposed to do with the message, e.g., print the message, or just read it and reply an answer. Therefore, the learner should not get used to one way and exclusively use that way

- **Degree of mastery**; The fourth parameter is characterised by certain features of the execution of an action, e.g., the easiness and the rate with which the action is carried out, and the degree of automation (Haenen, 1996). At first, every operation of an action is performed consciously and slowly. Gradually, the action will become more and more automatic. An action is mastered when the learner can perform it without the teacher.

> To master an act means not simply to remember it, but *independently to repeat it with new material and to obtain a new product from this material.* It does not mean to remember how an act was executed by someone else, but to execute it by oneself. (Gal'perin, 1969, p. 250)

Accordingly, during learning to use CSCW system, the learner must execute the action him- or herself. He or she will not learn the action to be performed in the system properly just by watching someone else using the system. The learner has mastered the action of using the CSCW system when he or she is able to execute the action automatically without the teacher, e.g., correctly answer another participants in a chat system.

Some learners have a high degree of mastery of some actions when material objects are used (at the material level), e.g., when adding by directly counting objects one by one (Haenen, 1996). According to Gal'perin, this is a premature automation. It can be an impediment for future arithmetic tasks. Hence, a high degree of mastery can be a negative property of an action. A high degree of mastery is desirable at the mental level. At the material and verbal level performance in its extended form, i.e., a low degree of mastery, is instead to be desired.

The four parameters mentioned are relatively independent (Haenen, 1996). During the formation of an action, all of the three levels of appropriation are gone through. At each level, the other three parameters (degree of generalisation, degree of abbreviation and degree of mastery) will vary. To reach the intended full-fledged mental action, at each level of abbreviation, the other three parameters have to be elaborated according to the intended requirements. The three levels of abbreviation are related. A higher level is dependent on the lower levels, i.e., the second and third level are dependent on the first and second level respectively. To sum up, to assure the systematic formation of a full-fledged mental action, all parameters have to change in the intended directions.

This third prerequisite (the four parameters of an action) together with the previous two prerequisites (the learning motive, and the orienting basis) constitute the fourth prerequisite (the stepwise procedure), which is explained in the next section.

6.3.4. The stepwise procedure

The fourth prerequisite providing systematic formation is the stepwise procedure. Haenen (1996) claimed that the stepwise procedure is the 'burgeoning kernel' in Gal'perin's research program. The previous three prerequisites are integrated in the fourth, which can be viewed as a teaching strategy, or, in Gal'perin's terms, a "stepwise" teaching learning process. He used the term "stepwise" because he was of the opinion that an action goes through a number of steps before it becomes a full-fledged mental action (Haenen, 1996). Gal'perin describes such actions to a great extent as (Haenen, 1996):

- **General(ised):** The constant and essential features can be discerned or perceived by the learner. When an action is generalised the knowledge can be transferred to other, similar or related tasks.

- **Abbreviated:** An abbreviated action is shortened. The number of operations needed to correctly perform the action is reduced. Some of the operations are put together and combined, others are left out.

- **Mastered:** An action that is mastered is automatically and unconsciously performed. A mastered action differs from an action, which is not mastered. An action, which is not mastered, is instead slowly and consciously performed.

By means of the stepwise procedure an action can get these properties. At every level of appropriation, the action is performed in a new way and is transformed in the right direction (Haenen, 1996). Therefore, the other three parameters (degree of generalisation, degree of abbreviation and degree of mastery) determine the quality of the action at each level.

The full-fledged mental action is preceded by a formation process of internalisation consisting of six stages (Haenen, 1996):

1. Motivational stage

2. Orienting stage

3. Material or materialised stage

4. Stage of overt speech

5. Stage of covert speech

6. Mental stage

The stages will be briefly explained below. The orienting stage, the material stage and the stage of overt speech will be explained in more detail than the others, since they have a greater relevance for this thesis. Figure 12 depicts the range of stages in the stepwise procedure, and the parameters involved.

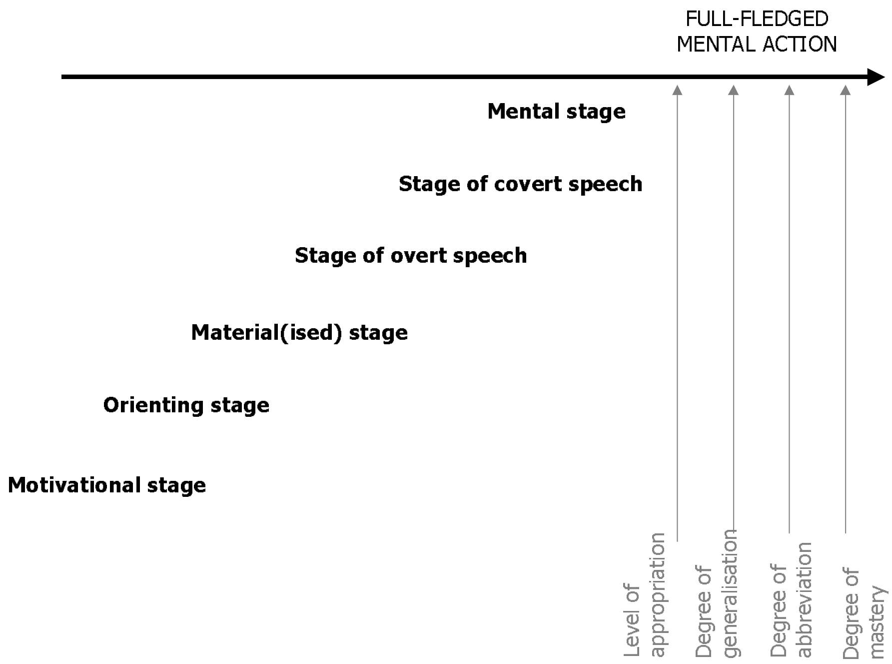

Figure 12: The stepwise procedure

6.3.4.1 The motivational stage

The first stage was called "the motivational basis of an action" by Gal'perin (1982, 1985 in Haenen, 1996, p. 133). The aim of the stage is to introduce the learner to the action to be learned. Among other things, the goal of the action is described. This information is complemented with additional explanations of the action. The purpose is to motivate the learner on the eve of the teaching-learning process to come. Hence, within CSCW, when a system is to be introduced and learned by a number of individuals in an organisation, the CSCW system and task of learning must be carefully presented to the prospective users, so that they are interested in learning. As previously mentioned, lack of motivation in one participants affects all participants. Therefore, motivation is especially important in the context of CSCW.

6.3.4.2 The orienting stage

Every action is based on some orientation (Haenen, 1996). The orientation is the determining factor of the quality of the action. Therefore, the orienting stage has a key role in the stepwise procedure. The aim of the stage is to provide the learner with all information necessary for a correct execution of the action.

In Section 6.3.2 the orienting basis of an action (OBA) was described. OBA is the whole set of orienting elements by which the learner is actually guided.

> The orienting basis is the most important aspect of the psychological mechanism of an action. It defines the outline of each operation and guarantees control of the action in the process of execution. The orienting basis of an action may be formed in different ways with varying degrees of success. (Gal'perin, 1969, p. 251)

It is difficult for learners to find the OBA by themselves. Some learners can do that, which is an implication of genuine creativity. Most learners require help, i.e., scaffolding, when developing an OBA of an action. In Gal’perin’s research program comprises guidelines of how to create an OBA between teacher and learner. These guidelines can be seen as a teaching strategy for learning in ZDP, or, in other words, a teaching strategy for scaffolding.

Gal’perin also introduced the term Scheme of Complete Orienting Basis of an Action (SCOBA) (Gal'perin, 1992b). While OBA is the learner’s actual orienting basis, SCOBA is the desired orienting basis. By means of a SCOBA, a correct execution of an action is provided. OBA, on the other hand, does not necessary lead to a correctly performed action. An OBA is also already appropriated by the learner and can be disposed by the learner. A SCOBA, on the contrary, is an externally presented schema. Before it can be used, a SCOBA has to be appropriated by the learner (Gal'perin, 1992b).

The purpose of the orienting stage is to clearly explain the SCOBA to the learner and encourage the learner to use the SCOBA in the future as a “frame of mind” or “cognitive map” of his or her orienting basis (Haenen, 1996, p. 134). The aim is to transform the OBA into a SCOBA. The purpose and properties of the SCOBA are first verbally explained, to give the learner an overall view of what the action is and what is supposed to be done. The structure of the action and the feature of the material involved are also accounted for. An elucidation of the successive operations constituting the action is also included. It is of importance to give the learner an understanding of the relations between operations and the changes in the material. Since the components of the SCOBA are complicated, the learner is also given an orienting chart, i.e., a materialised representation of a SCOBA or a ‘cheat sheet’. The purpose is to give the learner an evident and explicit idea of the SCOBA. In the orienting chart the components of the SCOBA are summarised. According to Gal’perin, a SCOBA has five components. However, Haenen pointed out that Gal’perin did not include the orienting chart as a component. Since the orienting chart is an important part of the SCOBA, Haenen claimed that the orienting chart should be added as the sixth component. The six components are (Haenen, 1996, p. 135):

1. the intended output of an action;
2. the pattern or model of the action as executed by an ‘expert’;
3. the means of the action;
4. the objects of the action;
5. a general plan of action, an ‘action-algorithm’ or ‘operational thinking scheme’ giving the course of the action and the sequence of its operations in a summarised form;
6. the orienting chart or ‘cheat-sheet’ representing the previous five components in such a way that it serves as a ‘tool of action.’

Within CSCW, during learning to, e.g., send an email, the intended output may be a correctly sent email. The pattern of the action as executed by an expert would be the operations necessary in an effective order. The means are, e.g., the email program and a keyboard. The object of the action is the not-yet-ready email. The general plan of an "action-algorithm" describes the operations necessary to execute the action, e.g., pressing the compose-button and typing and email address. The orienting chart will illustrate the intended output, the pattern of the action, the means, the object, and the action algorithm. For other systems, e.g., shared documents, or videoconference systems, an action could be to wait for another participant acting, and to perceive other participants' actions.

By means of the orienting chart, the learner appropriates the components of the SCOBA. The learner does not need to learn the orienting chart by heart. Gal'perin argued that there is no reason for learning by heart, since, by following the instructions of the orienting chart, the learner will unexpectedly easily and incidentally learn the components and how to execute the learning task. Gal'perin argued that incidental learning has a greater capacity than learning by heart. Hence, according to Gal'perin, the biggest advantage of the stepwise procedure is that the process does not require that the learner learns anything by rote. The course of the orienting stage is to a great extent governed by the orienting chart.

As mentioned earlier, the learner is guided by the actual orienting basis (OBA). The aim of the orienting stage, however, is to get the learner guided by the SCOBA. Haenen (1996, p. 136) describes the relationship between the OBA, the SCOBA and the orienting chart:

> The OBA, referring to the learner's actual orienting basis, is the 'sediment' in the learner's mind of the externally presented SCOBA. This also refers to the orienting charts. In the stepwise procedure the learner appropriates the orienting chart as one of the components of the SCOBA .

In Figure 13 an example of an orienting chart is illustrated.

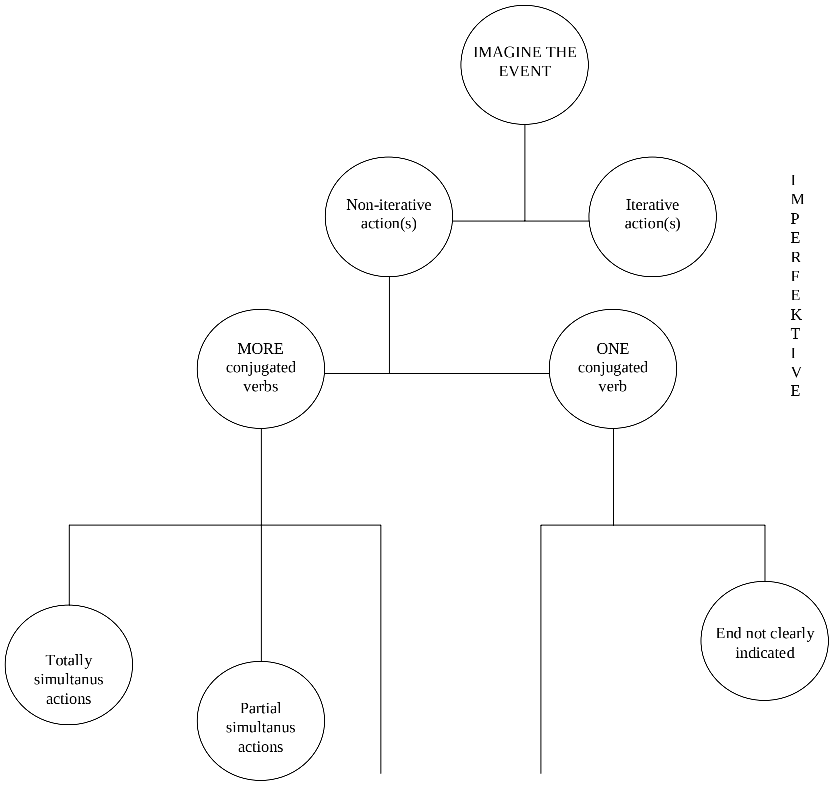

Figure 13: A part of an orienting chart of semantic criteria for choosing the correct aspect form of the Russian verbs (modified from Carpay, 1974, in Haenen, 1996).

The SCOBA, which is externally presented to the learner, remains constant. The OBA, on the contrary, is gradually and 'incidentally' transformed during the stepwise procedure. During the learning process the OBA will be more and more similar to the SCOBA. The greater extent to which the OBA resembles the SCOBA, the more successful formation of a full-fledged mental action. The degree of success is determined by the orienting stage.

6.3.4.3 The material or materialised stage

At the material or materialised stage real objects or their representations are used in the execution of the action. The objects or representations are manipulated and investigated (Gal'perin, 1989). A *material action* refers to an action with actual and perceptual objects. An example is doing arithmetic by means of hands-on manipulation. An action can also be performed by means of *materialised objects*, i.e., representations of physical objects, e.g., models, displays, diagrams, maps and drawings.

> *All such representations accurately reproduce the characteristics and relationships of concrete things which are important for the act and permit the subject to accomplish the act by using these substitutes.* (Gal'perin, 1969, p. 253, original emphasis)

In learning situations it is often impossible to use real objects. By means of materialised representations the learner can still begin with a material form of an intended action.

The material or materialised form of an action is not only of importance for lower forms of educational systems “or in the beginning phases of a course or curriculum” (Haenen, 1996, p. 139). Studies have shown that the material or material stage is essential also for adults learning fundamentally new knowledge. The new mental actions to be learned requires at least partial materialisation. In chemistry, for instance, models of molecules are used. Hence, adults, without previous network technology experience, learning to use CSCW systems may need models to explain, for instance, how an email gets from the sender to the receiver. Within CSCW, changes in a system can also be made by other participants, and the learner must be able to detect, and understand them. Besides, the actions performed by a learner are not always perceivable for him or her, but only for another participant. Therefore, models are of special importance, in order to get the learner to understand the actions and their consequences.

Lompscher (1985, in Haenen, 1996, p. 139) stated that a model used in a teaching situation can be described as “a representation of the action and its object, which at the same time is immediately given for perception and manipulation”. Hence, models and modelling are essential in the learning process. According to Talyzina (1968, in Haenen, 1996), a bad consequence of an underestimation of the material(ised) stage is that the knowledge is not “properly practiced and embedded in the learner’s repertoire of mental actions” (Haenen, 1996, p. 139). Subsequently, the material or materialised stage cannot be left out during the process of learning to use a CSCW system.

According to Gal'perin (1969, p. 254), a full-fledged mental action appears to exist only if it is preceded by a material or materialised form of the action:

> At the present time we do not have any experimental data which indicate the possibility of forming a mental act directly in the mind. We do not deny such a possibility, but our analysis of the process leads us to believe that each new mental act must be formed from the beginning as something external, material, or materialized.

Through manipulation of material or materialised objects the learner gets an understanding of the content of the action for himself and "achieves his first practical appropriation of this content" (Haenen, 1996, p. 139).

> Consequently, a paramount problem in the construction of the stepwise procedure of any new action is finding the initial material or materialised form of the action to be appropriated and in precisely establishing its contents. (Haenen, 1996, pp. 139–140)

6.3.4.4 The stage of overt speech

The next stage in the stepwise procedure is the stage of overt speech. In this stage the learner does not need to rely on material objects or materialised representations anymore. The action is instead executed by means of speech (Gal'perin, 1989). In the previous stage, speech was used to indicate the phenomena, which were visible to the learner. In this stage, on the contrary, speech is used both to execute the action and to indicate its objects (Gal'perin, 1969). The material objects or materialised representations of the material(ised) action is replaced by words and reflected in speech. According to Gal'perin (1969, p. 262):

> … [w]e must emphasize that transferring an act to the verbal plane means not only expressing the act in speech, but above all verbally executing a material act; that is, it not only means communicating about the action, but it is an act in a new, verbal form.

Gal'perin (1969, p. 260) also stated that:

> ... an action in audible speech is not material or materialized, nor is it yet a mental action, since the pupil is not yet able to perform it silently 'in his mind'.

Thus, the stage of overt speech can neither be considered material nor mental. Instead, it is a transitional stage between the material or materialised action and the mental action. "A practical advantage [of this stage] is that new tasks can be introduced with the aid of speech which could not be conveyed at the preceding stage" (Haenen, 1996, p. 140). Gal'perin (1969, p. 258) emphasised the importance of the stage of overt speech:

> Without audible speech the young child cannot act. Even restricting the child to a whisper or to voiceless lip movements significantly hinders and even precludes the act. (Gal'perin, 1969, p. 258)

The stage of overt speech is also essential for adults (Haenen, 1996). Individuals learning to use CSCW system should therefore explain verbally what they are doing with the system. In addition they also need to explain what other participants are doing, since they also change the system in use.

Gal'perin discovered two reasons for the importance of the stage in the stepwise procedure. The first reason concerns the "theoretical" nature of the action of overt speech. The material(ised) action has been transformed to a verbal action, free from actual objects. The second reason concerns the function of speech as a means for communication. The learner must execute the action, not only in a way that makes him- or herself understand the action, but in a way that makes other people understand the action as well (Gal'perin, 1969). "Learning how to execute an action in speech is learning a relation to this action from the standpoint of other people" (Haenen, 1996, p. 140). "[I]t creates in [the learner] … a 'co-knowledge', a consciousness of just this action" (Gal'perin, 1989, p. 53). Hence, verbalisation during learning of CSCW means, on the one hand, that users take one step further towards the mental action, and, on the other hand, that users learn the same concepts and terms. Learning the same concepts is important, since the learner must be able to, in an effective way, communicate the knowledge with each other.

Gal'perin called the stage of overt speech the stage of 'audible speech' and later 'socialised speech'. The term socialised speech can be seen as a link between Vygotsky's general genetic law and Gal'perin's ideas. According to the general genetic law social speech becomes the source of thought (see section 4.5). It is only after the action has been shared by individuals through speech that the proper internalisation of the action can occur. To sum up, the generalising function of speech together with the communicative function of speech makes the stage of covert speech of utmost importance for the stepwise procedure.

At the stage of overt speech, the action is performed at the verbal level of appropriation. Simultaneous changes in the other three parameters (degree of generalisation, degree of abbreviation and degree of mastery) are required for an intended formation of action at the stage of overt speech. There is no longer a need for material or materialised objects. Instead speech is used. Because of the break with the direct presence of things, the action becomes more generalised. “The generalisation must be made secure by introducing learning tasks which could not be presented at the preceding stage” (Haenen, 1996, p. 141). Abbreviations often occur spontaneously at this level. However, the abbreviations should be consciously carried out and sufficiently mastered “so as to become a reliable basis for the formation of the action on the two subsequent stages” (Haenen, 1996, p. 141).

6.3.4.5 The stage of covert speech

At the stage of covert speech, instead of speaking aloud, the learner whispers to him- or herself. The transition from overt to covert speech often occurs spontaneously, without conscious efforts (Gal'perin, 1989). Covert speech can not be placed on equality with “speech minus sound”. Covert speech requires a semantico-grammatical transformation of the structure itself.

The stage of covert speech is always preceded by the stage of overt speech. Covert speech can be resembled ‘audible images’ of the world. The stage of covert speech is a prerequisite for the formation of mental actions.

> As the action at this stage becomes more habitual, it becomes more and more abbreviated. When the action on this stage has been developed almost to the point of being automatic, there can be a transition to the sixth and final stage. (Haenen, 1996, p. 142)

Hence, during learning to use CSCW systems it is of importance to let learners speak quietly to themselves, despite the fact that other people are present (teacher, and/or other participants), who may want to communicate aloud.

6.3.4.6 The mental stage

At the final, mental stage the action is executed entirely in the mind, as it has become a purely mental action. The action can be performed faultlessly and quickly. As soon as all information necessary is given, the learner can give the right answer, or correctly perform the action. The learner does not know how he or she performed the task, the learner "just know[s] that's how it is" (Gal'perin, 1989, p. 54). The action is therefore inaccessible to both observation as well as introspection. The teacher has no interest in the successive operations anymore, but pays attention to the outcome. Gal'perin (1996, p. 263) stated that

> ... when the pupil begins to execute all the operations without error and so quickly that he [or she] can give the correct answer as soon as he receives the proper information, we remote our control of each step and pass to control the final result

From the perspective of CSCW, the teacher guiding a learner of a CSCW system only needs to look at the result of a task, e.g., if an email has come to hand to the receiver correctly, and does not need to control how the task has been executed.

After the actions has become 'pure' thought, they

> … do not simply disappear. They take on a status in which they are treated as if they had been performed and are hence being 'kept in mind'. As a result, actions acquire a very specific form. … At … the mental level the action itself is not carried out, but is only 'being kept in mind' beyond the limits of what is actually being done. (Gal'perin, 1966, in Haenen, 1996, p. 142)

The mental actions are executed by means of mental images and concepts, and have an orienting function. By the aid of mental actions, situations and behaviour can be anticipated (cf. section 6.2.2). Thus, the stepwise procedure leads to mental actions, which have an orienting function, which is viewed by Gal'perin as the subject matter of psychology.

6.4. Teaching strategies

According to Gal'perin an action consists of two parts: an orienting part and an executive part (Gal'perin, 1992b). An orientation is made before the action is executed. Usually, only the executive part is concerned when actions are discussed (Haenen, 1996). However, the orienting part is also of great importance, for instance in chess playing (Talyzina, 1981). Gal'perin explained the difference between the orienting component and the executive component by referring to the terms understanding and ability. To understand something is a prerequisite for the ability to perform a task. However, an understanding of a task does not imply the ability to perform it. It requires practice. In the same way, the orienting part of an action is a prerequisite for the executive part and practice is required for the execution of the action. In Gal'perin's research program understanding and ability is interconnected and the gap between them is closed. The orienting stage includes understanding and the material stage, the stage of overt speech, the stage of covert speech and the mental stage have to do with the performance (Haenen, 1996).

As previously mentioned, the orienting basis is a prerequisite for the formation of a full-fledged mental action. In the process of learning the OBA is transformed into a SCOBA. Talyzina (1981) discerned three distinctive features which characterise different kinds of orienting bases: degree of generalisation (concrete or general), degree of completeness (incomplete or complete) and way of appropriation (ready-made provided or guided constructed). A SCOBA is considered concrete if it can only be applied to a limited set of learning tasks, but general if it can also be applied to related tasks. Despite the name SCOBA (scheme of *complete* orienting basis of an action), Talyzina characterized SCOBAs as incomplete or complete. In practice a SCOBA is not always complete. Gal'perin used the term incomplete scheme of the orienting basis of an action (ISOBA) to denote incomplete SCOBAs. Hence, an incomplete SCOBA is, strictly speaking, not an SCOBA. The third feature mentioned by Talyzina is way of appropriation. It concerns whereas the SCOBA is provided ready-made to the learner or has to be constructed by the learner under guidance of the teacher. In theory, eight types of SCOBAs can be constructed from the features (evident from three features with two options each). Gal'perin experimentally distinguished three of them. In Table 2 the three types of SCOBAs and their features are presented. Talyzina further elaborated the other five types (for an explanation of the five SCOBAs, see Talyzina, 1981).

Table 2: Overview of three SCOBA types (modified from Talyzina, 1981, p. 90).

The SCOBA types						
SCOBA types	Degree of generalisation		Degree of completeness		Way of appropriation	
	Concrete	General	Incomplete	Complete	Ready-made provided	Guided constructed
1	+		+			+
2	+			+	+	
3		+		+		+

The formation of the SCOBA in the stepwise procedure is responsible for the progress in the teaching-learning process (Haenen, 1996). Therefore Gal'perin used the term "teaching strategies" to denote the different types of orienting basis. Gal'perin distinguished three types of SCOBAs, which also have three corresponding teaching strategies (Haenen, 1996), or instructions, as Arievitch and Stetsenko (2000) designate them. The first teaching strategy studies made concerned handwriting and the formation of linguistic concepts (Haenen, 1996). The three different types of teaching strategies will be briefly presented below. The third teaching strategy is superior to the other two.

6.4.1. Teaching strategy I

The first teaching strategy is based on SCOBA type 1 (see Table 2). The SCOBA is characterised by the features concrete, incomplete, and guided constructed (Haenen, 1996). The main attribute of this type of teaching strategy is the learner's lack of understanding of the properties and conditions of the task (Arievitch & Stetsenko, 2000). The learner is therefore hindered to execute the action correctly and in the correct order (Gal'perin, 1969). The trial and error method is commonly used and mistakes are frequent (Gal'perin, 1992b). The success varies between different learners. The orienting basis can also contain more information than the SCOBA. "Such an 'overcomplete' orienting basis will to some extent interfere with a correct execution. Functionally the orienting basis will be, in this instance, less than a complete basis" (Haenen, 1996, p. 153).

This teaching strategy is commonly used in teaching settings (Haenen, 1996). Both Vygotsky and Piaget came to the conclusion that children cannot form and use genuine concepts before the age of 10-12 years. Gal'perin was of the opinion that the fact that children show this capability at the age of 10-12 years should not be explained in terms of inherent regularities in the minds of the children, but instead in terms of teaching strategies. According to Gal'perin, most teaching strategies fail to provide the child with all tools and conditions necessary to understand and hence accomplish the task (Arievitch & Stetsenko, 2000). Instead they only provide the child with parts of the necessary tools (Gal'perin, 1992b).

One reason why the teacher does not succeed in giving the learner all tools necessary to perform a task is that many of the rules and regularities unconsciously taken into consideration by the teacher is hidden to the learner (Arievitch & Stetsenko, 2000).

6.4.2. Teaching strategy II

The second teaching strategy is based on the second SCOBA type (see Table 2). The SCOBA is concrete, complete and ready-made provided (Haenen, 1996). The complete orienting basis provides the learner with all information necessary to correctly perform the action (Gal'perin, 1969).

> Since such a complete scheme is at hand, the learners' involvement in the very process will grow. Fluctuations in the quality of the execution from one learning task to the next are insignificant and consequently the learners' attitude toward learning will change. (Haenen, 1996, p. 153)

By means of the second teaching strategy, the learner performs the action faster than with the previous teaching strategy (Gal'perin, 1969). The conditions are organised in an understandable system in a generalised symbolic form (Arievitch & Stetsenko, 2000). The learner can directly use the system as a whole as a new cognitive tool. When using the tool to solve a problem the usage goes through a series of transformations to become internalised. However, the instruction is based on empirical concepts, in which the inner logic in a given domain is hidden to the learner. This limits the performance of the learner and the cognitive tool acquired by the learner can only be used for a limited number of tasks in a given domain (Arievitch & Stetsenko, 2000). This is a shortcoming of the teaching strategy (Gal'perin, 1992b).

> The orienting basis for every new class of learning task must be indicated a new, because transfer remains limited. The scheme of conditions for a new task can be found empirically by checking to what extent the conditions are still valid. (Haenen, 1996, p. 153)

Because of the need of checking the validity of the conditions for new tasks, Gal'perin used the term empirical when referring to the second teaching strategy (Haenen, 1996).

6.4.3. Teaching strategy III

The third teaching strategy is based on the third SCOBA type (see Table 2). The SCOBA is general, complete, and guided constructed (Haenen, 1996). The teaching strategy is more complex than the two previous ones (Gal'perin, 1969). Under the teacher's guidance, the learner creates a complete orienting basis for the learning task (Haenen, 1996). This type of teaching strategy provides the learner with tools for theoretical generalisation, which allows the learner to understand the phenomena under study (Gal'perin, 1992b). It makes it possible for the learner to acquire a general method to construct a foundation of understanding to solve any problem in a given domain (Arievitch & Stetsenko, 2000). Gal'perin (1969, p. 252) stated that with this teaching strategy "the subject learns general methods of analysis at the same time that he learns acts connected with concrete phenomena".

Learning by means of the third teaching strategy always means that the child actively investigates a phenomenon in cooperation with a teacher. Symbolic and graphical models of the relation between objects are commonly used (Arievitch & Stetsenko, 2000). By the aid of the third teaching strategy the learner can "correctly execute new tasks from the very beginning" (Gal'perin, 1969, p. 252). The central factor that determines the potential of development of a specific type of instruction is the quality of the cognitive tools, which is offered the learner trough the instructions (Arievitch & Stetsenko, 2000). If the amount of tools is insufficient and empirical concepts are used, the potential of development is relatively limited. On the other hand, if the amount of tools is sufficient and based on theoretical concepts, the instructions can result in profound progress in the development. The instruction then generates a direct cognitive development (Arievitch & Stetsenko, 2000).

According to Gal'perin (1969, p. 252)

> … [e]rrors are insignificant in instruction with the third type of orientation. They occur primarily at the beginning of training and relate almost entirely to instruction in the analysis of the condition for the new task.

The teaching strategy is of psychological and educational relevance and interest, since it can be viewed as “an example of teaching in ‘the zone of proximal development’” (ZPD) (Haenen, 1996, p. 154).

By means of the third type of instruction Gal’perin showed that 6 years old children could learn mathematical concepts not usually acquired until the age of 10-12 years. The six years olds not only developed their capabilities in the domain, which the instructions concerned, that is mathematics, but also developed other cognitive functions as well (Arievitch & Stetsenko, 2000).

Hence, this third instruction type is preferable in learning settings, e.g., when learners learn to use CSCW systems. Under the teacher’s guidance, the learner will create a complete orienting basis which can be used for the learning task, as well as for related tasks. This teaching strategy does not take longer time than the other teaching strategies (rather it takes less time, since the learners learn correctly in the beginning and can apply the knowledge on similar tasks), and hence, it is not more costly than the other strategies. The difference between the strategies is the way information is presented to the learner, and how the learners will work with the information.

6.5. Critique of the systematic formation of concepts and thought

The role that Gal'perin ascribed to material action has been widely criticised. Gal'perin thought that all mental actions are shortened and transformed material actions and the outcome of an internalisation process. According to the critics, one of the problems is that Gal'perin stated that mental actions preserve the deep structure of material actions (i.e., a mental action "is conceived in a way isomorphic to the material action" (Haenen, 1996, p. 187)) and at the same time mental actions are not considered a replica of the material action. However, Gal'perin never considered mental and material actions morphologically equal. According to him, the equivalence between the two forms of actions can be seen as a functional isomorphism. "The two forms are not the same, but functional relations in the material action are directly related to functional relations in the mental action" (Haenen, 1996, p. 187).

Another problem concerning material action was raised by Van Oers (1987, in Haenen, 1996). Van Oers stated that hands-on manipulation of external objects could, instead of supporting the teaching-learning process, overturn it. Learners can begin to expect that abstract qualities have concrete existences. Consequently, a material action can be a psychological barrier. Nelissen (1987, in Haenen, 1996) shares Van Oers' view. According to Nelissen, material actions are ineffective in education of mathematics. The learners become dependent upon the objects used and cannot transfer the actions to other classes of material objects. It is true that Gal'perin emphasised material action. However, according to Gal'perin, materialised actions are preferable to material actions. Gal'perin discovered three shortcomings of material actions (Haenen, 1996): it is often impossible or impractical to use material objects, a material action "is bound up with the physical structure of the objects themselves" (p.189), and a material action "may encourage a narrow epistemological attitude among learners and create, in a sense, an 'applied' rather than a 'theoretical' attitude toward the reception and (re)production of knowledge" (p. 189). Of course, this issue is dependent to the task to be learned.

According to Menchinskaia (in van der Veer, 2000) and Kalmykova (in Haenen, 1996), Gal'perin's research program has a narrow range of applicability and is very limited. Kalmykova made experiments which show that pupils, by means of Gal'perin's approach, have difficulties solving school book problems.

Gal'perin has also often been criticised for viewing the learner as a passive recipient of information and for "designing an expository or 'one-way' teaching strategy with an extremely high amount of teacher guidance, which leaves the learner no room for initiative" (Haenen, 1996, p. 193). According to Kalmykova, Menchinskaia, Freudenthal and Iakimanskaia (in Haenen, 1996) passivity of the learner can hinder the development of productive or creative thinking. Menchinskaia and Kalmykova argued that the learner should be viewed as an active participant in the learning process, in which knowledge is (re)constructed. However, it can be questioned if Gal'perin did view the learner as a passive recipient. According to Arievitch and Stetsenko (2000), Gal'perin was of the opinion that for appropriation of mental actions to take place, it is important that the learner *actively* investigates phenomena under a teacher's guidance. For further details of criticism raised against Gal'perin, see e.g. Haenen (1996) and van der Veer (2000).

6.6. Summary

Gal'perin was influenced by Vygotsky, Leont'ev, Pavlov, and Marx and extended their works. He concluded that

> ...[p]sychology is concerned with mental (ideal) orienting activity stemming from material (practical) activity and emerging as the final product in the course of internalization. (Haenen, 1996, p.112)

According to Gal'perin orienting activity is the subject matter of psychology. Orienting activity can be carried out owing to mental actions. Gal'perin distinguished a number of stages, which are gone through during the formation of mental actions. First, the student has to be motivated to learn. The learner must also get an explanation of the action to be learned, which should include, e.g., the means used and the goal of the action. A SCOBA (Scheme of Complete Orienting Basis of an

Action) should be appropriated by the learner. Material or materialised objects are essential during learning, since mental actions are transformed and shortened material(ised) actions. Overt and covert speech is also of importance for the formation of mental actions. Finally, after the stage of covert speech the action is performed entirely in the mind and is quickly and faultlessly performed.

Every action can be characterised by four parameters (level of appropriation, degree of generalisation, degree of abbreviation and degree of mastery). The parameters must change in intended directions for a full-fledged mental action to be appropriated.

Gal'perin distinguished three types of SCOBAs, which correspond to three types of instructions or teaching strategies. The third SCOBA, which is general, complete, and guided constructed, provides the appropriation of a full-fledged mental action. This teaching strategy implies that the learner actively investigates a phenomenon under teacher's guidance (Arievitch and Stetsenko, 2000).

7. Summing up

So far, we have seen that CSCW is a growing field, which aims at supporting group activities by means of technology. There is no coherent definition of CSCW, since different authors have differing views of what should be included in the term. The research context differ between the United States, and Europe. In the United States, focus is on small groups, with less than three or four participants. In Europe, on the other hand, focus is on larger project groups, with six or more participants. There are a number of different CSCW systems. They can be classified in different ways. The most common way is by using a time/geographical location matrix, with four categories: synchronous/collocated systems (e.g., meeting support), synchronous/ remote systems (e.g., videoconferences), asynchronous/collocated systems (e.g., argumentation tools), and asynchronous/remote systems (e.g., email). Systems can also be categorised according to the kind of support they offer, and by the degree of sharing they provide. There are several advantages with CSCW. For instance, using CSCW technology can be economically beneficial (Kraemer & King, 1988). CSCW systems can also make communication possible, which would not otherwise be possible (Dix et al., 2004). It can also make communication clearer (Olson & Olson, 2003). However, there are also issues, and aspects that have been overlooked within CSCW. One aspect that has been, more or less, neglected is the aspect of learning (Venkatesh, 2000; Wulf, 1997). Users, especially novices, often have problems learning, and understanding, the systems and their functions (Wulf, 1997). Despite the fact that organisations spend as much as $20B each year on computer-related education (Venkatesh, 2000), only 10 % of all education leads to an altering in the users' behaviour (Georgenson, 1982; Venkatesh, 2000). Therefore, there is a need for more effective education, pecially for CSCW learners. Subsequently, theoretical frameworks, which include theories of learning is necessary for the field of CSCW.

Activity theory is one widely used theoretical framework within the field of CSCW. Almost all parts of activity theory are commonly applied to the field. However, the learning theories within activity theory do not seem to have been used within CSCW.

Because of the learning problems within CSCW, it seems proper to apply also these learning theories to CSCW. Gal'perin developed activity theory further and focused on learning. His research program does not seem to have been used within CSCW at all. Both Leont'ev's activity theory and Gal'perin's research program may be useful to support learning within CSCW. Both Leont'ev's and Gal'perin's works have their origin in the works of Vygotsky. Therefore, in order to understand Leont'ev's, and Gal'perin's theories Vygotsky's cultural-historical theory has been described.

Vygotsky emphasised the role of social interaction for learning and development. He claimed that it is during cooperation that humans develop. All knowledge is first interpsychological before it, through internalisation, becomes intrapsychological. He introduced the concept of the ZPD, which is the distance between a learner’s actual developmental level, and the level of potential development. Tool use is characteristic for humans. There are both psychological and technical tools, which mediate activities. One of the most important tools, according to Vygotsky, is speech. He distinguished two types of concepts used in verbal interactions: scientific, and everyday concepts.

Leont'ev developed Vygotsky's theory further into activity theory. Activity is a key concept within the theory. An activity is always directed towards an object According to Leont'ev, activities consist of actions, which in turn consist of operations. During learning, actions become automated, and thereby become operations. Hence, the border between actions and operations is indistinct. The border between actions and activities is also blurred. Because of the continuous changes between activities, actions and operations, activities always develop. Just as Vygotsky, Leont'ev emphasised the importance of the social context, tool mediation, and internalisation and externalisation. In the activity system model the relations between individual, community, tools, and objects are illustrated.

Gal'perin developed both Vygotsky's, and Leont'ev's theories further. According to Gal'perin, the subject matter of psychology is orienting activity, by which humans are guided. Orienting activity is possible owing to mental actions. Therefore, Gal'perin's research program focuses on the action level. Focus is on how actions are transformed from material to mental form. Gal'perin identified four prerequisites for the formation of mental actions: the learning motive, the orienting basis, the four parameters of an action, and the stepwise procedure. The first three prerequisites are integrated in, and constitute, the fourth. The stepwise procedure consists of six stages: the motivational stage, the orienting stage, the material or materialised stage, the stage of overt speech, the stage of covert speech and the mental stage. During the stepwise procedure the orienting basis of an action (OBA) is transformed into a scheme of complete orienting basis of an action (SCOBA). Gal'perin experimentally investigated three types of SCOBAs, which correspond to three teaching strategies. The third teaching strategy, based on a SCOBA, which is general, complete, and guided constructed, is superior to the other two strategies.

Hence, we have seen that there are a lot of advantages with CSCW, but also problems. The aspect of learning seems to have been overlooked. Vygotsky's, Leont'ev's, and Gal'perin's approaches, which include theories of learning, have also been described. In the next chapter, these learning theories will be applied to CSCW in order to investigate the contribution they can make to support learning of CSCW systems.

8. The learning theories applied to CSCW

The previous chapters (Chapters 4-6) described Vygotsky's cultural-historical theory, Leont'ev's activity theory, and Gal'perin's research program. In this chapter the theories of learning are applied to CSCW. This chapter includes an analysis of the applicability of the theories within CSCW as well as descriptions of what the learning setting within CSCW ideally should look like. The analysis does not focus on separate, specific systems, but has a general focus and only differentiates between categories of systems. The categories of the time/geographical location matrix (see Section 2.4.1) will be the basis. While systems and tasks may be more, or less complicated, the analysis takes, for the sake of simplicity, what might appear as less complicated tasks as examples (such as sending an email).

What is of interest to the area of CSCW is that the learning approaches described in the previous chapters include aspects of the learning situation, the role of the teacher, and the learning process. In this chapter, a discussion of these aspects within CSCW is presented. Gal'perin's research program is of special interest in this thesis, since it concerns how to learn new tasks correctly. In section 8.1 the most important aspects of the three theories of learning concerning the learning situation are described. Section 8.2 focuses on Gal'perin's theories about teaching strategies, and the role of the teacher. Section 8.3 discusses the stages that needs to be gone through during learning, identified by Gal'perin: motivation, orientation, materialisation, covert speaking, overt speaking, and mental action, respectively. Finally, in section 8.4 the findings are summarised in the form of a number of guiding principles.

8.1. The learning situation

The learning approaches described in the previous chapters include statements about some conditions of the learning situation, which are advantageous to learning. Therefore, it is important to take these conditions into consideration within CSCW, when considering learning of CSCW systems. In this subsection, the aspects of the learning situation are applied to CSCW.

All three approaches of learning, previously described in this thesis, emphasise the importance of the social-cultural context (cf., e.g., Section 4.3). Through participation in social settings humans can reach higher mental functions, such as learning to use CSCW systems. Therefore, learning of CSCW systems should take place in a social context. Higher mental functions are mediated by cultural tools, that is, psychological or technical tools, e.g., procedures or models. The tool used is dependent on the cultural context. The tools make the activity or action possible. Hence, it is of importance that the right tools are used during learning of CSCW systems (further discussed in section 8.3.3). It is during cooperation that individuals expand their capabilities. During learning, interpsychological knowledge is internalised and becomes intrapsychological knowledge. The concept of the ZPD refers to the distance between a learner's actual level of knowledge and the level of knowledge reached in cooperation with more skilled persons. Applying this theoretical view to CSCW systems, would mean that knowledge about a CSCW system first exists at an interpsychological plane, before becoming intrapsychological knowledge. It also implies that a learner of a CSCW system needs a more knowledgeable person (a teacher). The more knowledgeable individual guides the learner. The teacher needs to discern the learner's actual knowledge of computers and CSCW systems to know where to start the guiding process. Verbal interaction is an important factor. The teacher uses speech as a mediating means. The teacher should guide the learner through all stages and ask guiding questions, or provide guiding comments, e.g., "Why?", "How do you mean?", "Please, clarify what you mean", and "That is right". During learning the learner appropriates scientific concepts, e.g., the concept of network connection. Through such concepts, the actions constituting the activity of learning to use CSCW systems can be more generalised, i.e., approach the mental forms.

Depending on the kind of system to be learned, the teaching-learning situation looks different. When learning to use *synchronous/collocated systems* the users work at the same place. No matter if all the users are learners, or only one of them is, just one teacher is needed. The teacher has a view of all the learners and can guide them. During learning of *synchronous/remote systems*, on the other hand, the ideal would be to have one teacher for every learner. One teacher cannot guide all of the learners, since they are at different places. Even though the systems can be used for communication and guidance, the learners cannot use the system before they have learned at least some basic functions. It is not possible to take turns in learning the system either, because the learner cannot learn to communicate with other participants by using the system one by one (then, there are no other participants to communicate with). Hence, the need for one teacher for every learner. It may be possible to let, for instance 3 learners at a time learn the system. In that case, there is only a need for three teachers. It may also be possible to gather all participants in one room during the learning process, and only use one teacher. However, then, the learning situation is different from the work situation, which is not to prefer (cf. the importance of the socio-cultural context above). Learners learning to use *asynchronous/collocated and asynchronous/remote systems* work at different times. Since the learners do not need the teacher at the same time, it may be enough with one teacher, which alternates between the learners. For some asynchronous/remote systems, e.g., email systems, several learners can use one computer each but work at the same time in the same room during the learning process. Then, one teacher may be sufficient. Hence, the number of teachers needed is dependent on the number of learners, and the category of system to be learned.

All activities are object oriented (cf. Section 5.2.1). An activity can be seen as a link between the subject and the object. An activity is composed by a number of actions. Actions in turn, consist of operations. During learning the border between operations and actions (in Leont'ev's meaning) are indistinct and change. Changed circumstances can also make the border between activities and actions blurred. Hence, activities, actions and operations continuously develop. The activity system model (cf. Section 5.3) illustrates the relation between subjects, tools, objects and the community. It is of importance that the learner and the teacher both know and share the same object of the activity. A discussion of the object may be needed before the beginning of the learning process. The goal of the actions, which constitute the activity, must also be clarified for the learner (further discussed in section 8.3.2).

This subsection can be summarised as *learning should take place in a social-cultural context. The learner needs guidance by a more skilled person. The number of teachers needed depends on the number of learners, and the category of system to be learned.*

Gal'perin's research program focuses on actions, and in particular the formation of mental action, or learning of action. Therefore, it is of special importance in this thesis. The systematic formation of mental action can be seen as a teaching strategy within the ZPD. The next section describes the most preferable teaching strategy identified by Gal'perin and its application to CSCW.

8.2. Teaching strategy

Gal'perin distinguished three teaching strategies. One of them is superior to the other two. It is based on a scheme of complete orienting basis (SCOBA), which is general, complete and guided constructed (cf. section 6.4). This teaching strategy could possibly be used in the teaching-learning process within CSCW. The learner should actively participate in the process. Different material should be used, e.g., graphical and symbolic models of network connections. The learner will be given all information necessary to understand every operation of an action and to be able to get an overall picture of it. Using this teaching strategy means that the stages of learning identified by Gal'perin are gone through. In the next section, the stages applied to CSCW are described.

This subsection can be summarised as *during learning of CSCW systems, the teaching strategy based on a SCOBA, which is general, complete, and guided constructed should be used.*

8.3. The learning process

Gal'perin distinguished four prerequisites for the formation of mental actions. The first three, the learning motive, orienting basis, and the four parameters of an action, are integrated in and constitute the fourth, the stepwise procedure (cf. Section 6.3).

Since the first three prerequisites are integrated in the fourth, they will not be explicitly discussed in the analysis. Instead, the discussion focuses on the stepwise procedure, which consists of six stages. These stages must be considered essential for learning CSCW systems, since they are a prerequisite for the formation of a full-fledged mental action, and hence, for learning things correctly and fully. The aim of the process is to get the learner of the CSCW system to appropriate a scheme of complete orienting basis of an action (SCOBA), which can guide the learner's future actions. The SCOBA should be general, complete and guided constructed, since then the learner appropriates the knowledge to be learned, but can also apply the knowledge on similar, and related tasks. Learning needs may differ between different categories of CSCW. In the analysis of the stages, it will be explicitly described if differences between categories are assumed.

8.3.1. Motivation

The first act in the teaching-learning process of the use of CSCW systems is to motivate the learner. The goal and the actions need to be explained. For instance, with regard to learning to use a video conferencing system, it must be explained to the learner that the system can make communication between remote co-workers possible, that it can reduce cost of travelling, etc. How the system is to be used also needs to be described. Thus, for a successful learning process to take place, learners must be motivated to learn. Unfortunately, despite the fact that Gal'perin stated that it is of importance to motivate the learner, he did not pay much attention to how to motivate learners. Therefore, further investigations are needed. Ackerman also emphasised the importance of incentives, or rewards for using CSCW systems. However, it is questionable whether the meaning of motivation is the same for Gal'perin and Ackerman (further discussed in section 9.1). Venkatesh (2000) stated that game-based training increases the users' motivation to use CSCW. Venkatesh's meaning of motivation seems to be in accordance with Gal'perin's meaning of the concept (further discussed in Section 9.1). This subsection can be summarised as *learners needs to be motivated to learn.*

8.3.2. Orientation

After having motivated the learner to learn, the learner should appropriate a complete orienting basis of the action to be learned. A learner is always guided by an orienting basis of an action (OBA) (cf. Section 6.3.2). Thanks to OBAs, humans can handle new situations and new tasks. The real action is preceded and prepared by orienting activity. During learning, the OBA is supposed to be transformed into a scheme of complete orienting basis of an action (SCOBA). All properties and features necessary to understand the action to be learned must be explained to the learner. The success of the learning process is to a great extent determined by the orienting stage. Hence, before performing the action, the learner must be oriented in the action.

During the orienting stage several learners of CSCW systems can be guided by one teacher. At a general level the orienting stage can be regarded as the same for all kinds of CSCW systems. First, the learner must get an overall picture of what is supposed to be done and how. When a learner is supposed to, e.g., learn to use an email system, it must, e.g., be explained to the learner that messages are sent via the Internet, that the delivery time is very short compared to the delivery time of regular mail and that it is possible to attach digital files. Information must also be given about how the action is done and what means must be used. Relations between specific operations and changes in the material used must also be explained, e.g., that the operation of attaching a file means that the receiver will receive the file. The learner must be able to observe the system. All of the six components of a SCOBA shall be explained; intended output, the pattern or model of the action as executed by an "expert", the means of the action, the objects of the action, a general plan of action, and the orienting chart (a cheat sheet). Since the activity of learning to use a CSCW system includes several actions, a number of orienting charts are needed. Each orienting chart may be large. However, orienting charts are important for the learning process, and therefore, during the stage of orientation, orienting charts should be used. Even though the orienting stage, at a general level, can be seen as the same for all types of CSCW systems, different systems and tasks of course require different information about actions, relations etc.

In this orienting stage it is also necessary to get the learners to understand the concepts used in the learning task, e.g., when learning to use a videoconferencing system, it is of importance to understand the concept of video conference. Some learners may have everyday concepts of the features involved in the learning task, but they need to acquire scientific concepts. A discussion can be held, where learners give their own view of the concepts, read (working-) definitions of the concepts and give positive and negative examples of the concepts. During a discussion of the concept of video conferencing, positive examples, such as, “remote workers can talk to each other”, and negative examples (i.e., examples, which are false), such as, “it is possible for one participant to talk in private with another participant” (if this is not possible) can be given. This discussion also helps the teacher gain an understanding of the learner’s actual level of knowledge, i.e., the lower level in the ZPD. The teacher needs to guide the learners, so that they can reach a higher level. Questions, such as, “How do you know that?”, “Why?”, and “How do you mean?” can be asked. Sometimes there is conflicting information. In that case, the teacher should describe all possibilities. For instance, regarding shared documents, some systems allow modifications by two participants at the same time, while other systems do not. Giving all information helps the learner to get a holistic picture of the action to be learned.

To sum up, *before performing the action to be learned, the learner must be oriented in the action*, and *during the stage of orientation, orienting charts should be used*.

8.3.3. Materialisation

In the previous stages, the goal, properties, operations etc., of the action to be learned have been explained. To understand the action in more detail, the learner also needs to perform the action. According to Gal'perin, the material or materialised form of an action seems to be a prerequisite of its mental form. After the orienting stage, the learner should therefore perform the action by means of material or materialised objects.

Under the teacher’s guidance, the learner will begin to perform the action. The learner has at his, or her disposal the orienting chart. Gal'perin stated that to master an action, it is not necessary to remember how the action was performed by someone else, but to be able to execute it by oneself. Therefore, during learning of CSCW systems, e.g., learning to use an argumentation tool, several learners should not share one computer, i.e., each learner should perform the action by him- or herself, not just look at someone else executing the action, or take turns to perform a part of the action.

Gal'perin emphasised the importance of using different materials during learning. Otherwise, there is a risk that the learner gets used to inessential properties. The use of a variety of materials during learning provides generalisation of the action to be learned. Therefore, when learning, e.g., to use an email system, the teacher can vary, e.g., the instructions and the way the action is performed. The learner can be verbally asked to send an email to a certain address, the learner can get written instructions, the learner can get a scenario and be given the task of acting based on that, etc. The action can also be slightly different from time to time, e.g., the task can be to send an email without any attached file, with attached files, to send a regular email by typing the address and composing the message, sending an email by replying to another email, or sending an email by forwarding an email.

To fully understand the action to be learned, it may be important to use models explaining the action. The models needed differ between the different categories of CSCW systems. For all systems it is valid to show video recordings of “experts” using the systems. It can help a learner to understand how a system is supposed to be used.

When using *synchronous/collocated systems*, e.g., electronic brainstorming, users can see and talk to each other as in regular face-to-face communication. One learner can ask the other participants questions about how a certain operation affects them. It is also possible to walk around and observe the other participants screens. However, models may be needed for explaining, e.g., how the computers used are connected, and where the information is stored.

The use of *synchronous/remote systems*, e.g., videoconferences, implies users working at different locations. The learner cannot communicate with the other participants before he or she knows how to use the system, i.e., after learning. Then, the learner gets feedback, e.g., when another participant answers a question. However, before that it can be hard to understand the system. Models may be needed for explaining how it is possible (technically) to see and talk to each other via the system. Models can also be used for gaining an overview of the working situation, e.g., how many participants can participate, how to communicate, who's turn it is to talk, how one can see who is participating, etc.

During the use of *asynchronous/collocated systems*, e.g., argumentation tools, one user at the time uses the system. Hence, no one else than the learner changes the state of the system. Therefore, it seems to be easier for the learner to understand the action to be learned. Even though the operations involved may be many and complicated, the learner him- or herself does all the changes at that time. Still, a model illustrating how and where the information is stored can be needed.

Learning to understand *asynchronous/remote systems*, e.g., email systems, can be difficult since there is no direct feedback from the other participants. To fully understand the actions involved, the learner may need models illustrating how an email gets from the sender to the receiver, where the mail is before the receiver reads it, what happens when the inbox is opened, etc. Besides, it might be useful to watch the other participants' screens to see how a certain action affected them, or to send an email to oneself.

To sum up this subsection, *the learner should perform the action him- or herself, not just observe someone else perform the action. The action to be learned should be performed by means of material, or materialised objects.*

8.3.4. Overt speech

The next step in the learning process is to perform the action by means of speech instead of material or materialised objects. During the whole learning process, the learner of a CSCW system and the teacher, need to have a dialogue, in which the teacher guides the learner. Hence, the learner should be encouraged to verbally describe what he, or she, is doing. At a certain point, there is no need for the material(ised) objects anymore. The learner has reached the stage of overt speech. Instead of performing an action by means of things, the action is performed by means of concepts. The action has become more generalised.

During learning of *synchronous/collocated systems* several users work in the same room. It does not matter if all of the users are learners, or only one of them is a novice, the learner(s) should explain their actions verbally. Despite the fact that speech may be regarded bothersome for other users, it is important not to reduce the learner to silence, since it can be bad for the learning process. Instead, advantage should be taken of the benefits of communication. Besides helping the learning process, the dialogue provides the learners with the same concepts and terms.

When using the other three types of systems, i.e., *synchronous/remote, asynchronous/collocated, and asynchronous/remote systems*, the learner does not work in the same room as other users. Therefore, the learner cannot communicate with the other participants (not until he or she has learned to establish a contact via the system anyway). Hence, the dialogue is exclusively with the teacher. It is important that different teachers teach the learners the same terms, and concepts, so that the learners can communicate.

This subsection can be summarised as *the learner should explain verbally what he or she is doing*.

8.3.5. Covert speech

The next stage, the stage of covert speech, often occur spontaneously. When learning to use *synchronous/collocated systems,* it could be problematic if the learners reach the stage at different times. In that case, some of the learners still wants to speak aloud and carry on a conversation, whereas other participants need to speak quietly to themselves. Covert speech can also be intricate during learning to use *synchronous/remote systems*. The aim of the systems is to establish a communication between participants. The learner then needs to speak quietly to him- or herself during the action of communicating aloud with the other participants. This may result in interruptions, or delays in the verbal conversation. However, this is an important stage in the learning process.

Hence, *after verbal explanation the learner should be allowed to quietly speak to him-or herself during the performance of the action.*

8.3.6. Mental action

Eventually, the action can be performed fluently and unconsciously. Then, it has become a purely mental action. The action has been learned and will be correctly solved if all information necessary is accessible. The higher level of knowledge in the ZPD, earlier reached by the aid of a teacher, has become the actual level of knowledge.

8.4. Guiding principles

The aspects identified (Sections 8.1-8.3) as important within CSCW concerning the learning process, the learning situation, and teaching strategies, can be summarised in a number of guiding principles for learning to use CSCW systems. In the list below the principles are listed without any order of precedence among them. None of the aspects are considered less important than any other aspect. Several of the guiding principles are interrelated. Principles 1-3 concern the learning situation, providing a good learning process, i.e., prerequisites for a correct and effective learning. Principles 5, 6, 9, 10,and 11 relate to Gal'perin's stepwise procedure, i.e., they refer to the learning stages in the learning process. The later stages are dependent on the previous stages, and hence, these guiding principles are interdependent. There are factors, which can make the learning process possible, or help, and improve the learning process. Principles 4, 7, 8, and 12 refer to these factors. Some of the principles can be regarded as simple, but they are specified in separate principles because of their importance for the learning process. Some of the principles can also be regarded as valid for all kind of computer-related learning. However, these principles are especially important to CSCW, because of the problems of understanding consequences of actions. Besides, the principles should not be seen in isolation, but as a whole, since they are interrelated. The relations between the principles are illustrated in Figure 14. The guiding principles are presented below. They are presented according to the following structure: the title of the guiding principle, the aim of the principle, how to accomplish the principle, and an example of the accomplishment. Comments are distinguished by square brackets.

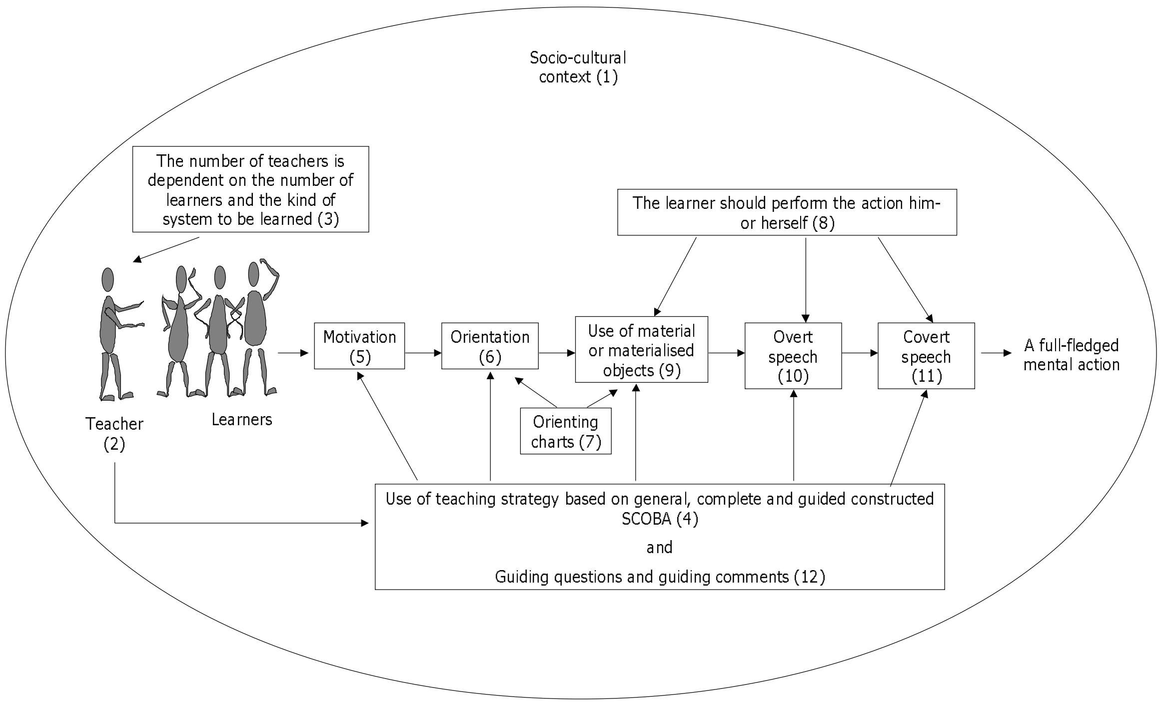

Figure 14: Relations between the guiding principles

1. **Learning should take place in a social-cultural context** (see Section 8.1).

   Aim: The aim of this principle is to create a propitious setting for learning. Human development takes place in a socio-cultural context, and hence learning cannot take place in isolation from social and cultural factors.

   Accomplishment: Let the learning situation to the greatest possible extent resemble the actual (future) work situation. The learning exercises should be realistic, and should not be simplified.

   Example: In one company with three offices, a videoconference system is to be introduced. During learning of the system, the learners learn the system at the same places as they will use the system in the future, that is in their respective offices. The learning exercise resembles a task in an ongoing project, e.g., a discussion about a design solution. The users get information related to the learning exercise from different sources, just as in reality. All the users have the roles as they usually have in the organisation.

2. **The learner needs guidance by a more skilled person** (see Section 8.1).

   Aim: The aim of this guiding principle is to create opportunities for the learners' achievement of the higher level of development in the ZPD. It is during cooperation with a more skilled person that humans develop, and therefore, teacher guidance is an important factor in the learning process.

   Accomplishment: The teacher should:

   - before the learning process:
     - obtain an overview of the activity of learning by creating an activity system model, and identify the different parts, i.e., tools, objects, outcome, individual, community, rules and division of labour (cf. section 5.3).

    - distinguish the actions constituting the activity of learning the CSCW-system.
    - distinguish the tools needed to perform the actions.
    - identify the goals of the actions
    - distinguish the operations constituting the actions.
    - identify the concepts necessary to understand to perform the actions of the activity.
    - create a learning exercise.
  - during the learning process:
    - guide the learner(s) through the stages of learning (motivation, orientation, materialization, overt speech and covert speech) (see guiding principles 5, 6, 9, 10, and 11).
    - ask guiding questions, and guiding comments (see principle 12).

Example: A design team in an organisation is given the task of learning to use an electronic brainstorming system. The teacher begins with creating an activity system model of the learning activity: *Subject* – one individual learner. *Community* – the learners, i.e., the members of the design team. *Tool*- the system, knowledge about brainstorming, models (see guiding principle 9). *Object* – the incomplete knowledge about the system, or a not yet completed brainstorming session. *Outcome* – a sufficient knowledge about the system, or a finished brainstorming session. *Rules* – [the formal and informal rules of the organisation]*Division of labour* – [the working roles, etc.]

The *actions* and *operations* of the activity need to be identified:

  - Actions: add a suggestion to the system, perceive others' and one's own suggestions, see the order of the suggestions, use the system during the discussion of the suggestions, remove a suggestion, modify a suggestion.

- Operations: For the action “add a suggestion”: push the button “new suggestion”, type the suggestion in the empty field, push the button “add”. [The operations of the other actions should also be identified.]

Goals: The goal of the action “add a suggestion” is to make a contribution to the brainstorming session by adding a suggestion. [The goal of the other actions should also be identified.]

Concepts: network, connection, storage.

The teacher also creates a *learning exercise*: a discussion of a design solution

During the learning process the teacher guides the learners and asks guiding questions.

3. **The number of teachers needed depends on the number of learners, and the category of system to be learned** (see Section 8.1).

   Aim: The aim of the guiding principle is to provide all learners with guidance. Since guidance by a more skilled person is a prerequisite of effective learning, all learners need teacher guidance.

   Accomplishment: During learning of

   - synchronous/collocated systems - only one teacher is needed.
   - synchronous/remote systems - the ideal situation would be to have one teacher for every learner. If this is not possible, all learners can be gathered at the same place, but let them communicate via the system, and then, since the learners are at the same place, one teacher may be sufficient.
   - asynchronous/collocated systems – the ideal situation would be to have one teacher, which alternates between the learners. First, one learner learns the system, then another learns it, etc. If there is no time

for such an arrangement, all learners can be gathered and learn at the same time, but use different computers instead of the same.

- asynchronous remote systems the ideal situation is to have one teacher for every learner. However, the learners can learn at the same place at the same time, and accordingly only require one teacher.

Example: Four managers in the same company, but at different cities are given the task of learning to use a videoconference system. The equipment of the videoconference system is placed at the managers' office, where the system and the equipment are supposed to be used in the future. Four teachers are involved in the learning process - one for each learner.

4. **The teaching strategy based on a SCOBA, which is general, complete, and guided constructed should be used** (see Section 8.2).

Aim: The aim of this guiding principle is to guide the learner in a way that makes the learner appropriate the learning task correctly, but also makes the learner able to apply the knowledge to similar tasks. The learner should build up a "knowledge base", by which the learner can be guided, i.e., in Gal'perin's terms a "scheme of complete orienting basis of an action" (SCOBA). The "knowledge base", or SCOBA" is a cognitive tool, and by means of the tool the learner can mentally simulate actions before performing them externally.

Accomplishment: When explaining the system, its functions and the different actions to the learner, principally in the orienting stage (see guiding principle 6), the teacher should help the learner identify characteristics of the different actions, task, and operations. Several examples should be used. During the first example, the teacher should explain how to identify the characteristics. Then the learners should work with the example by themselves (under teachers' guidance), and learn how to identify the distinguishing qualities. The active participation by the learner is important. This teaching strategy also implies that the motivational stage, the orienting stage, the material stage, the stage of overt speech and the stage of covert speech (see guiding principles 5, 6, 9, 10, and 11) are gone through.

Example: A group of learners should learn how to send an email. An email can be sent in different ways, compose a new message, reply an email, reply one or several persons, or forward an email. It is important that the learners learn to identify the characteristics of the different ways of sending the email. The teacher explains that composing a new email is useful, when the prospective receiver has not already sent an email to you. If the prospective receiver has sent an email to you, on the other hand, replying the email is recommended. If the email sent to you includes several addresses you can reply just the sender, but also choose to reply to all the addresses. This is useful, if, for instance, the sender is your manager, and she will know if you and the other employees are available at 9.00 the next day. It may be useful, not only for the manager, but also for the other employees to see your answer. Therefore, replying all addresses is suitable. Forwarding an email is recommended if you will send to a person exactly the same message as you have gotten. The teacher uses an example scenario, in which a person has received an email with the question "Where will the meeting on Monday take place?". The teacher explains that because the prospective receiver of the answer has sent you an email, replying is a good option. Then, the teacher hands out a number of different scenarios, which should be classified by the learners.

5. **Learners need to be motivated to learn** (see Section 8.3.1).

Aim: This stage of the learning process aims at motivating the learner. Motivation is a prerequisite of a successful teaching-learning process, since the learner needs to actively participate in the learning process.

Accomplishment: The teacher needs to:

- Introduce the learners to the action
    - The action can preferably be introduced by describing the problems the CSCW system aims at solving

- o Explain the goal of the action

In addition, motivation can be increased by letting the users play a networked game (for further detail, see Venkatesh, 2000).

Example: A teacher, who is to introduce a videoconference system, gathers the learners. The teacher begins by describing a problem: Our different offices in England, in the United States and in Germany, needs to have an urgent meeting. Unfortunately, there is no time for a face-to-face meeting, since the travelling time is too long. What are we supposed to do? The teacher encourages the learners to discuss a solution. They come to the conclusion that a videoconference would be useful. The teacher goes on by describing that the purpose of the meeting is to discuss the development of a certain product. The development takes place at the office in England, whereas the office in Germany has the major responsibility of the economy and the office in the United States will be responsible for the production of the product. What information is needed for the meeting? The learners discuss that all the participants needs to see the product prototype. The teacher then asks "Ok, how can we solve that?". After discussions the group comes to the conclusion that they need a camera, which films the prototype. The teacher then introduces the object camera. [etc.]

6. **Before performing the action to be learned, the learner must be oriented in the action** (see Section 8.3.2).

Aim: The aim of this stage in the learning process is to provide the learner with all information necessary to perform the action to be learned. The learner should understand the action, in order to assimilate the ability to perform the action in future stages.

Accomplishment: The teacher needs to explain or discuss with the learners:

- o what actions constitute the activity.
- o how the action should be performed, i.e., the pattern of the action as executed by an expert.

- what means are needed.
- the relations between operations and the material used.
- Intended output/come
- The object(s) of the action
- the concepts necessary to understand
    - discuss what the learners already know
    - positive and negative example
- conflicting information (if any)
- who participates
- how the participants communicate and affect each others' actions

It is also necessary to let the learners observe the system to be learned.

Example: A group of workers should learn how to use an electronic brainstorming system. The teacher describes the different types of actions of the activity: add a suggestion, see the suggestions added, see the order of the suggestions, remove a suggestion, modify a suggestion, use the system during discussion of the suggestions. The operations of the action are also presented to the learners: For the action "add a suggestion": push the button "new suggestion", type the suggestion in the empty field, push the button "add". [The operations of the other actions should also be identified.] No more material than the system is needed for the performance of the actions. The teacher also explains how the operations changes the material, for instance, pressing the button "add" means that a suggestion is added to the system, and will be shown on the screen. [The relations between the other operations and the material also needs to be explained.] The intended output of the action "add a suggestion" is an added suggestion, which is shown on the screen in the suggestion list. [The intended output of the other actions should also be explained.] The object of the action "add a suggestion" is the not yet finished and added suggestion. [The object of the other actions should also be described.] Then, the teacher discusses with the learners the concept of brainstorming, electronic brainstorming, network connection, and storage. Positive and negative examples are used, e.g., "in a brainstorming session all participants have the right to add suggestions", and "it is possible to shown a suggestion to only one of the other participants", respectively. The teacher also explains that all the members of the group can participate. Since the system is supposed to be used by collocated co-workers, they will be able to see which of their co-workers also participate. The learners will communicate verbally with each other, as they usually do, since they are at the same location. They will affect each other by adding suggestions, which will be shown on the screens.

7. **During the stage of orientation, orienting charts should be used** (see Section 8.3.2).

Aim: The aim of this guiding principle is to get the learner to appropriate a scheme of complete orienting basis of an action (SCOBA), i.e., a "knowledge base" which guides the learner's actions. By means of orienting charts, i.e., cheat sheets, which includes all information of the SCOBA, unintentional learning can take place and the learner can appropriate the SCOBA.

Accomplishment: Create a model for each action, which includes:

- the intended output of an action.
- the pattern of the action as executed by an expert.
- the means of the action.
- the objects of the action.
- A general plan of the action, an "action-algorithm" giving the course of the action and the sequences of its operations in a summarised form.

Example: A simplified example of a part of an orienting chart, illustrating actions of an email system, is presented in Figure 15**.**

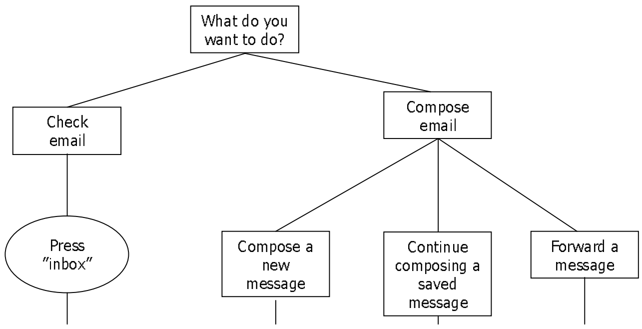

Figure 15: A simplified part of an orienting chart for actions in an email system

8. **The learner should perform the action him- or herself, not just observe someone else perform the action** (see Section 8.3.3).

   Aim: This guiding principle aims at getting the learner to assimilate the ability to perform the action to be learned. To be able to learn how to perform an action, it is of importance to execute it by oneself.

   Accomplishment: The learners should work at one computer each. Two or more learners should not share one computer or take turns to perform a part of an action. It is not sufficient to give a lecture and talk about the system and show it on a screen.

   Example: In one organisation five learners are given the task of learning a group calendar system. They learn to use the calendar in the same place as they will later use the calendar (cf. guiding principle 1), that is in their respective rooms. The system is installed at the learners' respective computers, and they use one computer each, during the learning session.

9. **The action to be learned should be performed by means of material or materialised objects** (see Section 8.3.3).

   Aim: The aim of this stage in the learning process is to get the learner one step closer to the formation of a mental action. The use of material or materialised objects seems to be a prerequisite for sound knowledge.

Accomplishment: For each action to be learned, models should be used, which:

- illustrate the action.
- explain the connection(s) between the participants.
- Explain how the connections are possible (technically).
- explain the information flow.
- illustrate how experts perform the action
- explains how to detect changes made by other participants.
- How to see one's own changes.
- How one is affected by other participants' changes.
- How the changes made affect the other participants

Orienting charts should also be used (cf. guiding principle 7).

Example: During learning to use a chat system, the learner is provided with several models explaining the action to be learned. One of the models is an illustration of an satellite placed in the earth's orbit, capturing radio waves (Figure 16).

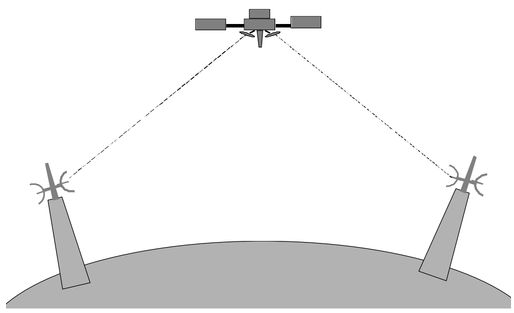

Figure 16: A satellite capturing radio waves (modified from Bandyo-padhyay, 2000)

Another model illustrates a centralised network (Figure 17) [The other models necessary for learning should also be created]

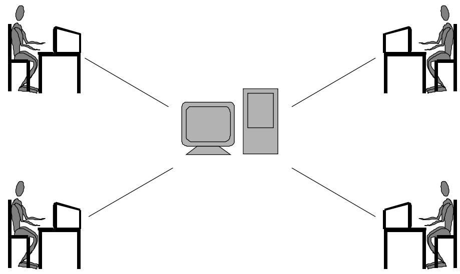

Figure 17: A centralised network

10. **The learner should explain verbally what he or she is doing** (see Section 8.3.4).

    Aim: The aim of this stage of the learning process is to get the action to be learned more generalised, and hence, a step further toward the mental form, through using speech instead of material or materialised objects.

    Accomplishment: The learner should be encouraged to verbally describe:

    - what he or she is doing.
    - why he or she is performing the operation, or action.
    - the consequences of the operation, or action.
    - how a certain operation, or action affect the other participants.
    - how other participants affect him or her.
    - what changes other participants have done in the system.

    Example: During the learning of a group decision support system one learner explains: "Ok, I push the button 'Add' here to add a suggestion. The suggestion is listed below Karl's suggestion. Now, everyone can see my suggestion. Oh, Maria just added another suggestion. I select her suggestion and push "details" to read more about her suggestion." [etc.]

11. **After verbal explanation the learner should be allowed to quietly speak to him- or herself during the performance of the action** (see Section 8.3.5).

Aim: The aim of this stage in the learning process is to let the learner take one step further toward a full-fledged mental action, through quiet speech.

Accomplishment: After verbal explanation of the action the learner often spontaneously becomes silent, but can still perform the action. Then, the teacher should not force the learner to speak verbally. It is also necessary to let the learner get the time he or she needs. The learner should not be hurried. Neither should the other participants force the learner to speak or hurry the learner.

Example: During learning of a videoconference system one learner becomes silent. The learner performs the actions correctly, but slowly. The communication via the system is delayed. Despite this, the teacher does not hurry the student.

12. **Through the whole process the teacher should guide the learner and ask guiding questions, and guiding comments** (see Section 8.1).

Aim: The aim of this guiding principle is to help the learner in the different stages of the learning process, and facilitate the learning process.

Accomplishment: The teacher should ask guiding questions, and guiding comments, such as:

- Why?
- How?
- How do you mean?
- What if….?
- That is right!
- You are on the right track!

Example: A learner learning to use a group calendar describes what he is doing. "Then I push this button…." When the learner does not explain the action in more detail, the teacher asks "Why? What will happen if you do that?" The learner answers "Well, I will be able to modify the time for the

> meeting planned." Since the answer is right the teacher comments the learner by saying "That is right!" [etc.]

The purpose of this list is to give a summarised indication of aspects based on Vygotsky's, and Leont'ev's cultural-historical theories in general, and Gal'perin's research program in particular, that may be useful when considering the teaching-learning process of CSCW systems. These guiding principles may provide a theoretical starting point for taking a closer look at, or possibly reducing learning problems pointed out within CSCW, problems that so far have been, more or less, neglected. Taking these aspects into account may also lead to more effective use of existing CSCW systems.

9. Discussion and conclusions

In this chapter, conclusions and some thoughts about the result, working process, and future work are presented. In section 9.1 conclusions are presented. In Section 9.2 reflections on the result are described. Section 9.3 is about some thoughts about the working procedure. The chapter is concluded by a discussion of possible future work (Section 9.4).

9.1. Conclusions

The main conclusions drawn from the analysis is that there are aspects in Vygotsky's and Leont'ev's cultural-historical theories, and in Gal'perin's research program in particular, which seem to be relevant for CSCW. These aspects are summarised in a number of guiding principles (see Section 8.4), which can be seen as a theoretical first step towards a closer examination, or possibly a reduction of, problems concerning learning within CSCW. Accordingly, further investigations are necessary. Considerations of the guiding principles may also lead to an achievement of a more effective use of existing CSCW technology.

9.2. Reflections on the result

When introducing new systems in organisations, personnel training is of course required. Organisations devote time to introductions of CSCW systems. Yet, users have problems learning to use the systems, or learn to use them correctly. It seems as the importance of the learning aspect has been overlooked within CSCW. Several authors emphasise the problems of learning within CSCW (e.g., Blumenthal, 1995; Venkatesh, 2000; Wulf, 1997). It appears as no guidelines have been created for how to learn CSCW systems. It can also be questioned if a sufficient amount of time is devoted to the learning of the systems. The analysis presented in this thesis indicates that the learning process cannot be hastened. Since the process of learning is stepwise, the previous stages must be finished before a new stage can be appropriated. The learner must get the time he or she needs. Of course, the time needed also depends on the kind of system to be learned.

The guiding principles identified in this thesis may be useful for the field of CSCW. The problems of learning may be reduced and hence, the CSCW applications can be used correctly and in a more effective way. However, the guiding principles are just a first step towards overcoming the problems of learning within CSCW. Each principle needs further investigation and empirical testing. The practical use of the principles have not been evaluated.

One condition of an effective use of the guiding principle is, of course, an understanding of the meaning of every principle. For instance, one of the principles stresses that material or materialised objects should be used. However, how and why the material should be used, and what material is suitable must also be understood.

In this thesis, general guiding principles applicable to all categories of CSCW systems, categorised according to the time/geographical location matrix, has been proposed, since the learning aspect has been, at least to a great extent, neglected within CSCW. It is possible that more detailed and adapted principles for the different categories could be specified if each category was studied separately in more detail.

The analysis indicates that it is essential that the learner performs the task by him- or herself. The learner cannot learn the system properly by watching someone else, be it an expert or another learner, executing the actions to be learned.

The analysis points to several responsibilities of teachers. The success of the learning-process depends, not only on the learner, but also on the teacher’s ability to guide the learner. Therefore, the teacher should have knowledge of the theoretical approaches described in this thesis. Experience of teaching from the perspective of the approaches is also desirable.

Gal'perin stated that motivation is a critical factor for learning. Ackerman (2000) emphasised the importance of incentives regarding the use of CSCW systems.

However, it can be argued that compensation may not be what Gal'perin looked for. Rather, Gal'perin looked for a genuine interest in the task to be learned. A reward system of the kind emphasised by Ackerman may motivate users to devote time to perform the task, but interest for the task itself may not become enhanced. Venkatesh (2000) showed that game-based training can increase the users’ motivation to use CSCW systems. Subsequently, it could be assumed that game-based training may increase the motivation to learn the system and its functions too.

Taking the guiding principles identified into consideration of course implies a cost. Personnel and time must be devoted. The work of, e.g., making orienting charts may also be extensive. Organisations may find the cost and work discouraging. According to Venkatesh (2000) until 1996 organisations spent as much as $20B on education, but, according to Georgenson (1982) only 10% of all education changes the users’ behaviour. Therefore, a new approach for education is necessary. Hence, taking the guiding principles into account may imply benefits. After learning, the use of the CSCW systems is possibly effective. Since the system is mastered by the users, fewer errors can be assumed to be made. When errors are made, often the users will probably know how to solve them. That means that less time for searching for and locating errors, as well as for user support is needed. Besides, without a proper learning, there is a risk that the CSCW systems will be unaccepted and unused. Hence, taking the theoretically based guiding principles into consideration could be economically advantageous in the course of time.

According to the cultural-historical theories, during activities objects are transformed into an intended outcome. Hence, the intended outcome is specified before the activity is concluded. This can be seen as problematic within the perspective of learning. The object during learning is the incomplete knowledge about the thing to be learned. The intended outcome is then a sufficient, or complete, knowledge. This means that knowledge can be seen as something “ready”, and ”well-defined”. This view of knowledge is questionable. Can we really know beforehand exactly all aspects of a learning task that we need to acquire?

Gal'perin, and Leont'ev use the word operation with different meanings (cf. Section 6.1). In Leont'ev’s meaning operations are used to denote the means by which an action is carried out, and the conditions under which an action is performed. Operations are automatic. During learning, actions are transformed into operations. Gal'perin viewed operations as components or parts of an action (Gal’perin, 1969). An action becomes automatic when the operations constituting the action become automatic. Hence, actions are not transformed into operations. This may cause some confusion when using and bringing the theories together. For instance, in Gal'perin's view, when a task has been learned, a full-fledged mental action has been developed. Within activity theory, on the other hand, a task, which has become automatic, instead implies a transformation from action to operation.

In Gal'perin's research program, four prerequisite for the formation of a mental action is specified (cf. Section 6.3). The first three prerequisites (motivation, orientation and the four parameters of an action) constitute the fourth (the stepwise procedure). Motivation is one of the first three prerequisites, but is also included in one of the steps of the fourth prerequisite. The same is true for orientation. Gal'perin stated that the prerequisites are interrelated, and that the first three prerequisites become integrated components of the fourth. However, the relation between the first three prerequisites and the fourth is still unclear, and woolly. For instance, Gal'perin does not seem to have clarified why motivation and orientation are separate prerequisites, whereas, e.g., materialisation is not, or why motivation, and orientation are both a prerequisites and parts of the stepwise procedure.

The principles specified in this thesis only concern the teaching-learning situation. Learning problems within CSCW can also be due to the development of the system, i.e., systems may have been developed without consideration of usability aspects. The systems can then be problematic to learn and understand, in spite of a good teaching-learning strategy. There is a need both for usable systems, which are easy to learn, and strategies for how to learn to use them. Therefore, guiding principles concerning learning applicable to the development of CSCW systems may also be important.

9.3. Reflections on the working procedure

The theoretical foundation in this thesis is Russian psychology, since large parts of the Russian cultural-historical theories are already used within CSCW. However, there are a number of other approaches to learning. Using another theoretical foundation as a point of departure had probably led to a different focus of the analysis and perhaps other guiding principles.

The literature used as a basis of the analysis is written in English. However, the original language of Vygotsky's, Leont'ev's, and Gal'perin's approaches is Russian. Owing to translations, and cultural differences, it is possible that some aspects has not been fully, or correctly understood. It is possible that a more detailed analysis could have been conducted if the original language had been the front source.

The analysis was limited to include only categories of CSCW from the time/geographical location matrix. Other ways of categorising were excluded. It is possible that the analysis had looked slightly different if the point of departure had been another way of categorising or if several ways of categorising had been taken into consideration.

On the whole, technical aspects have been left out in this thesis, since they appeared not to be of direct interest for the purpose of this thesis. Nevertheless, it may be possible that a more thorough knowledge about technical issues of CSCW had affected the analysis. However, the analysis concerned CSCW systems in general, and did not dig out details.

The research focus differs between Europe and the United States. In the United States focus is on small groups, whereas in Europe focus in on project groups. In this thesis both small groups and project groups are included in the term CSCW. It is possible that there are differences regarding learning needs between the two groups, which are not considered in this thesis.

9.4. Future work

Further investigations concerning the guiding principles are needed. For instance, the guiding principles specified in this thesis are theoretically constructed. No empirical studies have been carried out. There is a need to study their practical significance. Each of the stages and principles specified need a thorough investigation.

In this thesis, the purpose is to take a first step towards a closer look at learning and learning problems within CSCW. Cultural-historical theories of learning have been introduced in CSCW. The analysis indicates that the learning theories include aspects, which seem to be relevant for CSCW. Moreover, the guiding principles seem to be possible to use to support learning within CSCW. To gain a complete overall picture, it may also be necessary to investigate CSCW and cultural-historical learning theories from another perspective, e.g., examining the suitability of the cultural-historical learning theories within CSCW is most likely advisable for a comprehensive picture of the issue.

In this thesis, the point of departure has been learners with no experience of network technology. The examples, the analysis and the guiding principles have been created based on that particular group of learners. Learners with more experience may have different needs. However, the stages in the learning process seems, on the whole, to be valid even for experienced learners, since it is still actions that will be learned. The difference is that the level of actual development is higher than for inexperienced learners. Therefore, the content of the knowledge used in the stages must be different. Some stages may also be shortened or excluded, for instance, when an action to be learned resembles previously learned actions. The orienting basis used for the previous actions can then be modified to be useful even for the new action. However, further research concerning learning needs for experienced users is needed.

The point of departure in this thesis has been Russian psychology. However, there are a number of other approaches to learning, which may also be useful. Therefore, further investigations of learning within CSCW based on other learning approaches are needed.

The stage of motivation is considered important, but almost no research of motivation has been made within the framework of Gal'perin's research program. Motivation is a prerequisite for active participation of the learner, which is aimed at in the learning process. Ackerman (2000) and Grudin (1994b) also stress the importance of incentives. No matter if the view on motivation differs between Gal'perin, on the one hand, and Ackerman and Grudin, on the other, there is a need for further studies.

The orienting stage determines to a great extent the success of the learning process. The creation and use of orienting charts is an important part of the stage. Therefore, investigations of the possibility of using orienting charts within CSCW is of importance. Since every CSCW system may include several actions, a number of orienting charts may have to be created. Every orienting chart may also be large.

Within the approaches, which serve as a basis for the analysis in this thesis, the importance of tools is included. Gal'perin stated that the use of material or materialised objects is a prerequisite for the formation of mental actions. Hence, models, diagrams, etc., should be used during learning of CSCW systems. Psychological tools, e.g., procedures, are also of importance. However, the right kind of tools must be used. Therefore, there is a need to test and evaluate the tools to be used within CSCW during learning.

Vygotsky stated that an individual learns in a social context. Leont'ev and Gal'perin agreed that it is in social settings that individuals develop. Gal'perin's research program focuses on instructions rather than on social cooperation. In this thesis Gal'perin has been in focus. It has been suggested in the analysis that remote learners need one teacher each. That implies that in one location, there is just the learner and the teacher. However, it may be possible that learners benefit from learning together. Although, gathering remote learners during learning would mean changing the settings. The learning situation will then be different from the situation, in which the users later will work. The aspects of the learning situation needs to be further examined.

Vygotsky emphasised the importance of everyday and scientific concepts. In Gal'perin's research program, the importance of speech has been stressed, but not concepts as such. It is possible that an understanding of particular scientific concepts is essential for learning. The significance of the use of scientific concepts during learning of CSCW needs further investigation.

It has been stressed that trust and awareness are important factors during the use of CSCW. Working together through CSCW applications change, e.g., some social clues, which are common in customary communication. Since awareness and trust affect communication it may be presumed that they will affect learning as well. During learning the learner needs to learn the new social clues to be used during communication through the CSCW system. Therefore, the importance of awareness and trust during learning needs to be studied.

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