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ADAPTIVE EXPERTISE IN TEAMWORK ENVIRONMENT: THE IM-  
PORTANCE OF SOCIAL ASPECTS IN EXPERT WORK AND LEARNING

Master's Thesis in Education

FACULTY OF EDUCATION

Master's Degree Programme in Learning, Education and Technology

2016



Master's Degree Programme in Learning, Education and Technology		Tekijä/Author Pihlaja Kaisa	
Työn nimi/Title of thesis Adaptive expertise in teamwork environment: The importance of social aspects in expert work and learning			
Pääaine/Major subject Education	Työn laji/Type of thesis Master's thesis	Aika/Year June 2016	Sivumäärä/No. of pages 68
Tiivistelmä/Abstract <p>Today's society and modern working life is in a constant change which poses challenges for professional expertise as well as to educational systems that are expected to produce the future experts. Work tasks are becoming increasingly complex and multifaceted in which domain-specific knowledge and routine expertise may not suffice anymore, but calls for adaptive expertise: the ability to adapt in new and unfamiliar settings, use knowledge flexibly in creating high-quality, innovative solutions to problems, and to constantly learn new and renew expertise.</p> <p>The previous studies on expertise have informed our understanding about expert performance and learning of expertise, but have mainly concentrated on the cognitive aspects of expertise. Thus it is important to gain more information about adaptive expertise, and especially about the social aspects of adaptive expertise which has been studied less. Also, due to the challenging nature of expert work in modern working life and the fact that work is in increasing amounts performed in teams, this context is important to study. The current study aims at exploring adaptive expertise in working life, more precisely, in the context of teamwork environment to gain more information about the social aspects of adaptive expertise, learning of expertise, and what kind of an effect teamwork environment has in it.</p> <p>The participants in the current study were six adaptive experts from ICT domain. ICT domain was selected as the setting for studying adaptive expertise for the reasons that the domain includes knowledge workers whose jobs require specialization and adaptive expertise on specific domains, often knowledge on only one domain is not enough but diverse knowhow and skills are needed, and work is mainly done in teams. The data was gathered with semi-structured interviews and qualitative content analysis was used to analyze the interview data.</p> <p>The results of the present study give further evidence that adaptive expertise is a highly social phenomenon. Adaptive experts possess good social skills which they make use of when solving work-related complex problems in collaboration with other people, which in turn leads to further growth of their knowledge and skills. The current study also brought forward the various challenges but also the affordances of teamwork environment which not only provide for effective problem solving but also learning and developing expertise when collaborating with other people. Also, the results of this study give support to the view that ICT companies could be considered as second-order environments that promote learning of expertise. In an ICT company the continual contributions to technological and strategical knowledge means that conditions keep changing, and thus there is a need to adapt to these progressive set of conditions. This in turn means that experts need to continually redefine problems at a higher and usually more complex level that are beyond their existing competence, which in turn develops their expertise further.</p> <p>Based on the results of the current study, implications are suggested related to optimal composition of teams as well as communication and information sharing in organizations, the importance of collaborative problem solving in educating future experts, as well as how in expert research the social aspects of adaptive expertise and learning of expertise should be regarded with equal importance as the cognitive aspects.</p>			
Asiasanat/Keywords: adaptive expertise, learning of expertise, second-order environment, teamwork			

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# 1 INTRODUCTION

Earlier companies could come up with a product or service and refine it over several decades. In similar vein people could develop particular kinds of expertise and be successful within it throughout their careers (Bransford, 2007). However, today's society is often depicted with terms such as information society, knowledge society, or networked society in which rapid development of information and communication technology, growing production of knowledge, increasing amounts of information, and networking between people and organizations lead to changes in the demands of occupations and work contents (Tynjälä, Slotte, Nieminen, Lonka, & Olkinuora, 2006).

In the continuous challenge of developing new practices and social innovations, many organizations have become knowledge intensive innovation centers which demand collaborative work, networking, and transformative and creative learning. Companies need employees who can quickly adapt and learn new skills, use new technologies, and identify new opportunities that make companies more productive and profitable (Brophy, Hodge, & Bransford, 2004). Thus, information society can also be seen as learning society in which continuous development and life-long learning is needed.

Experts' jobs in a society today requires diverse skills in addition to solid domain-specific knowledge. They must have many social skills, such as communication, collaboration, and teamwork skills. They need to be able to crucially analyze, conceptualize, and synthesize knowledge, and make conclusions and decisions based on ambiguous or inadequate information (Tynjälä et al., 2006). In addition to these, self-regulation, self-reflection, life-long learning skills, and adaptive expertise, that is the ability to work in changing situations, is needed (Bereiter & Scardamalia, 1993; Tynjälä et al., 2006). Furthermore, a relatively high education, continuous on-the-job learning, and the use of ICT are essential for experts (Pyöriä, Melin, & Blom, 2005).

*Routine expertise*, the ability to excel in well-known, often highly routinized tasks, and solve problems that are familiar and expected in stable and familiar conditions (Bransford, 2001; Hatano & Inagaki, 1986; Miller, 1978; Sonnentag, Niessen, & Volmer, 2006) may not suffice anymore in the modern working life. Rather there is a need for *adaptive experts* who are able to use their knowledge and skills in novel and unexpected tasks and problem solving cases, construct new knowledge and produce innovative solutions, tolerate ambig-

ity, adapt in new and challenging conditions, and learn from new situations, challenges, and problem solving cases (Bransford, 2001; Bransford, Brown, & Cocking, 2000; Hatano & Inagaki, 1986; Hyvönen, Impiö, & Järvelä, 2014; Miller, 1978; Sonnentag et al., 2006).

Expert research and literature on expertise have informed our understanding about expert performance and learning of expertise, but has mainly concentrated on the cognitive aspects of expert performance and learning of expertise (Alexander, 2003; Brand-Gruwel, Wopereis, & Vermetten, 2005; Bransford et al., 2000; Brophy et al., 2004; Chase & Simon, 1973; Chi, 2006; Crawford, Schlager, Toyama, Riel, & Vahey, 2005; Ericsson, 2006a, 2006b; Fisher & Peterson, 2001; Gartmeier, Bauer, Gruber, & Heid, 2008; Glaser & Chi, 1988; Lajoie, 2003; Larkin, McDermott, Simon, & Simon, 1980). To better understand the phenomenon of expertise, it would be important to gain more information about adaptive expertise, and especially the social aspects of it which has been studied less. Also, due to the challenging nature of expert work in modern working life and the fact that work is in increasing amounts performed in teams, this context in itself is interesting and important to study.

The general aim of the current study is to address adaptive experts' work in team environment to gain more information about the social aspects of adaptive expertise, learning of expertise, and what kind of an effect teamwork environment has in it. To gain more insight into the social aspects of adaptive expertise, the following three research questions were set for the study: RQ1.) How adaptive experts act to enhance teamwork, RQ2.) How adaptive experts describe their learning in teamwork environment, and RQ3.) How adaptive experts perceive their working environment. To find answers to these questions, the current study explored adaptive experts in ICT domain, in Finnish, international ICT companies, which have knowledge workers whose jobs require specialization and adaptive expertise on specific domains, often knowledge on only one domain is not enough but diverse knowhow and skills are needed, and work is mainly done in teams.



## 2 THEORITICAL FRAMEWORK

In order to understand the characteristics of adaptive expertise, and to ground the need and the aims of the current study, a review of the findings of the previous expert research and theories of expertise will be explored in the following chapter. First, the conception of an adaptive expert, the focus of this study, is defined in the light of the findings from the previous studies about the characteristics of expertise. This is followed by a review of the different research traditions and expert studies, their views on expertise, and also criticism towards these traditions. After that learning of expertise is discussed in the light of experience, problem solving, process of expertise, and socio-emotional factors.

### 2.1 Adaptive expertise

There is no single and straightforward definition of an expert or expertise, resulting these terms being used rather ambiguously. In common understanding experts are often considered as people who have characteristics, extensive knowledge, and skills in a certain domain, which distinguish experts from novices and less experienced people (Bereiter & Scardamalia, 1993; Ericsson, 2006a). According to the definition of Oxford dictionary (2016) an expert is “a person who is very knowledgeable about or skillful in a particular area”. Merriam-Webster (2016) defines expert as: “having, involving, or displaying special skill or knowledge derived from training or experience”.

While it is common to identify and distinguish differences between experts and novices, there are differences to experts as well, and Miller (1978), and Hatano and Inagaki (1986) were the first to distinguish these differences. Miller identified proficient or “artisan” persons who are limited to their usual skills, and competent or “virtuoso” persons who can go beyond these limitations (Bransford, 2001; Miller, 1978). In the same lines, Hatano and Inagaki identified *routine* and *adaptive experts*, routine experts being merely skilled experts who are fairly routinized in what they do, and contrasting to this, adaptive experts who are highly competent, flexible, and more adaptable experts (Bransford, 2001; Bransford et al., 2000; Hatano & Inagaki, 1986).

In this section the characteristics of expertise is explored based on the findings of previous expert studies and literature analysis of the researchers in the field, which traditionally have concentrated on examining the cognitive aspects of expert performance and differ-

ences between experts and novices. The discussion is then extended to making a difference between routine and adaptive experts, which is an important distinction as the target group in the current study is adaptive experts.

### 2.1.1 Characteristics of expertise

There is a consensus in expertise literature about the most significant characteristics in expert performance. Those characteristics are connected to experts' *strong cognitive processes and specific approach to problems* (see table 1). Compared to novices, experts have better skills in organizing knowledge and memories, analyzing and representing problems in more abstract terms and at a deeper level, self-monitoring, and searching new information (Brand-Gruwel et al., 2005; Bransford et al., 2000; Chi, 2006; Ericsson, 2006a; Gartmeier et al., 2008; Glaser, 1992; Glaser & Chi, 1988; Hatano & Oura, 2003; Hyvönen et al., 2014; Sonnentag et al., 2006; Zimmerman, 2006).

Earlier expert studies have provided valuable information which form the basis of our current knowledge about what is expertise and how experts perform. The early studies of expertise in chess by deGroot in 1940's and later extended work of Simon and Chase in the 1950's and 1970's demonstrated that strong players are able to correctly reproduce large patterns of chess positions after only a few seconds of viewing compared to weaker players (Ericsson, 2006a). Skills similar to chess experts have been later demonstrated for experts in other domains, such as electronic circuiting (Egan and Schwartz in 1979), radiology (Lesgold in 1988), and computer programming (Ehrlich and Soloway in 1984). This superior recall ability of experts have been explained in terms of "chunking", the *ability to chunk information into familiar patterns* (Bransford et al., 2000; Ericsson, 2006a; Hatano & Oura, 2003; Sonnentag et al., 2006). However, Sonnentag et al. maintain that this is not a sufficient explanation to differences in recall.

Experts have a rich body of usable knowledge from their domain, and the knowledge they have acquired affects what they notice and how they organize, represent, and interpret information in their environment (Bransford et al., 2000). This helps in developing a sensitivity to *patterns of meaningful information* that are not available to novices (Bransford et al., 2000; Brophy et al., 2004; Chi, 2006; Glaser & Chi, 1988), which it turn affects the memory for what experts and novices see.

The experts' better ability to see and remember meaningful patterns does not however reflect a generally superior perceptual ability. Rather, it shows that experts have a great amount of *domain-specific knowledge* which enables them to excel in that specific domain. Compared to novices experts excel in *generating the best solution*, such as best solution in solving problems, or the best design in a designing task (Chi, 2006). However, there is little evidence that a person skilled in one domain could transfer the skills to another domain, thus expertise is widely regarded as being highly *domain-specific* (Bereiter & Scardamalia, 1993; Chi, 2006; Feltovich, Prietula, & Ericsson, 2006; Glaser & Chi, 1988; Sonnentag & Schmidt-Braße, 1998).

In addition to experts being able to perceive and remember patterns of meaningful information, they are also able to *see and represent problems or situations in their domain in a more deep level* than novices (Brophy et al., 2004; Chi, 2006; Glaser & Chi, 1988). Novices tend to represent a problem at a superficial level. This can be seen in studies of, for example, Chi, Feltovich, and Glaser (1981) and Weiser & Shertz (1983) where experts and novices were asked to sort problems and analyze the nature of the categories. These studies have shown that both experts and novices have conceptual categories, but experts' categories are principle-based whereas novices' categories are surface-feature oriented (Glaser & Chi, 1988).

Experts are able to *perform faster and solve problems with less effort* and with little error on their domain compared to novices (Brophy et al., 2004; Chi, 2006; Glaser & Chi, 1988). In simple tasks, such as typewriting, experts are able to perform faster than novices because they are actually faster in the skill itself, but also because their skill have become so automated that they are able to use the freed mental capacity for processing other aspects of the task (Glaser & Chi, 1988). Experts do not only have extensive domain-specific knowledge, but additionally they are good at retrieving the knowledge that is relevant to a particular task or problem. Experts' ability to flexibly retrieve important aspects of their knowledge with little effort has been explained by experts' knowledge being "conditionalized", that is, it includes a specification of the contexts in which it is useful (Glaser, 1992). People's ability to retrieve information can vary from effortful, to fluent, or automatic. Bransford et al. (2000) maintain that automatic and fluent retrieval are important characteristics of expertise, as the ease of processing some aspects of a task or a problem gives an expert more capacity to attend to other aspects of the task or problem.

Although experts can perform faster in their domain compared to novices, experts spend relatively long in *analyzing a problem qualitatively* by developing a problem representation by adding many domain-specific and general constraints to the problems (Brand-Gruwel et al., 2005; Chi, 2006; Glaser & Chi, 1988). Experts try to understand the nature of the problem in more depth whereas novices try to make maximal use of their limited knowledge, and try to solve the task or problem based on surface features.

Experts are more successful at choosing the *appropriate strategies* to use than novices. According to Chi (2006), studies have shown that compared to novices experts are better at choosing a strategy or procedure that is better for a given situation, and also they are more likely to use strategies that have more frequently proved to be effective. Also, experts are more opportunistic when making use of different information sources. Compared to novices they are better able to make use of whatever source of information is available (Chi, 2006).

Additionally, experts have shown features of *self-regulation* in their ability to monitor their current level of understanding, and deciding when it is not adequate (Bransford, 2000; Brophy et al., 2004; Chi, 2006; Gartmeier et al., 2008; Glaser & Chi, 1988; Hyvönen et al., 2014; Zimmerman, 2006). This has been shown in, for example, studies in physics where physics experts were better able to judge the difficulty of the physics problem or in chess where chess experts were more accurate in estimating the number of chess pieces they thought they could recall compared to novices (Chi, 2006).

Table 1: Characteristics of experts with regard to knowledge and cognitive processes

<b>Characteristics of experts</b>	
Possess vast amount of knowledge	<ul style="list-style-type: none"> <li>• Knowledge highly domain-specific</li> </ul>
Experts have strong cognitive strategies:	
Efficient skills in organizing knowledge and memories	<ul style="list-style-type: none"> <li>• Sensitivity to patterns of meaningful information: the knowledge they have acquired affects what they notice and how they organize, represent, and interpret infor-</li> </ul>

	<p>mation in their environment.</p> <ul style="list-style-type: none"> <li>• Superior recall ability: ability to chunk information into familiar patterns</li> <li>• Knowledge “conditionalized”: it includes a specification of the contexts in which it is useful</li> <li>• Ability to flexibly retrieve important aspects of their knowledge with little effort</li> </ul>
Efficient in analyzing problems	<ul style="list-style-type: none"> <li>• Try to understand the nature of the problem in depth</li> <li>• Represent problems in more abstract terms and at a deeper level than novices</li> <li>• Analyze problems qualitatively through developing a problem representation by adding many domain-specific and general constraints to the problems</li> </ul>
Efficient in solving problems	<ul style="list-style-type: none"> <li>• Able to perform faster and solve problems with less effort compared to novices</li> <li>• Successful at choosing the appropriate strategies</li> <li>• As their skill have become so automated, they are able to use the freed mental capacity for processing other aspects of the task</li> </ul>
Efficient in self-monitoring	<ul style="list-style-type: none"> <li>• Ability to monitor their current level of understanding, and deciding when it is not adequate</li> </ul>
Efficient in searching new knowledge	<ul style="list-style-type: none"> <li>• Opportunistic when making use of</li> </ul>

	different information sources
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Although cognitive aspects in expert performance and learning remains important, it gives one-sided picture of expertise neglecting the importance of social aspects in expert work and learning. In modern working life experts are not only engaged in multiple tasks and work actions, but they are also increasingly involved in multiple teams and networks, which require good communication, collaboration, and teamwork skills. Thus social aspect are an inevitable part of expert work, and need further attention in understanding expertise. This issue will be addresses in the current study as the social aspects of adaptive expertise in teamwork environment will be explored.

### 2.1.2 Routine and adaptive experts

Miller (1978), in his study on information system designers, identified proficient or “artisan” persons who are limited to the usual skills of their job, and competent or “virtuoso” persons who can go beyond these limitations. Later Hatano and Inagaki (1986) introduced the terms *routine* and *adaptive experts*, and these terms have become established in the expert studies to explain the differences between experts. Routine experts are merely skilled experts who are fairly routinized in what they do, and contrasting to this, there are highly competent experts who are flexible and more adaptable, so called adaptive experts (Bransford, 2001; Bransford et al., 2000; Hatano & Inagaki, 1986).

Miller (1978) studied information systems designers who worked on designing computer systems for clients that allowed them to efficiently store and access relevant information. Miller found that “artisans” (routine experts) tend to accept the problem and its limits as stated by the clients, and their approach to these problem solving tasks is primarily to find things that they have done before which can be applied to the new situation. “Artisans” attempt to solve the problem as efficiently as possible and then move on to the next task. In contrast to the “artisans” (routine experts), the “virtuosos” (adaptive experts) regard the clients’ statement of the problem being a point of departure for further exploration of the problem solving task. Also, adaptive information system designers treat their clients’ problems as opportunities for learning new by expanding their thinking and increasing their existing solution strategies (Bransford, 2001; Miller, 1978).

Thus, routine experts can be seen as having learned a set of well-known, often highly routinized tasks that can be very complex and sophisticated, and the experts become very skilled at applying them (Bransford, 2001; Sonnentag et al., 2006). Routine experts can perform in their skill fast and accurately, but without constructing or enriching their conceptual knowledge (Hatano & Inagaki, 1986). Routine experts continue to learn throughout their lives, but the learning tends to be one of becoming increasingly efficient at doing what they have been accustomed to do. Individuals characterized by routine expertise show superior performance in well-known, routinized tasks, and they are competent in solving problems that are familiar and expected.

Contrasting to this, individuals characterized by adaptive expertise are able to master problems that are novel and unexpected. Adaptive experts have such a *deep conceptual understanding* of the domain that allows for a *transfer of knowledge and skills to novel tasks* (Sonnentag et al., 2006). Rather than simply applying existing knowledge and routinely solving problems, adaptive experts seek to understand the problem and learn from the problem solving, thus at the same time construct new knowledge (Hyvönen et al., 2014).

Adaptive expertise is characterized by flexibility, innovation, creativity, and ability to adapt in new and challenging conditions (Hatano & Oura, 2003). Research has shown that adaptive experts are more *flexible in using knowledge, they see problem solving as an opportunity to broaden their expertise, they tolerate ambiguity, and adapt in uncertain and changing situation* (Bransford, 2001). Compared to routine experts, adaptive experts are more likely to relish in challenges that require them to work at the edge of their competence and go beyond their current knowledge and skills (Bransford, 2001).

According to Sonnentag and Lange (2002), high performing software professionals (adaptive experts), compared to moderately performing software professionals (routine experts), develop more comprehensive representation of the entire work task, including necessary features of co-operation with co-workers. Modern professional software development takes place mainly in project teams, suggesting that expertise in software design is not only a matter of knowledge and task strategies but also requires social and communicative skills.

Sonnentag et al. (2006) discuss field studies which suggest that high performers show better communication and co-operation competencies than moderate performers. In a field study by Curtis, Krasner, and Iscoe (1988), it was found that exceptional software designers showed superior communication skills, and much of their design work was accom-

plished while interacting with other team members. A study by Sonnentag (1995, as cited in Sonnentag et al., 2006) showed that experts did not spend more time on typical software development activities (design, coding, or testing), but were more often engaged in review meetings and spend more time in consultations compared to other team members.

Also, study by Palosaari-Aubry (2014) on adaptive expertise highlight the importance of *collaboration and sharing of expertise* in adaptive experts' work. Collaboration involves many advantages as well as challenges (Bereiter & Scardamalia, 1993; Bransford, 2001; Hakkarainen, 2006; Hyvönen et al., 2014; Palosaari-Aubry, 2014), but in challenging collaborative work situations the adaptive experts use their communication, interpersonal, and teamwork skills to proceed and find solutions (Palosaari-Aubry, 2014). Further, a study by Ferris, Witt, and Hockwarter (2001) found that social skills was more strongly related to job performance among programmers with high general mental ability (GMA) than for those with average or low levels of GMA. Thus, social skills in combination with high GMA, not high mental abilities by themselves, are related to the highest level of performance.

Research on adaptive expertise has shown that adaptive experts are more prepared and willing to learn from new situations and that they are successful learners who are able to constantly learn throughout their lives. Also, individuals with adaptive expertise do not mind making mistakes (Hatano & Inagaki, 1986), but rather making mistakes provides opportunities to learn. The reason behind the willingness to learn may be that adaptive experts view their knowledge as dynamic and evolving as opposed to routine experts viewing their knowledge as static (Crawford et al., 2005; Fisher & Peterson, 2001), and consequently this leads adaptive experts to continuously acquire new domain knowledge and skills (Bohle Carbonell, Könings, Segers, & van Merriënboer, 2015). According to Bransford (2001), adaptive expertise involves habits of mind, attitudes, and ways of thinking and organizing one's knowledge that are different from routine expertise and that take time to develop.

Table 2: Main differences between routine and adaptive experts with regard to performance, problem solving, and learning

<b>Routine experts</b>	<b>Adaptive expert</b>
Superior performance in well-known, often	Able to master problems that are novel and



highly routinized tasks	unexpected
Competent in solving problems that are familiar and expected	Ability to transfer knowledge and skills to novel tasks
Attempt to solve problems based on their former experience and knowledge	Seek to understand the problems and see them as opportunities to learn Use their communication and collaboration skills in work tasks and problem solving
Apply existing knowledge in solving problems	Construct new knowledge when solving problems
Efficient in familiar and stable conditions	Tolerate ambiguity, and are able to adapt in new and challenging conditions Relish in challenges that require them to work at the edge of their competence
View their knowledge as static	View their knowledge as dynamic and evolving
Learning tends to be one of becoming increasingly efficient at doing what they are accustomed to	Successful learners who are prepared and willing to learn from new situations, challenges, and solving problems

The target group in the current study is adaptive experts, and in this section the characteristics of adaptive experts were described making a distinction to routine experts. Although there are difference to routine and adaptive expertise, they do not oppose each other, but rather, adaptive expertise builds on routine expertise (Bohle Carbonell et al., 2015). Both routine and adaptive expertise contain the ability to perform standard, domain-specific tasks without errors, but the difference becomes manifest in non-standard, unfamiliar situation. The key characteristics that distinguishes adaptive experts from routine experts are that they are flexible, adaptive, and innovative in using their knowledge and skills when faced with novel and unexpected situations, tasks, or problems. Also, they see challenges in a positive light as opportunities to learn, and they are successful in constructing new knowledge, learn, and renew themselves throughout their lives (see table 2).

Discussing the characteristics of adaptive expertise above serves several purposes. Firstly, it defines the concept of adaptive expert, which is the focus of the current study. Secondly, it provides justification to why adaptive expertise, over merely routine expertise, is called

for in the modern society which is in constant change. And thirdly, it provides a set of criteria for selecting adaptive experts for the current study (see Appendix A).

## 2.2 Expert studies

In the following section the different research traditions and previous expert studies are discussed to give a picture of the different approaches to studying expertise, and what is their view on expertise. Also, the position that is taken in the current study in relation to these research traditions and previous expert studies is reflected.

### 2.2.1 Absolute and relative approaches

Expertise is easiest to identify when it differs drastically from what ordinary people can do (Bereiter & Scardamalia, 1993). Experts can be considered as exceptional individuals whose performance in a domain seem outstanding compared to common people. Thus, studies on expertise have traditionally been focused on *individual* expertise where exceptional people's *performance on limited domains*, such as sports, music, writing, physics, decision making, and medicine have been studied (Ericsson, 2006a).

Chi (2006) outlines two general ways in which the nature of expertise has been approached: absolute and relative. According to Chi, in the *absolute approach* studies the aim was to understand how experts perform in their specific domain of expertise, either formal or informal. Thus, the studies in the absolute approach were concentrated on studying exceptional people to understand their superior performance, and how they are distinguished from the masses.

In *relative approach* the emphasis was on viewing the differences between experts and novices in their strategies for searching for a solution. Like in absolute approach, relative approach studied the processes of performing tasks. However, the main difference between these two approaches was that the objective in relative studies was to understand how experts became that way so that others can learn to become more skilled and knowledgeable (Chi, 2006).

In relative approach expertise is seen as a level of proficiency that novices can achieve, thus expertise is being regarded as something that can be learned. Presumably the more skilled person has become expert-like from having acquired knowledge about a domain,

that is, from learning and studying (Chi & Bassok, 1989) and from deliberate practice (Ericsson, 2006b; Ericsson, Krampe, & Tesch-Römer, 1993; Weisberg, 1999). Because of this assumption, the definition of expertise is more relative, in the sense that the more knowledgeable group can be considered the “experts” and the less knowledgeable group the “novices.” Thus the term “novice” can refer to a range of non-experts, from the naives to the journeymen (Chi, 2006) (see table 3).”

Table 3: Chi's proficiency scale of expertise. (From Chi, M. T. (2006). Two approaches to the study of experts' characteristics. In K. A. Ericsson, N. Charness, P. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 21-30). Cambridge University Press.)

<b>Level of expertise</b>	<b>Description of expertise</b>
Naive	One who is totally ignorant of a domain.
Novice	Literally, someone who is new a probationary member. There has been some minimal exposure to the domain.
Apprentice	Literally, one who is learning a student undergoing a program of instruction beyond the introductory level. Traditionally, the apprentice is immersed in the domain by living with and assisting someone at a higher level. The length of an apprenticeship depends on the domain, ranging from about one to 12 years in the Craft Guilds.
Journeyman	Literally, a person who can perform a day's labor unsupervised, although working under orders. An experience and reliable worker, or one who has achieved a level of competence. Despite high levels of motivation, it is possible to remain at this proficiency level for life.
Expert	The distinguished or brilliant journeyman, highly regarded by peers, whose judgments are uncommonly accurate and reliable, whose performance shows consummate skill and economy of effort, and who can deal effectively with certain types of rare or “tough” cases. Also, an expert is one who has special skills or knowledge derived from extensive experience with sub-domain
Master	Traditionally, a master is any journeyman or expert who is also qualified to teach those at a lower level. Traditionally, a master is one of an elite group of experts whose judgments set the regulations, stand-

	ards, or ideals. Also, a master can be that expert who is regarded by the other experts as being “the” expert, or the “real” expert, especially with regard to subdomain knowledge
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Despite the many contributions to our current understanding about expertise and the advantages of absolute and relative approaches, they have also received criticism. These approaches give a static picture of expertise in merely showing what experts know and do at a given moment, and typically the tasks used in the studies have been too easy for the experts (Bereiter & Scardamalia, 1993; Bransford, 2007). Additionally, absolute and relative studies do not take into consideration the context of experts’ performance, that is, the natural settings in which the experts usually perform, such as working life in which problem solving is usually a long process that includes many subtasks (Clancey, 2006). Alexander (2003) also points out that it has proven difficult to translate the findings of the early expert studies into educational practice as the research has not been undertaken with schooling or students in mind. Additionally, these approaches do not address the question how experts acquire and maintain their expertise. Moreover, researchers in absolute and relative approaches considered expertise from a purely cognitive perspective, overlooking motivational and sociocultural forces (Pintrich, Marx, & Boyle, 1993). Without understanding those motivational and affective dimensions, it is difficult to understand why some individuals persist in their journey toward expertise, while others do not (Bereiter & Scardamalia, 1993).

In this study the view of adaptive expertise draws from both the absolute and relative approaches as adaptive experts are considered as high performers who are able to excel in their domain, but also adaptive expertise being something that can be learned by acquiring knowledge and skills from the specific domain. The current study addresses the shortcomings the absolute and relative approaches have been criticized for by studying adaptive experts in their natural settings, more precisely in working life in team environment which is a typical environment for expert work in the modern society. Also, the current study does not only explore experts’ performance (how adaptive experts act to enhance teamwork), but also how they learn and maintain their expertise in teamwork environment, concentrating especially on the social aspects of adaptive expertise.

### 2.2.2 Retrospective interview studies and studies of expertise in working life

The questions of learning of expertise, and the effect of motivational and sociocultural forces in it has been addresses in retrospective interview studies. As Sosniak (2006) explains, these studies are inherently biographical as they study life experiences. Yet instead of biographical material they rely on interviews which allow the individuals to report their experiences within the theoretical framework of the interviewer. Retrospective interview studies support a long-term perspective on the development of expertise, and allow an examination of experiences through the learner's eyes, which can be very different to what an outside observer would perceive (Sosniak, 2006). Compared to absolute and relative studies on expertise which concentrate on the examining the expert performance, relative interview studies aim at uncovering the aspects of why experts became that way. They try to shed light on how the development of high levels of talent is achieved.

As any other research method, retrospective interview studies have also their limitations. Sosniak (2006) remind that interview studies suffer from what participants are able or willing to report on their lives. Also the role of the researcher as the interviewer is central as the interview questions and interpretations of the data are directed by the researcher's subjective view and theoretical framework used in the study. However, studies concerning the development of expertise over time have little choice but to make use of retrospective interviews. Thus these kind of studies are important in their own right, and have contributed to our knowledge of expertise, especially about how expertise is learned (Sosniak, 2006).

More recently in expert studies, the focus has been on natural settings in which the experts usually perform, that is, in working life. The aim of these studies is to examine experts' performance in their natural setting in order to understand what it takes to be an expert in a work context and how expertise is manifested in those environments. These studies have provided valuable information about experts' problem solving, collaboration, and shared expertise in work context (Engeström, 2006; Hakkarainen, 2006; Hyvönen et al., 2014; Palosaari-Aubry, 2014).

Traditional view of expertise is based on individualism and vertical development in which expertise is seen to develop gradually through experience. Engeström (2006) maintains that expert work today is so complex and requires managing new situations and change that individual experts could not handle it on their own. Rather, *expertise is shared* and it can be seen as a *community endeavor*. It also calls for horizontal development, that is, perform-

ing expert work involves many competing but also complementing perspectives, theories, and knowhow, and requires being able to move between and combine them (Engeström, 2006). Thus, rather than seeing expertise as constricted to and a property of individuals, expertise can be seen as a *feature of networks* (Hakkarainen, 2006).

The current study continues in the lines of this research direction by addressing adaptive experts' performance and learning of expertise in working life, but bringing an additional perspective to it, namely the context of teamwork environment. Expert work is in increasing amounts performed in teams, and as team environment is fundamentally social in nature, studying adaptive experts' performance (how they act to enhance teamwork) and learning in this context should yield more information about the social aspects of adaptive expertise, and what kind of an effect teamwork environment has in it.

### **2.3 Learning of expertise**

As the aim of the current study is to gain more information about learning of expertise, and what kind of an effect teamwork environment has in it, it is important to review the previous research on learning of expertise. There are some common patterns that appear in the findings of retrospective interviews. The main findings from these studies point out the element of time in that specific, continued, and long-term experience with the domain is needed before a person realizes exceptional accomplishment (Ericsson, 2006b; Hakkarainen, 2006; Sosniak, 2006). However, long-term experience is not all of one kind, but involves a series of phases of qualitatively different experiences, or transition points (Alexander, 2003; Ericsson, 2006b; Sosniak, 2006).

#### **2.3.1 Experience and learning**

It is a widely accepted finding in expert studies that learning of expertise is a long process (Bereiter & Scardamalia, 1993; Bransford, 2001; Ericsson, 2006b; Hakkarainen, 2006; Hatano & Oura, 2003), but merely experience in years will not guarantee expertise. Ericsson (2006b) claims that usually over ten years of experience is needed to achieve expertise in a domain. However, there are also contradicting evidence to this, as for example in Ha's recent study it was found that ICT workers develop mastery in a technology usually in around three to five years (Ha, 2015). Also, already learners' can exhibit expert-like features at the beginning of their studies. According to Bereiter and Scardamalia (1993), ex-

pert-like students resemble experts in what they are trying to do and how they approach novel problems. Bereiter and Scardamalia also make a distinction between experts and experienced non-experts. Experienced non-experts can accumulate similar kind of experience over many year, but vast amount of experience does not qualify them as experts. Rather, their career may conform merely to routines which do not advance expertise and problem solving. Moreover, findings in several expert studies in different domains have shown that years of experience is a poor predictor of high performance (Sonnentag et al., 2006).

Experts in all fields acquire most of their knowledge through experience (Bereiter & Scardamalia, 1993). However, extensive experience on a domain does not necessarily lead to expert levels of achievement. After usually years of experience professionals reach a stable, average level of performance, and stay on this level for the rest of their lives while some continue to improve and eventually reach the highest level of mastery in their profession (Bereiter & Scardamalia, 1993; Ericsson, 2006b). Thus, for acquiring expertise, the experience in years is not as crucial as what is done during those years.

Ericsson (2006b) points out that extended engagement in domain-related activities is necessary to attain expert performance in that domain. Ericsson argues that *deliberate practice*, that is, regularly pursued purposeful and effortful learning and practice in domain-specific activities is crucial to achieve and maintain expert performance. The effects of merely accumulating more routine experience differ greatly from deliberate practice, where individuals concentrate actively in trying to go beyond their current abilities which lead to increased level of performance.

Learning of expertise involves *qualitatively different phases* which are not necessary linear. Alexander (2003) has developed a model in which individuals' progress from acclimation through competence to a proficiency to perform as expert. In these different phases the components of *knowledge*, *strategic processing*, and *interest* configure differently.

In Alexander's model, acclimation phase is the initial stage in domain expertise in which learners have limited and fragmented knowledge, which often leads them to resort to surface-level strategies. Situational interest is also common in this phase. The transformation into the next phase, competence phase, requires quantitative and qualitative changes in individuals' knowledge base. Competent individuals possess a vast body of domain knowledge which is cohesive and principled in structure. Further, they are able to apply a

mix of surface-level and deep-processing strategies, which are linked to the individual's personal interest in the domain. According to Alexander (2003), any one of the components can catapult the transition from acclimation into competence.

Contrasting to the transition from acclimation to competence by a single component, a synergy among components is required to move from competence into expertise. In addition to the knowledge base of experts being both vast and deep, the experts are also contributing new knowledge to the domain. To create new knowledge, experts must actively be engaged in problem finding and solving that push the boundaries of the domain. The use of deep-processing strategies as well as the individual interest among experts is high, which allow them to maintain their engagement over time (Alexander, 2003).

Lajoie (2003) suggest that expertise can be fostered by making the expertise *trajectory* visible to learners through models of expertise, feedback, or examples that promote the active transfer of knowledge and self-monitoring. In Lajoie's view, the transition from student to expert professional can be accelerated through effective assessment, feedback, and practice opportunities for learner engagement in realistic contexts. This means that learners should be engaged in *problem solving*, during which feedback is given on their progress. This supports the learners' to develop and critique their knowledge structures, and to adapt or restructure learning to facilitate skill acquisition.

### 2.3.2 Problem solving and process of expertise

*Problem solving* can be seen as one key component in defining expertise (Bereiter & Scardamalia, 1993), and problem solving being a key process in learning of expertise (Bereiter & Scardamalia, 1993; Brenninkmeyer & Spillane, 2008; ChanLin & Chan, 2007). Compared to novices, experts have better skills in, for example, regulating their thinking processes, organizing their memories, and representing the problems in more abstract terms (Glaser & Chi, 1988). Expert's access to and use of different types of cognitive processes informs their understanding of the problem, and enables them to successfully solve problems in a particular domain.

Bereiter and Scardamalia (1993) point out two important aspects of expertise: *reinvestment of mental resources* and *progressive problem solving*. Pattern learning (the ability to recognize meaningful patterns in information or problems) and procedural learning (learning



skills, such as driving a car, which in time become habitual) can be seen as normal learning, but what distinguishes normal learning from learning that leads to expertise is what is done with the mental resources that are set free by normal learning. Bereiter and Scardamalia (1993) call this the process of expertise: experts reinvest their freed resources back into the activity or problem rather than direct them elsewhere. What was previously learned last time is invested back into the activity or problem at a higher level. Whereas normal learners tend to aim at problem reduction, progressive problem solving exhibited by experts leads to further growth of knowledge and skills. Hakkarainen (2006) defines adaptive experts to be individuals who regularly reinvest their freed mental resources to learning new.

### 2.3.3 Socio-emotional aspect of learning of expertise

Learning of expertise is not solely a cognitive matter, but in addition to it, personal interest, values, identity as well as social support are also important in acquiring expertise (Bereiter & Scardamalia, 1993; Hatano & Oura, 2003; Hunt, 2006). Retrospective studies as well as studies concentrating on expertise in working life highlight the social and affective aspects of learning of expertise. Findings in the retrospective studies show that family influence and studying with a master teacher is an important factor in learning of expertise. Also, creating and maintaining motivation is necessary to stay with the domain (Bereiter & Scardamalia, 1993; Sosniak, 2006). One of the main findings in the study on adaptive expertise by Hyvönen et al. (2014) was that expertise is a social and collaborative phenomenon. Gaining expertise in working life is more a collaborative than an individual process in which social skills, communication, negotiation, consultation, and understanding people are emphasized as key elements.

Bereiter and Scardamalia (1993) point out that the support of second-order environments affect the motivation of individuals and thus are also important aspects in the process of expertise. Bereiter and Scardamalia claim that *second-order environments* are central for the development of expertise. Second-order environments are knowledge building environments in which knowledge building is a community endeavor. Bereiter and Scardamalia elaborate that in such environments people pursue individual projects but there are also questions or objectives common to the individual efforts. The knowledge building community provides satisfaction of people's diverse motives that they will want to belong, which

means that the individual will need to adapt to continual investment of personal resources in the advancement of knowledge. Examples of typical first-order environments are work places and schools, whereas research centers can be seen as second-order environment. Bereiter and Scardamalia (1993) also suggest that technology firms might be regarded as second-order environments as they are building up “corporate memory”, a collective, frequently unrecorded body of knowledge.

Bransford (2007) considers the hard part of being adaptive and innovative is that it often requires change in the person himself or the environment, or both. This can evoke strong emotions and take a person outside their comfort zones by forcing to unlearn old skills, tolerate ambiguity and at times even chaos in order to move forward. Sometimes this transition also requires taking risks and accepting the possibility of being wrong. According to Bransford (2007), different configurations of social and organizational supports and hindrances affect the motivation and risk-taking that often accompanies innovation.

As have been indicated in some previous studies in working life, expertise can be seen as a social and collaborative phenomenon (Hyvönen et al., 2014; Palosaari-Aubry, 2014), and gaining expertise in working life is more a collaborative than an individual process (Hyvönen et al., 2014), in which social skills are important. The current study explores these issues further and brings an additional perspective to it, namely the context of team-work environment.

### 3 METHODS

The current study is a qualitative research in which semi-structured interviews (Gibson, 2010; Kvale, 1996; Tuomi & Sarajärvi, 2002) were used to collect the data. As the aim of the study is to gain more information about the social aspects of adaptive expertise, learning of expertise, and what kind of an effect teamwork environment has in it, it was sensible to inquire about these directly from the adaptive experts themselves. Through interviews it is possible for the study subjects to express their experiences, ideas, thoughts, and perceptions (Gibson, 2010), and for the researcher to view the phenomenon from the subjects' own perspective (Kvale, 1996). However, in interview data the meaning of the material is less obvious, thus interpretation is required, for which qualitative content analysis (Schreier, 2012) was used in this study. Qualitative content analysis (QCA) is a method for describing the meaning of qualitative material in a systematic way in which the research questions specify the angle from which the data is examined (Schreier, 2012).

In this chapter the aims and research questions are stated, followed by description of the participants, study design and data collection procedure, and data analysis. Further, a detailed analysis and rationale is given to validate that the participants in this study can be considered as adaptive experts, and thus as belonging to the target group of this study.

#### 3.1 Aim and research questions

As discussed above, the current study seeks further understanding about adaptive expertise in working life in teamwork context. ICT domain was selected as the setting for studying adaptive expertise for the reasons that the domain includes knowledge workers whose jobs require specialization and adaptive expertise on specific domains, often knowledge on only one domain is not enough but diverse knowhow and skills are needed, and work is mainly done in teams. The aim of the study is to gain more information about the social aspects of adaptive expertise, learning of expertise, and what kind of an effect teamwork environment has in it. To gain more insight into the social aspects of adaptive expertise, the following three research questions were set for the study:

RQ1. How adaptive experts act to enhance teamwork?

RQ2. How adaptive experts describe their learning in teamwork environment?

RQ3. How adaptive experts perceive their working environment?

### 3.2 Participants

The participants in this study are experts (four men and two women) from ICT domain working in international Finnish ICT companies. The participants are working with complex and challenging tasks related to software development and information design in work environments that consist of multiple teams. The age of the participants vary between 35 and 49 years ( $M_{age} = 42$  years), and they all have higher education degrees. All the participants have been working in the ICT domain for over ten years. To ensure the anonymity of the participants pseudonyms are used, and no further specific information is given about their education, organization, or their position in the organizations.

The participants were selected based on criteria created for the current study to ensure that adaptive experts would be chosen for the interviews (see Appendix A). The criteria was created to reflect the common and widely accepted characteristics of adaptive experts that have been identified in previous research on adaptive expertise (Bereiter & Scardamalia, 1993; Bransford, 2001, 2007; Bransford et al., 2000; Chi, 2006; Ericsson, 2006a, 2006b; Feltovich et al., 2006; Glaser & Chi, 1988; Hakkarainen, 2006; Hatano & Inagaki, 1986; Hatano & Oura, 2003; Hyvönen et al., 2014; Miller, 1978; Sonnentag & Lange, 2002; Sonnentag et al, 2006; Sonnentag & Schmidt-Braße, 1998), which has been presented in the theoretical framework section in this report. The participants chosen for the interviews were expected to have over ten years of experience from the ICT domain, they were expected to work in expert positions in their organizations dealing with complex and challenging tasks, and to be seen as experts by their peers and foremen. Additionally, they were expected to possess adaptive problem solving skills, and have a positive attitude towards challenges, new situations, and learning new. Further, as the study aims at understanding adaptive experts' behavior and learning in teams, the participants were expected to be working in one or multiple teams. Two Finnish ICT companies were contacted to find suitable adaptive experts for the study, and the participants were chosen based on the created criteria together with the foremen in the company.

The possible participants were contacted and asked to be interviewed for the study. When contacting the possible participants it was explained that the study participants should have at least ten years of experience from the domain, they should be working in teams, and

they should be working in expert positions in their organization. By accepting the request to be interviewed, the participants implicitly accepted the idea that they are experts. As the aim of the study was to investigate adaptive experts, the first part of the interview was designed to ensure that the participants are not only experts but adaptive experts: the first set of questions were related to features of adaptive expertise, that is, if their work mostly consist of complex and challenging tasks, if they have adaptive problem solving skills, and if they have a positive attitude towards challenges, new situations, and learning new.

### **3.3 Study design and data collection procedure**

The data for the study was collected using semi-structures interviews (Gibson, 2010; Kvale, 1996; Tuomi & Sarajärvi, 2002). Six experts from the ICT domain were interviewed in October 2015. The duration of the interviews were in average 50 minutes. The interviews were recorded with an audio recorder with the participants' permission. As the participants were Finnish, the interviews were conducted in their mother tongue to ensure that they were able to fully express their thoughts.

The aim of qualitative research interview is to understand themes of the lives from the subjects' own perspective (Kvale, 1996). As Kvale explains it, qualitative research interview seeks qualitative knowledge expressed by the interviewees rather than aiming at quantifying them. Further, it seeks to understand the meaning of what the interviewees dispose about the themes of their everyday lived world as they perceive it.

Technically, the qualitative research interview is a semi-structured interviews as it is neither an open conversation nor a questionnaire with highly structured questions (Kvale, 1996), but it consists of chosen themes and questions related to those themes (Tuomi & Sarajärvi, 2002). A semi-structured interview was found to be a suitable research method for the current study as the aims is to understand the participants' experiences, ideas, thoughts, and perceptions (Gibson, 2010). In the interview the interviewer follows up the participants' answers and seeks new information about or new angles to the research topic (Kvale, 1996).

The advantage of semi-structured interview over structured interview or questionnaire is that the participants have more freedom in voicing their experiences and thoughts, and the interviewer can adapt the questions based on the situation. Also, both the interviewee and

interviewer are able to ask for clarifications if needed, and the interviewer can ask the interviewee to elaborate on subjects that seem specifically interesting and relevant for the study (Tuomi & Sarajärvi, 2002).

In this study the interview question were sent to the participants before the interviews so that they would have time to familiarize with the subject and think about their answers. This ensured that the participants would feel more confident and relaxed when coming to the interview, and by having familiarized with the questions beforehand, it would help the participants to reflect more thoroughly the themes discussed in the interview.

During the interviews in this study it was estimated that six interviews will be enough for the research purposes, as the data seemed to become saturated, that is, the same topics kept appearing in the interviews, and interviewing more participants would not bring anything new to the research data (Tuomi & Sarajärvi, 2002).

The interview questions were divided to four themes with each theme including several questions (see Appendix B). The themes and questions were formed in the light of the researcher's previous knowledge about expertise and adaptive expertise. The first theme or set of the questions was to ensure that the participants could be considered as adaptive experts. The next three themes or sets of questions were formed to give answers to the three research questions in this study:

RQ1. How adaptive experts act to enhance teamwork?

RQ2. How adaptive experts describe their learning in teamwork environment?

RQ3. How adaptive experts perceive their working environment?

### **3.4 Data analysis**

Qualitative content analysis was used as a method in analyzing the interview data. Content analysis can be seen as a method for analyzing content that is either written, heard, or seen (Tuomi & Sarajärvi, 2002), and for describing the meaning of qualitative material in a systematic way in which the research questions specify the angle from which the data is examined (Schreier, 2012). In qualitative content analysis different phases in the analysis include deciding what is interesting in the data, going through the data and marking the

points that are interesting, leaving the rest outside of the research. The marked points are then collected together to be grouped, classified or categorized (Tuomi & Sarajärvi, 2002).

In qualitative analysis the inferences made about the data are usually described as inductive or deductive. In inductive analysis, the data analysis should be purely data-driven without the previous knowledge, perceptions, or theories having an effect on the analysis (Eskola, 2001; Tuomi & Sarajärvi, 2002). This makes the very idea of inductive analysis challenging, as already forming the research questions and choosing the methodology for research will affect the type of data that will be gathered and what it will tell about the phenomenon under research. An opposite method of analysis is deductive or theory-driven analysis in which data analysis is directed by a framework of already existing knowledge or a theory (Eskola, 2001; Tuomi & Sarajärvi, 2002). Deductive analysis is typically used in research in which an existing theory is tested in new context.

The data analysis in the current study is something between these two analysis models which is called abductive, or theory-oriented approach. In abductive analysis the inferences made by the researcher fluctuates between data-driven and theory-drive analysis (Eskola, 2001; Tuomi & Sarajärvi, 2002). The previous knowledge the researcher in this study has about earlier expert studies and findings about adaptive expertise affect what the researcher notices or picks up from the data, and in that sense neither the interviews nor the data analysis can be purely objective and data-driven (inductive). However, categories for data analysis have not been decided beforehand and theory is not tested, and thus the analysis cannot be considered as deductive. Categorization of the data is created based on the themes that emerge from the interviews with the intent to capture the original ideas and wording of the participants.

The data analysis in this study is based on Miles and Huberman's view on data-driven content analysis as a three-step process (see Tuomi & Sarajärvi, 2002). The first step in the process is to reduce the data, in the second step the data is clustered or grouped, and the final step is to abstract or create theoretical concepts (Tuomi & Sarajärvi, 2002). Figure 1 present the different phases of the data analysis in the current study.

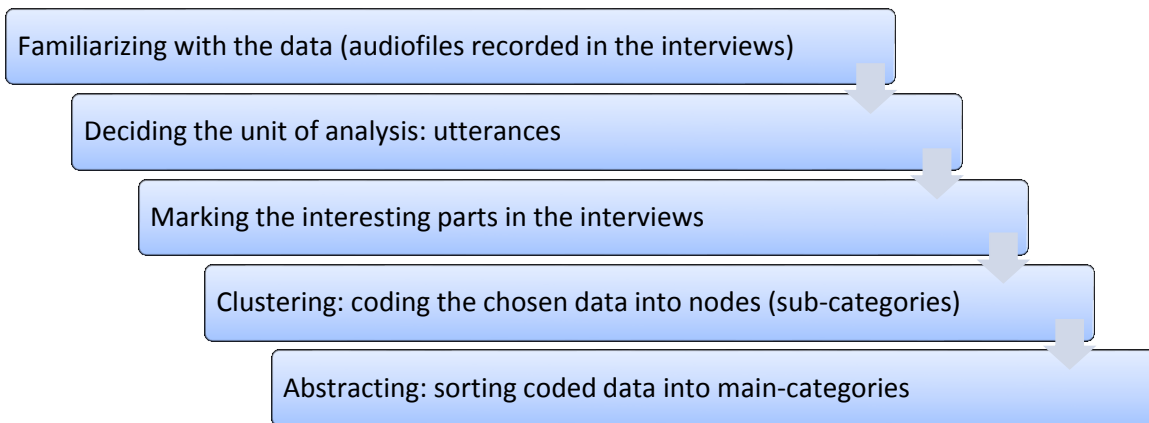


Figure 1: Data analysis process in NVivo

The data in this study was analyzed using NVivo –program. The first step in the analysis included getting familiar with the data by listening through the interviews and familiarizing with them. The second step was deciding on the unit of analysis. To capture the participants’ complete thoughts, *complete utterances* was chosen as the unit of analysis. After familiarizing with the data and choosing the unit of analysis, the data was reduced. This meant marking the interesting parts in the interviews which are directly related to and seem to give answers to the research questions, and leaving the parts out that are irrelevant for the research questions set out in this study. The parts that were left out was data that was outside the scope of the research questions and thus outside the scope of the current study.

After reducing the interview data the next step was to code the chosen data into categories in NVivo. In the qualitative coding process segments of data are identified as related to, or being an example of a more general theme or category (Lewins & Silver, 2007). In the coding phase the original expression of the participants are gone through carefully in search for concepts that depict similarities and/or differences. Similar contents and concepts are clustered under one node which is given a name that best describes the contents and concepts in the participants’ answers (Tuomi & Sarajärvi, 2002).

In the first parts of the interviews the aim was to ensure that the participants could be considered as adaptive experts. Thus, the nodes were created based on the criteria that reflect the common and widely accepted characteristics of adaptive experts that have been identified in previous research on adaptive expertise. The remaining parts of the interviews addressed the three research questions, and nodes for the remaining parts were created based



on the expressions and concepts of the participants to capture their original thoughts, ideas, and experiences.

After the clustering, that is creating nodes and assigning data into the nodes, the data was abstracted. This means that the coded data which is found to be meaningful for the study is sorted, and theoretical concepts and conclusions can be drawn (Tuomi & Sarajarvi, 2002). In practice this meant creating main categories under which the earlier created nodes were added as sub-categories. The main- and subcategories created in this study to answer the research questions are presented in table 4.

Table 4: Main- and sub-categories created in the data analysis of the current research

Research question	Main category	Sub-category	Example
	Characteristics of adaptive experts	Interviewees show features of adaptive expertise: they work with complex and difficult task and problem solving cases, they are adaptive in solving problems, they like learning, challenges and new situations, they work as experts in their organization, they have +10 years of work experience in the domain, they see themselves as adaptive experts.	<p>“My work consists mostly of problem solving.”</p> <p>“Learning new is a motivating factor in my work.”</p> <p>“I face new, challenging problems on a weekly basis.”</p>
<b>RQ1. How adaptive experts act to enhance teamwork?</b>			
	Enhance social and	Adaptive experts val-	“I try to pay atten-

	<p>emotional stability in team.</p>	<p>ue and try to enhance equality between all team members and low hierarchy. All team members are taken into account and are listened to. Adaptive experts trust other team members, and encourage and support them. Adaptive experts try to enhance good team spirit, and engage in informal social interaction with the team members.</p>	<p>tion that I listen to others.”</p> <p>“The best thing is that you can create an atmosphere where everyone’s contributions are valued.”</p>
	<p>Enhance team collaboration and shared expertise.</p>	<p>Adaptive experts share their information and know-how to others, aim at open communication, try to develop others thoughts and ideas, aim at developing uniform working methods, and solve problems collaboratively with other team members. They see that the team has a shared goal, and they try to make sure that</p>	<p>“We try to foster uniformity in how things are done.”</p> <p>“We have a shared goal and as a team we work together to reach it...and it’s our joint accomplishment.”</p> <p>“Information needs to be shared, you cannot hold it to yourself.”</p>

		team is able to reach that goal. Adaptive experts invest in team collaboration.	“When you work with others, and when you are confronted with a problem, it’s usually easier to start solving it with others.”
	Exhibit social intelligence in changing settings when interacting with different people.	Adaptive experts are sensitive to their own role in the team, and sensitive to how to behave in different settings with different people.	“There’s a certain, different setting... that define how I can approach these people.”  “My own role in the team depends on what kind of people there are.”
<b>RQ2. How adaptive experts describe their learning in teamwork environment?</b>			
	Learn from teamwork in contact with different people.	Adaptive experts learn from teamwork, from expert teams, and from different people.	“When you have different people in a team, you get different ideas...you don’t learn anything if you do things alone. You learn

			<p>things from how other do them, and how they act and think about things.”</p> <p>“Team environment is best, there you have others and you can discuss ideas with them, and at the same time you learn from others.”</p>
	Learn from everyday work	Adaptive experts learn new and maintain their expertise from practical situations, from everyday work, and from making mistakes.	“I maintain my expertise through everyday work, by seeing what others do, and solving problems.”
	Learn from problem solving cases.	Adaptive experts learn from problem solving and from challenges.	“It’s when you find a good solution to a new and challenging problem, and find a solution for it, it’s then that you learn new solution models.”
<b>RQ3. How adaptive experts perceive</b>			

<b>their working environment</b>			
	Factors that are perceived as challenging in the working environment	Adaptive experts find challenging in their working environment: orchestrating the ensemble when there are many teams working in the same field, communication and information sharing, cultural working differences, expectations from the employer, constant hurry at work, social relations in team, missing long strategical view, the need to be at the cutting edge of development, attitudes, budgets, missing support, changing projects and job content.	<p>“From organization to organization communication is always the most challenging thing, how to get the teams to work well together.”</p> <p>“International working environment brings its own challenges...many times communication takes a lot of time...at times it’s frustrating.”</p> <p>“Often teams have their own working methods, and so does individuals.”</p>
	Factors that improve working	Factors that adaptive experts find to make working easier: efficient tools for working and communication, teams and team members taking re-	<p>“There should be an encouraging atmosphere from everywhere from the organization.”</p> <p>“It helps if you</p>

		<p>sponsibility of their tasks, less bureaucracy and micromanagement, encouraging atmosphere, clear shared goals, skillful professionals, knowing your team members well, equality, good processes, information sharing, similar work culture, and formal training possibilities.</p>	<p>have seen the other team member at least once, it makes the communication more laid-back.”</p> <p>“The goal should be clear to everyone...”</p>
	<p>Factors in the working environment that develop expertise</p>	<p>Adaptive experts see working in a team to help in stress control and enable risk taking. Challenging tasks develop expertise. When being able to work with different people, getting perceptions of different people and sharing expertise enables learning new. Working with different people is a source of motivation.</p>	<p>“If you do same things for too long, it does not enhance your development.”</p> <p>“Different point-of-views from other people broaden your own perceptions...”</p>

In this type of data-driven content analysis process concepts are created and combined and this way answers to the study’s research questions are attained. Hämäläinen (1987) describes abstraction as a process in which the researcher forms a description of the subject

under study by using concepts. Content analysis is based on interpretation and inference in which the researcher proceeds from empirical data towards a conceptual understanding of the research subject (Tuomi & Sarajärvi, 2002).

### 3.5 Adaptive experts in this study

The first theme or set of questions in the interviews was aimed at ensuring that the participants can be considered as adaptive experts and thus suitable subjects for the study's aim. The results from the first set of questions is not discussed separately in the Results -section as it is not part of the research questions. Rather, the aim of the questions were to give evidence that the participants can be considered as adaptive experts.

To ensure that the participants can be considered as adaptive experts they were asked (1) if their work includes more routines or new and challenging problem solving tasks, (2) how they usually go about solving problems, (3) how they feel about new and challenging situations at work, (4) how they feel about learning new, and (5) whether they consider themselves as adaptive or routine experts. Also, they were asked if they have more than ten years of work experience in the domain, if they work in expert positions in their organizations, and if they work in at least one team.

The participants' work experience in their related domains was on average 13 years. They all work as specialists and in expert positions in their domain which was either software development or information design. All of the participants worked in at least one team, and three of them were members of several different teams, which were both international and included personnel from other (customer) companies.

All the participants' daily work included problem solving but also routine work tasks. There were differences to how the participants defined their "routine" work. David saw software development, which was his primary job, as being routine work. However, software development many times includes ill-defined problems that need to be solved. David on the other hand also saw challenging or new situations in work as normal or "routine". Ben and David identified routines, such as running automated test on software, as being something that take up their time from concentrating on real and important tasks, thus "*Routines should be reduced to minimum*" (Ben).

Routines were seen either as tasks that did not require thinking or problem solving (such as running automated tests on software) and prevent the participant from devoting their time to real, challenging problem solving tasks. Or either “routines” were seen as work that the participants do on a daily basis according to their job descriptions (e.g. software development) or phase of the project (e.g. reviewing documents according to process descriptions), which however can include problem solving tasks in themselves. In this case the participants can be seen as being so competent in their work that they see the daily tasks as “routine” although the tasks would include problem solving, flexibility and adaptive expertise.

Problem solving was related to new situations or challenging, ill-defined problems, which especially Adam and Ben identified to be part of their daily work with each day being unpredictable and bringing new tasks to be solved. *“What I do in my job role, it’s rather completely problem solving in one way or another...You could say that 90% of our job is problem solving”* (Adam). *“Every day there comes a lot of new things that need to be solved, problems, or helping others, or, it [day] is always different”* (Ben).

In problem solving situations, the participants rely either on their own knowledge and skills, or if they see that it is not enough, they turn to their team members or other people in their network for support. The participants rely on several sources of information and ways of solving the problems. As Ben explains it: *“Solving faults is, I think, the best learning environment as you have to think about the thing [fault] from many perspectives and think very carefully and concretely why it [fault] occurs that way and what is the root-cause. ... When you start solving a new problem, you have to rely on your team ‘s and other teams’ support...because the problems are always different, and in those, and especially in those, you have to go to areas you have not regarded before”* (Ben).

*“The need for problem solving increases the more you begin to understand [the substance]”* (Fiona). Both Ben’s and Fiona’s reflections indicates, that the participants have adaptive problem solving skills (Bereiter & Scardamalia, 1993; Bransford 2001, 2007; Bransford et al., 2000), and they are aware of their negative knowledge (Gartmeier et al., 2008), which have been identified as characteristics of adaptive experts. Adaptive experts spend time on analyzing the problem, and if they see that their current knowhow is not enough to solve the problem (this is defined as negative knowledge by Gartmeier et al., 2008), they readily turn to other sources of information.



New and challenging situations are part of the participants work, and predominantly the participants have a positive attitude towards them, and they see them as opportunities to learn. *“They [new and challenging situations] are of course the most interesting, you get to “chew” new things. Especially if you have time, it’s the best moment, that I enjoy the most”* (Carl). Adam’s reflection describes well what can be learned from those situations: *“You always learn new [from challenging and new situations] although you have been in this job for a long time. You learn, for example, solution models, details, your own strengths and weaknesses, improvement needs, you learn about team work and about your colleagues’ knowhow and how to make use of that. ... Because it’s close to, it is problem solving, I think you almost always learn something”* (Adam).

*“New and challenging situations are both interesting and stressful, and it’s very much related to how much time you have to be used”* (Adam). Both Carl’s and Adam’s answers reflect that they enjoy challenging situations, but feel also pressure about them mostly due to constant hurry at work. One feature of adaptive expertise is that they tolerate ambiguity and changing situations better compared to novices (Bereiter & Scardamalia, 1993). Ben’s answer reflects well a disposition to challenging situations, that even if one does not know the solution to it yet, one trusts that it will be resolved at some point of time one way or another. *“How you feel about new and challenging situations at work. They are in a way routines. ...They are nice to solve nonetheless. Essentially, as you know that the problem needs to be solved, you know that a solutions will be found”* (Ben).

One characteristics of adaptive experts is that they like to learn new things, and are considered as lifelong learners (Bereiter & Scardamalia, 1993). The participants in the study also expressed their interest in learning new, but typically due to lack of time in work they do not have the opportunities to concentrate on learning something new that is not directly related to their current tasks. *“I have been always very interested in and very open to learning new. ...It’s one of the most important factor in keeping up work motivation, that there is the possibility to learn new”* (Adam). *“I myself see it [learning] as a nice thing, I don’t see it as bad or arduous”* (Ben). *“Learning new is interesting as such, but at times there is so much other work to do that there simply is not enough time for it. Learning new always takes time, and seldom there is time given to familiarize yourself with something new”* (Elaine).

Based on their answers all the six participants exhibited characteristics of adaptive expertise and thus can be considered as such. Four of the participants (Adam, Ben, Carl, and David) agreed that they consider themselves to be adaptive experts, and two of the participants (Elaine and Fiona) felt that they consider themselves being between routine expertise and adaptive expertise.

Elaine expressed that she feels that in certain things she likes to rest on something that she has learned in the past, but on the other hand she is open to new perspectives. This is not, however, in contradiction with adaptive expertise, as adaptive experts do rely on knowledge and skills obtained in the past, and make use of those in the problem solving situations, but at the same time they are open to other perspectives and are able to implement and apply new information.

Fiona felt that she is not “an innovative person as such”. However, she also said that “*I feel that it [competence in work] has come to me along working life, as I have seen different solution models and approaches, and I can think about things from different perspectives*” (Fiona). Fiona seems to associate adaptive expertise to innovation or creativity, and does not see herself as a creative person. However, Bereiter and Scardamalia (1993) see problem solving as a link between creativity and expertise. When experts continually keep investing their freed mental resources to tackle ill-defined problems in their domain in trying to solve them, finding a solution can itself be seen as a creative achievement.

Based on their answers to the questions related to characteristics of adaptive expertise Elaine and Fiona can be considered as such. Their hesitation to label themselves as adaptive experts but rather as something between adaptive experts and routine experts can be caused by the fact that they both have just recently changed jobs - they both are working in new companies in a new positions. Bereiter and Scardamalia (1993) attribute expertise to career rather than to the person, that is, they see expertise as being connected to one's career. People can experience ups and downs in their career: they can maintain expert careers for years, but then become discouraged, or complacent or infirm, and their performance in work declines. Sometimes people's career can go into decline, but they can also pick up again (Bereiter & Scardamalia, 1993). In the case of Elaine and Fiona it can be seen that they have not lost their expertise, but rather they have momentarily ceased to maintain their expert careers as they are in new situation in having changed their jobs. Thus they are

in a point of their career that they have to redefine their expertise in the new working environment and build anew their network of colleagues they need in performing their jobs.

## 4 RESULTS

In this section the results of the data analysis are discussed in relation to the three research questions in this study, namely (1) how adaptive experts act to enhance teamwork, (2) how adaptive experts describe their learning in teamwork environment, and (3) how adaptive experts perceive their working environment. The results from the interviews are outlined in this chapter, and are further elaborated in the Discussion –chapter.

### 4.1 RQ1: How adaptive experts act to enhance teamwork

The analysis brought forward three major aspects in how adaptive experts act to enhance teamwork: adaptive experts exhibit social intelligence in changing settings when interacting with different people, they enhance social and emotional stability in teams as well as collaboration and shared expertise.

#### 4.1.1 Adaptive experts exhibit social intelligence in changing settings when interacting with different people

When roles and how the participants seen themselves acting in teams were discussed in the interviews they all saw it as being defined by their job roles as well as in what teams and with what people they are in contact or working with. *“My own role in a team depends on the job role [job description] I have...It depends if I’m acting as an expert in my own company’s team or in customer’s team...”* (Adam). *“It [own role in team] depends on what kind of people there are”* (Carl). *“There [in customer projects] is a certain, different setting... that defines how I can approach these people”* (Fiona).

The participants’ reflection indicate that they are acting in teams in a way to fulfill their expected job roles. However, in addition to that they are tuned to adapt their actions and behavior according to the situation which depends largely on the other people in it. The participants adapt their actions and behavior based on how they perceive the other people’s job roles, position in the organization, or their personality.

#### 4.1.2 Adaptive experts enhance social and emotional stability in teams

The participants' comments exhibit that they value and also try to enhance *equality* between team members, and promote *low hierarchy* in teams. Examples from Adam, Ben, and Elaine highlight this attitude towards working in teams: "*I like to think that in teams everyone's expertise could be made use of...and low hierarchy...for example I'm a project manager in my team, but I don't feel that I would be any different to others, I'm one of the team [members]*" (Adam). "*I'm a scrum master in my team, but it is not visible as I try to minimize it, I'm one actor among others, and I try to invest in our tasks and advance them...*" (Ben). "*The best thing is that you can create an atmosphere where everyone's contributions are valued*" (Elaine).

Adam, Ben, and Fiona bring up the fact that all team members are listened to and are taken into account. "*If you are helpful, and listen to others, also you yourself will receive help*" (Ben). "*I try to pay attention to listening to others*" (Fiona). Also, other team members are encouraged and supported. "*...I trust them [team members]. And I'm more a coach type of a person...and I encourage [them] to take up new types of tasks...then you learn new*" (Ben).

In all, all the participants try to *enhance good team spirit* and engage also in informal interaction with the team members to achieve this. Ben brings forward the importance of team spirit: "*Team spirit should be good... it should be possible to discuss things openly without having to think about it, that you can bring your ideas forward*" (Ben).

#### 4.1.3 Adaptive experts enhance team collaboration and shared expertise

As the above example from Ben shows, a prominent feature in the participants answers was that they all are active in *sharing their information and knowhow* to others, and generally try to aim at *open communication*. "*Information needs to be shared, you cannot hold it to yourself...it's quite open, you bring your own knowhow to be used by others, at the end it benefits everyone that information is shared*" (Elaine). "*You have to be ready to share information. ...We are colleagues, and we share information...*" (Fiona). "*I [try to enhance teamwork by] engage in conversation with others if there are some problems...I do not directly impose ready solutions...but we discuss the issue, it's important that people*

*notice themselves the problems and realize that something needs to be done about it”* (David). *“When we find something new, we teach it and give courses to others”* (Ben).

Sharing information and knowhow, and also listening to others opens up a possibility to *develop others’ thoughts and ideas*, and thus enhance the team’s work. As Adam explains: *“I try to bring my own knowhow to the team, try to listen to others’ ideas and develop them to benefit the team”* (Adam). Other ways of enhancing the team’s benefit in addition to developing on others thoughts and ideas is to aim at developing *uniform working methods*, as noticed by Elaine: *“We try to foster uniformity in how things are done”* (Elaine). *“I try to enhance the ways of working here [in the company]”* (David).

From the participants answers discussed above it can be seen that they *acknowledge the team’s benefit*, and actively try to contribute to it by working for the *team’s common good*. Important factor in it is that team is seen as having a *shared goal(s)* towards which they work in collaboration. *“We have a shared goal and as a team we work together to reach it. You have that kind of knowhow and I have this kind of knowhow, and how we, when we combine that reach the goal, and it’s our joint accomplishment”* (Fiona). *“I’m a scrum master in my team...I try to invest in our tasks and advance them. Block everything from managers if they try to give us wrong type of tasks, I try to block them so that we can concentrate on essential [tasks]”* (Ben). Ben’s statement highlights how he tries to make sure the conditions are such that the team is able to concentrate on their core tasks and reach the shared goal(s).

All the participants see the benefit in teamwork being that when they are working on ill-defined and challenging problems they can turn to their team members or people from other teams for help. *“When working with others, and when you are faced with a problem, it’s usually easier to start solving it with someone...you can solve more quickly when you work on it in collaboration”* (David). *“First you start to think about what is the root-cause behind it (the problem)...if I notice that the problem is on someone else’s competence area, I go and ask them if they know what the problem could be about”* (Carl). The participants’ answers exhibit that in their work they have to deal with novel and complex problems which are hard or even impossible to solve alone, and *working in collaboration* with other team members the problems are easier to solve.

## 4.2 RQ2: How adaptive experts describe their learning in teamwork environment

The analysis shows that adaptive experts learn from teamwork when they are in contact with different people, and when they are working on everyday tasks and solving problems in teams.

### 4.2.1 Adaptive experts learn from teamwork in contact with different people

All the participants agreed that they learn a lot from working in teams. Adam explains his preference for learning with others in the following way: *“It’s [learning in teams] more interesting, more versatile...fundamentally it’s a more motivating way to learn [compared to learning individually]”* (Adam). *“Some kind of loose team environment is the best [for learning] where you have other people that you can “juggle” the matters with, and there at the same time you learn from others, and the matters get refined. Practical situations are the best for learning...”* (Elaine).

All the participants viewed that learning in teams is enabled by having other people around you who can provide alternative views to your own. *“When you have different people in a team, you get different ideas...you don’t learn anything if you do things alone. You learn things from how others do them, and how they act and think about things”* (Fiona). *“Working in teams is perhaps the best way to get alternative, new perspectives to your work and to the challenges in the work”* (Adam). *“It broadens your own views when you hear others’ perceptions to it. That way it’s possible to think about different viewpoints to it which would not be possible to do alone”* (Elaine).

The participants viewed that a team comprised of experts is the best possible team to work in and also to learn in. However, the expertise does not have to be all of the same kind, and the group does not need to be homogenous. *“It’s not necessarily wise to have same domain, or who are very specialized, to put them in the same team because they consume each other...They should complement each other, the experts”* (Carl). *“A heterogeneous team, if there is people from different cultures and ages, men and women, and from different domains...heterogeneous [team] has that positive aspect that there is a possibility to learn a lot...It helps to think outside the box”* (Adam).

However, the prerequisite for good teamwork and learning in teams is that knowhow and information is shared. A good team is, as Adam puts it: *“...teams in which there is open*

*communication and where everyone's expertise is made use of. And in teams where there is low hierarchy and informal social interaction"* (Adam).

#### 4.2.2 Adaptive experts learn from everyday work and problem solving situations in teams

All the participants in the study brought forward the fact that they learn in teams from practical, everyday working situations and from solving problems together. *"I learn in teams in situations when there is a problem, and the other person has some specific expertise that I don't have. In that situation when you talk, you learn a lot"* (Carl). *"In work you learn the best. In the practical situations, there learning happens, both how to and how not to [do things]"* (Fiona). *"When you really probe into and look at the problem from many different angles, and when you finally find a solution to it, you have learned a lot from many perspectives"* (David).

The participants thought that working in teams is not only a way to learn new but they see it also as a way to maintain their expertise. *"Working in teams has been many times, and perhaps now for a long time, the only possible way to develop your own expertise, to get ideas and thoughts from elsewhere. When you think about work time, there's so little time and resources to invest in developing your expertise, that it [working in teams] is one of the rare, good, effective ways of developing your expertise..."* (Adam). *"I maintain my expertise through everyday work, by seeing what others do, and solving problems"* (Fiona).

### 4.3 RQ3: How adaptive experts perceive their working environment

In the current study the adaptive experts brought forward various factors from their working environment which they perceive as challenging or improving their work, as well as developing their expertise. The factors will be discussed in more detail in this section.

#### 4.3.1 Factors that are perceived as challenging in the working environment

When inquired about the challenging factors the participants perceive in their working environment, the most prominent in their answers was *communication and information sharing*. All the participants noted this as the most challenging factor in their working environment. *"From organization to organization communication is always the most challeng-*



*ing thing, how to get the teams to work well together*” (Carl). *“International working environment brings its own challenges...many times communication takes a lot of time...at times it’s frustrating”* (Elaine). Carl’s and Elaine’s examples brings forward the second most noted challenges in the working environment, that is, *organizing or orchestrating the ensemble* when there are many teams working in the same field. Also, all the participants work in international companies, and saw *cultural differences* as one challenge.

According to the participants, when communication and information sharing is lacking, time is wasted and the produced results are not as good as they could be. Poorly functioning communication and information sharing can lead to misunderstandings, uncoordinated division of work, and even doing unnecessary, overlapping work in different teams. This is especially the case when working on a big and complex product (for example software), and when there are many teams working on it in multiple locations. *“The more there are people working, and especially if they are in different locations, and are not able to discuss with each other, then the palette starts to break down...”*(Fiona). In the case of complex, multisite projects the need for exact and timely communication and information sharing is of essential importance to coordinate and orchestrate the ensemble efficiently.

The participants felt that many times they are working in conditions when they do not have adequate information to perform their tasks in the best possible way, or feel that “the big picture” is missing. *“The software is so big that you are not always on the map and know what is happening [elsewhere]”* (David). This again is connected to lack of communication and information sharing.

International, multisite projects also brings the aspect of multiculturalism to the participants’ work. It was seen as a challenge in a sense that as the teams are dispersed to several sites across the world different ways of working (work cultures), language barriers, and time difference complicate collaboration. *“Often teams have their own working methods, and so do individuals”* (David). *“It’s strange to me that in some cultures information is regarded as your personal asset and it’s withheld and you don’t share your knowhow because it is a competitive advantage”* (Fiona). *“I’ve noticed that people from different cultures have different ways of thinking about for example how a project is done”* (Adam).

As discussed previously the participants try to enhance social and emotional stability in teams, and some of the participants also saw *social relations and attitudes* in teams as challenging factors in their working environment. *“There has been easy teamwork environ-*

*ments and challenging ones. It depends on the people's personalities. ... It depends on the team how much care it needs, it depends on the people there are*" (Fiona). *"The type of personalities that do not give up on their point of views are difficult, it kills the teamwork that they are so dominant..."* (Ben).

Other factors that the participants see as challenging in their working environment is the *lack of resources* caused by restricted budgets which results in *constant hurry at work* when tasks need to be performed within tight schedules with a limited number of employees. *"We usually have our hands full of work, the schedules are very tight"* (David). *"When schedules get tighter and budgets get tighter, we need to think more carefully how to do things and what is reasonable so that we stay within the schedules and budgets"* (Fiona).

Hurry at work results in that the participants concentrate on performing their work tasks, but it does not leave room for *developing their expertise*, and also has negative effect on motivation. *"It kills people's effort ... It kills people's innovativeness when everything has been made so tight...invoicing and reporting and such...you are not allowed to use time for anything extra"* (Elaine). Developing expertise would however be very important not only for the participants but for the benefit of the companies that they work for. *"In this domain learning new is a prerequisite to stay at the cutting edge of the development... It's like we are in world championship games, we need to perform faster and better than our competitors, so that there will be enough work for us"* (Ben).

Adam and Elaine talk about how the companies should have a *long strategical view* and the companies should invest in training their personnel according to the strategies and visions. According to Adam, sometimes it seems that certain companies are missing this kind of long-term plan. *"...it depends on what customers we get and what they want and then we try to do that. It's more that we try to react to the customers' needs than try to think where we [the company] would like to specialize in, and make plans for that and people [personnel] could be trained"* (Adam).

Also, there can be a mismatch between the company management's expectations about the competence and skills of their employees and the reality. As Adam explains: *"In the workplace it is often assumed that people in certain roles, that their expertise develops and maintains automatically...And if there are any changes, that the information about the changes just transfers into these people "* (Adam). Also Fiona talks about changes, and

stressed the fact that especially when the project and job contents change, *support* should be readily available. *“Going outside your comfort zone is as such okay, at times you have to go outside your comfort zone but it has to be for the right reasons. If the reason for going outside the comfort zone is that you are not getting support in new tools or any new things as processes or such, then it’s wrong kind of discomfort...”* (Fiona).

#### 4.3.2 Factors that improve working

The participants were also inquired about the factors that makes or would make their working easier. This question spurred many different thoughts and suggestions which are connected to collaboration and communication, socio-emotional factors, ways of organizing the work efficiently, tools for working, and formal training possibilities.

For good collaboration shared goals and information sharing is needed. Ben and Carl talk about shared goals: *“Everyone should be aware of what is the goal...and how to get to that goal”* (Ben). ... *”why something should be developed. The goal should be clear, if a person is told that you should study this, and he doesn’t understand at all what he should do, then it’s no use for anyone”* (Carl). Also, as the participants saw the lack of communication and information sharing as one of the biggest challenges, they naturally hoped that it could be improved. *“Information sharing...I cannot develop if I don’t know about the things, if I don’t have the information available”* (Fiona). Elaine noted that tool such as video- and conference calls has made multisite communication easier. *“The tools have made life easier. It fades [the borders], it makes virtual teams, so there’s necessarily no need to be in the same location”* (Elaine).

In addition to tools for communication, Ben, David and Fiona also bring forward the need for good technical tools for working. *“Good tools, adequate and up-to-date tools are needed”* (Fiona). *“Work equipment, they should be such that you don’t have to struggle with them. To my own team, I try to get new work equipment [computers] to all of them”* (Ben). *“We mainly do have good tools, efficient tools for doing this job”* (David).

Carl, David and Elaine take up in their answers the socio-emotional factors in the working environment that enhance or improve working. They talk about how *encouraging atmosphere, knowing your team members, and equality between team members* across companies’ borders make working easier and more rewarding. *“There would be an encouraging*

*atmosphere all around the organization. It would be rewarding for every actor, you would see that you can build something out of it for yourself that you develop yourself. And it advances everyone's actions" (Carl). "When you get to a state of equality that everyone has their own domains of specialization, and when the borders between the companies are not thought about, although there always are borders, but they are not actively brought up..." (Elaine).*

The ways of organizing the work efficiently comes up in Adam's, Carl's and Fiona's reflections. They talk about the *need for good processes, less bureaucracy and micro-management, similar work cultures, and having skillful professionals and teams who take responsibility over their work tasks*. Fiona talks about the need for good processes especially in cases when the project is large and there are many people working on it in different teams in different locations. According to her, good processes enable smooth working as people know what needs to be done in different phases of the project, and things are done in similar way. Adam also sees the need for similar ways of working when he talks about the differences between cultures: *"If there is similar (work) culture and similar work experience, a similar understanding of the way of working. I've noticed that people from different cultures have different way of thinking about for example how a project is done"* (Adam).

Carl on the other hand sees unnecessary micro-management and bureaucracy as hindering the work. *"Perhaps needless bureaucracy is always, it should be avoided. ... Needless intermediate management should be reduced as much as possible. ... The customers and the producers should get closer to each other"* (Carl). Related to this, Carl also talks about the need for giving responsibility over the tasks to individuals and teams as when having the responsibility the individuals and teams can drive the tasks forward to the right direction.

Fiona is the only one to mention *formal training opportunities* as one factor seen as helpful in work, though during the interviews the other participants did also express their wish for training possibilities. *"Training possibilities do of course help if I need to use some specific tool, or in other issues as well"* (Fiona).

### 4.3.3 Factors in the working environment that develop expertise

In the participants' views about their working environment, it becomes manifest that there are certain features that develop their expertise. One of the most important factors is that the environment provides *challenges*, and working on versatile, multifaceted, complex tasks that stretches the participants' limits and develops their skills and knowledge. *"If you do same tasks for too long, it does not advance your development, because the world does not remain the same"* (Fiona). *"Challenging tasks advance development of expertise"* (David).

The participants do not however need to solve the challenging tasks alone, but they have the knowhow and support of their team that they can rely on when needed, that is, they solve problems collaboratively. Ben does not only talk about individual expertise, but highlights the expertise of a team: *"...it [the team] is now surely more ready to work on a new product faster because it [team] has had time to learn. And has gotten new perspectives, and is faster, and it [team] can be given a new product...there you have a crew that is more ready to generate ideas and do things..."* (Ben).

Though social relations in teams are seen in some cases as challenging, the participants also see *working with different people* as enriching as getting perceptions of different people and sharing expertise enables learning new. Adam also sees working with different people as a source of motivation: *"The working environment is motivating where there's many teams and you can be part of a team. ...When having a possibility to learn new and work with different people, those are the biggest motivating factors"* (Adam).

Also, Adam and Ben noted that working in a team *helps in stress control* and *enable risk taking*. *"Connected to development of expertise, if you should be solving all these issues (work tasks and problems) alone, it would be quite stressful...when you have colleagues in the team, we often "juggle" the issues together, talk, and work on the solution that way. Many things are so multifaceted and complex that it is much easier to find a solution to them in a team"* (Adam). *"Fear [of making mistakes] in our work is, that if you fear too much for example to make a change in the code so that it wouldn't break anything. OK, you can test it for a week that it does not break anything, but possibly you make redundant work for a week. ... There [in a team] is leeway so you don't have to worry about it [making mistakes], that you will not be accused about it [making a mistake], but it's the team"* (Ben).

Adam and Ben see that taking risks and not fearing of making mistakes is something that is needed in their working environment. Adam talks about these issues when he is reflecting about the things he sees making working easier in the work environment: *“Having professional people in team it helps. And having people that are quite bold and take some risks that helps, and are not afraid to fail and if something sometimes fail, well then it fails, and then you just figure out how to continue”* (Adam).

Additionally, the ICT domain itself is seen as such that it requires constantly learning new. This is described well in Ben’s statement: *“In this domain learning new is a prerequisite to stay at the cutting edge of the development...”* (Ben). This requirement come forth also in the answers of the other participants as they saw that one constantly needs to learn new things when solving new types of problems or when faced with new situations.

#### **4.4 Summary of the findings**

The results in this study show that the participants are socially intelligent in adapting to the different teamwork settings depending on what are the roles and position in the organization as well as personalities of other people in the situation. The participants also acknowledge that the team has a shared goal(s), and to reach the goal the team has to work well together. Thus the participants try to enhance social and emotional stability as well as collaboration and shared expertise in the team. This is shown in the way the participants value and try to promote equality, low hierarchy, and good team spirit. They also share their information and knowhow to others, and generally try to aim at open communication. They see this as a prerequisite for good collaboration where problems and challenges can be solved together, which benefits the whole team in reaching the shared goal(s).

All the participants view teamwork environment as a good environment to learn in. Learning in teams is enabled by having other people around you who can provide alternative views to your own. A team comprised of experts was seen as the best possible team to work and to learn in, but the team can be heterogeneous including experts of different age, sex, background, and experience as this enables having various perceptions, knowhow and skills in a team. The participants also viewed that they learn new and also maintain their expertise through problem solving and everyday work. In the ICT domain the participants are working with challenging and often complex problem solving tasks, and they felt that

those tasks are easier to solve in collaboration with other. Also, working in collaboration with other people in team(s) enable both learning new and maintaining expertise.

The participants felt that there are many challenging features in their working environment the most prominent in their answers being challenges in communication and information sharing, organizing or orchestrating the ensemble when several teams are working together, and cultural differences. Other challenges mentioned were related to social relations and attitudes, lack of resources, constant hurry at work, missing long strategical view, lack of support, and possibilities for developing one's expertise. When inquired about the factors that would help and further improve the adaptive experts' work the participants' suggestions centered on collaboration and communication, socio-emotional factors, ways of organizing the work efficiently, tools for working, and formal training possibilities. The environment in which the participants work in is seen as developing expertise as the work consists of challenging tasks, but also the support of a team in which the knowledge and skills of different people can be made use of when solving problems collaboratively. Working with different people is seen as enriching and also motivating, and getting perceptions of different people and sharing expertise promotes learning. Additionally, working in teams helps in stress control and enables risk taking. Also, the ICT domain itself is seen as such that it requires constantly learning new.

## 5 DISCUSSION

The aim of the current study was to gain more information about adaptive expertise, especially the social aspects of it which has been studied less than the cognitive aspects of expert performance and learning of expertise. Also, due to the challenging nature of expert work in modern working life and the fact that work is in increasing amounts performed in teams, this was chosen as the context for the study. Based on these aims the following three research questions were set for the study: RQ1.) How adaptive experts act to enhance teamwork, RQ2.) How adaptive experts describe their learning in teamwork environment, and RQ3.) How adaptive experts perceive their working environment. In the following sections the results of the study are discussed in wider perspective connecting them with previous studies and theories of adaptive expertise and learning of expertise.

### 5.1 Adaptive expertise as a social and collaborative phenomenon

Regards the first research question in this study, how adaptive experts act to enhance teamwork, the major findings in this study indicate that adaptive experts are *socially intelligent* in adapting to the different teamwork settings. An earlier study by Ferris et al. (2001) found that social skills in combination with high general mental abilities (GMA), not high mental abilities by themselves, are related to the highest level of performance. The results of this study confirm the finding of the importance of social aspects of high performing professionals in showing that social skills are an important characteristics of adaptive experts.

This study further showed that adaptive experts try to *promote social and emotional stability* in the team. Adaptive experts seem to be good team players who put effort in building good team spirit not only because it would make work easier or nicer in a team, but they see that a team has a shared goal, and to reach it the team should be able to work in good collaboration. Adaptive experts in this study see that equality, low hierarchy, and that all team members are taken into account and listened to enhances *team collaboration and sharing of expertise*, which is important for the team to reach their shared goal. Adaptive experts invest their time in sharing their information and knowhow to others, aim at open communication, try to develop others thoughts and ideas, aim at developing uniform working methods, and solve problems collaboratively with other team members. These finding



are in line with previous studies of adaptive expertise which have indicated that collaboration and sharing of expertise is an important and inevitable part of adaptive experts' work (Palosaari-Aubry, 2014), and furthermore expertise is a social and collaborative phenomenon (Ferris et al., 2001; Hyvönen et al., 2014; Sonnentag et al., 2006).

## 5.2 Learning of expertise in teamwork environment

The second research question in this study seek to understand how adaptive experts learn in teamwork environment. The findings in this study show that adaptive experts' work predominantly consists of *solving problems* which are often challenging, complex, and multifaceted, and solving these kinds of problems develop expertise. This is in line with previous studies on expertise which has indicated that problem solving is a key process in learning of expertise (Bereiter & Scardamalia, 1993; Brenninkmeyer & Spillane, 2008; ChanLin & Chan, 2007).

Furthermore, the adaptive experts in this study many times *solve complex problems in collaboration* with other team members. They found that solving problems collaboratively with others is easier as alternative views and ideas can be provided and discussed to solve the problem. This finding highlight the fact that experts in modern working life need to solve increasingly complex problems which require an ability to make use of different perspectives, theories, and knowhow, and being able to move between and combine them (Engeström, 2006). A single expert does not need to possess all the needed knowhow or skills, but what is crucial is that the expert is able to make use of all the possible sources of information and skills which is available in teams. This is in line with Chi (2006), who maintains that compared to novices experts are more opportunistic when making use of different information sources. The finding of the current study also correspond with previous views of shared expertise (Bereiter & Scardamalia, 1993; Bransford, 2001) that collaborative problem solving may yield better results than when an individual is working alone. Furthermore, the findings in this study gives indications that expertise could be seen rather as a feature of networks than as a property of a single individual, as suggested by Hakkarainen (2006).

Also, the adaptive experts in this study told that they learn new and maintain their expertise through *practical situations and from everyday work*. The adaptive experts' work days are usually very hectic and there seldom is time or resources to invest in formal training or

learning something new outside the work tasks. Thus probably the best and almost only option to learn new and to maintain expertise is from everyday work. However, as the adaptive experts' work consists mostly of problem solving, and as this has been found in previous studies to be a key process in learning of expertise, it is most likely also the most efficient way to learn new and maintain expertise.

Also an interesting and important finding was that adaptive experts *learn in teamwork in contact with other people*. All the adaptive experts in this study viewed that learning in teams is enabled by having other people around you who can provide alternative views to your own. A team comprised of experts who share their information and knowhow, and work in collaboration enables learning, but further, importantly, the expertise does not have to be all of the same kind. Team comprised of experts from different educational background and experience, from different domains and cultures, of different ages and sex provides having different perceptions in a team thus enabling learning new.

Hyvönen et al. (2014) maintain that gaining expertise in working life is more a collaborative than an individual process in which social skills, communication, negotiation, consultation, and understanding people are emphasized as key elements. The current study confirms this view by showing the importance of social aspect in learning of expertise, but in addition to this, it also brings forward the optimal teamwork setting which promotes learning of expertise. A homogenous team is not necessarily the most optimal context for collaborative problem solving and in acquiring expertise, but rather a heterogeneous team consisting of people with various background and expertise.

### **5.3 Challenges and affordances of teamwork environment in ICT domain**

The third research question in this study set out to gain information about how adaptive experts perceive their working environment in the ICT domain which often consists of multiple teams. The adaptive experts in this study found that there are many challenges, as in any other working environments, which has been found also in other studies (Hakkarainen, 2006; Hyvönen et al., 2014; Palosaari-Aubry, 2014). Factors that were perceived as most challenging in the working environment were *communication and information sharing, orchestrating the ensemble when there are many teams working in the same field*, as well as *cultural working differences*. The challenges of communication and information sharing, and orchestrating the work was addressed by the adaptive experts in

their own daily work as they try to promote open communication and enhance team collaboration by, for example, actively sharing their own information and knowhow so that the team would be able to reach their shared goal(s).

On one hand, cultural working differences were seen as a challenge, but on the other hand also the differences between peoples' cultures, educational backgrounds, and experience was seen as positive, enriching, and providing learning opportunities in a team. This indicates that adaptive experts perceive and are aware of the challenging features in their working environment, but they address those challenges by their own actions, and can also see challenges in a positive light as learning opportunities and in acquiring expertise. This characteristics of adaptive expertise, the ability to learn from challenges and a generally positive attitude towards learning, has also been shown in previous research (Bransford, 2001; Bransford et al., 2000).

An interesting and important aspect of this study was the *factors in the working environment that develop expertise*. As noted earlier, adaptive experts predominantly work with challenging, complex, and multifaceted problem solving tasks, and working with challenging tasks promote developing expertise, which was also found in this study. Teamwork environment is fundamentally a collaborative work setting that creates both challenges but also affordances for effective problem solving and learning. When being able to work with different people, getting different perceptions, and sharing expertise enables solving problems that would be impossible for a single expert alone, as well as learning new.

The adaptive experts in this study indicated that they are capable of exploiting the teamwork environment in both problem solving as well as in learning. This calls for adaptive experts being aware of their negative knowledge and having good self-regulation skills, that is, the ability to monitor their current level of understanding, and deciding when it is not adequate (Bransford, 2000; Chi, 2006; Gartmeier et al., 2008; Glaser & Chi, 1988; Hyvönen et al., 2014; Zimmerman, 2006). In those situations adaptive experts in this study tend to consult their team members for additional information or perspectives. Furthermore, the adaptive experts show flexibility in making use of new information and alternative perspectives in being able to use it to construct new knowledge (create solutions to unfamiliar problems) and adapt their own way of thinking (learn new).

Working with different people was also seen as a *source of motivation*, and adaptive experts in this study also found that *working in a team helps in stress control and enables*

*risk taking*. Although teamwork and working with different people may present many challenges it may also be a strength if the atmosphere in a team is good and supportive, and all the team members are committed and willing to work together in good collaboration. Thus, teamwork can enhance motivation as well as help in stress control. Previous studies also stress the importance of social support and motivation in learning of expertise (Bereiter & Scardamalia, 1993; Hatano & Oura, 2003; Hunt, 2006; Sosniak, 2006). The findings of the current study also corresponds with previous findings that collaboration may increase the meaningfulness of one's work, and feedback, acknowledgement, and help from other persons in a team may have positive effects on work welfare (Palosaari-Aubry, 2014).

According to Bransford (2007), different configurations of social and organizational supports and hindrances affect the motivation as well as risk-taking that often accompanies innovation. Also, Bereiter and Scardamalia (1993) see that creativity, or innovativeness, is progressive problem solving under risky conditions. In a domain such as ICT that is constantly progressing to ever greater levels of complexity in problem solving and development, experts need to continually redefine problems at a higher and usually more complex level that are beyond their existing competence. This sometimes requires taking risks and the possibility of being wrong. The findings in this study indicate that adaptive experts feel that taking risks is sometimes necessary in their work, and that risk-taking is easier in a teamwork environment than if working alone.

Bereiter and Scardamalia (1993) maintain that progressive problem solving, a feature of adaptive expertise, requires going beyond one's current abilities, and the process of expertise is inherently "venturesome", which requires weighing the promisingness as well as the level of risk of the options for solving a problem. From the resulting success or failures of the direction taken to solve the problem, one acquires knowledge that can be used to judge promisingness in future problem solving cases. In this light teamwork environment can be regarded as providing affordances for progressive problem solving and learning of expertise.

### 5.3.1 ICT company as a second-order environment

In the current study the adaptive expert brought forward the facts that their work consist mostly of problem solving tasks that can be complex and challenging, and that the ICT domain in itself is such that it requires constant learning. According to Bereiter and Scar-

Scardamalia (1993) in the so called *second-order environments* the conditions to which people need to adapt change progressively as a result of the success of the other people in the environment. In ICT domain this entails that each company's advance in technology or strategy sets a new standard for others to surpass, which means that conditions keep changing as the result of continual contributions to knowledge, and thus there is a need to adapt to the progressive set of conditions. If one ceases to address problems beyond their current abilities, that is, they stay within their comfort zones and solve only problems that are simple enough for them to solve, the work conforms easily to routines. Furthermore, those types of problems may not be necessarily considered as worth solving in the domain (or company) if they do not progress the goals of the domain (or company). The findings of this study seem to confirm the suggestion of Bereiter and Scardamalia that ICT companies could be regarded as second-order environments that promote learning of expertise.

However, the biggest problem in the ICT domain or ICT companies can be, as suggested by the results of this study, the challenges in communication and information sharing. If information and knowhow is not shared efficiently, there is a risk that valuable information does not reach the ones who would need it in their work, and also, the standards for the progressive set of conditions will not raise. In an ICT company this at worst may mean that they are losing the competition in staying at the edge of the development.

## 6 CONCLUSIONS

In the following section implications are suggested based on the results of this study. Also, future research needs are identified.

### 6.1 Implications

The findings of the current study imply that teamwork environment creates both challenges and affordance for both effective problem solving as well as learning new and developing expertise. When forming teams in a company it should be carefully considered what is the objective or purpose of the team, and based on that, what is the optimal composition of a team. A homogenous team may not be the best possible option, but rather a *heterogeneous team* that includes people with different background and expertise. A team like this may yield better and more innovative solutions to problem solving tasks, and furthermore, enables the team members to develop their expertise. However, for the team to work well together and produce optimal results the socio-emotional factors in a team need special attention. Thus team leaders, foremen, and HR-professional should pay careful attention in attending to the needs and wellbeing of the teams.

ICT domain can be considered as a second-order environment which promotes learning of expertise as it provides employees with challenging problem solving tasks and conditions in which the requirements and knowledge grow all the time and thus raise the standards that have to be met. However, it is of special importance that *communication and information sharing* works well. This is a crucial factor for the employees to stay at the edge of the development and make use of all the available information and knowhow there is to perform their tasks in the most optimal level and produce creative and high-quality solutions. Thus, attentions should be payed to establishing processes and taking into use tools that enable effective and timely communication and information sharing within teams, across teams and the whole organization, creating networks of expertise.

In regards the educational systems that are expected to produce the future experts, the findings of the study reinforce the view that students should be provided possibilities for *collaborative problem solving*. Collaborative problem solving involves applying the knowledge and skills of all the team members into the tasks, thus creating new knowledge together which in turn leads to development of the knowledge base and skills of the indi-

viduals. Teamwork environment can, however, be socially and emotionally challenging which requires that attention is given also to guiding students in practicing their communication, collaboration, and teamwork skills.

The current study brings forward the importance of collaborative problem solving and the social factors in both adaptive experts' work as well as in learning of expertise. As demonstrated in this study, *adaptive expertise and the process of learning of expertise are highly social phenomena*, and should be regarded as important as the cognitive factors in adaptive expertise and learning of expertise. Further, adaptive expertise comes close to the idea of shared expertise, in which expertise can be regarded rather as a community endeavor than as an individual property. A team of individuals, or experts, can perform better than individuals alone in which the key is in combining the knowledge and skills of the individuals in creating new knowledge collaboratively. This implies that adaptive expertise is not merely a property of an individual, but can also be seen as a property of a team or a network of individuals.

## **6.2 Future research needs**

Modern professional work many times takes place in project teams, which suggests that in addition to knowledge and task strategies also good social and teamwork skills are needed. The findings in this study indicate that adaptive experts have good social and teamwork skills, and that it is also an inevitable part of adaptive experts' work as well as characteristics. However, this study does not address the question whether good social and teamwork skills are the result of learning of expertise or a prerequisite of developing into an adaptive expert, and thus suggests further needs for research. This would require a longitudinal study in which professionals are followed for a longer period of time to follow up their development, learning of expertise, and if and how social skills affect the process of learning of expertise.

## 7 EVALUATION

In order to evaluate the quality of the present study ethical issues, validity, and reliability of the research process is reflected and evaluated in the following chapter. Also, the limitations of this study are discussed.

### 7.1 Ethical issues

#### 7.1.1 Rights of the study subjects

One of the most important aspects when considering ethical issues in scientific research are the rights of the study subjects. According to Tuomi and Sarajärvi (2002) to protect the rights of the study subjects the researcher has to make sure that the participants in the study 1) know the aims, methods, and possible risks of the study, 2) the participation is voluntary, 3) the participants know what the study is about, 4) the participants' rights and well-being is ensured, 5) the gathered data is confidential, 6) the identity of the participants is protected, and 7) the researcher has to follow the agreements made. In this study, the possible participants were chosen by their foremen based on a set of criteria that was created for this study to ensure that adaptive experts would be chosen for the interviews. After that I contacted the possible participants individually, explained the aim of the study and the research methods to them. All the possible participants agreed to take part in the study voluntarily, but I emphasized to them that they can change their mind at any point of the study if they want to.

In the interview situation, I once more explained the research aims and methods as well as the rights to the participants. I also asked the consent of the participants to record the interviews and that I could use the recorded audio files to analyze the results. The audio files are safely stored, and no-one else has access to them nor will they be disclosed to any other parties. Also, the identity of the participants is protected, and to ensure the anonymity of the participants I use pseudonyms in this study and give no further specific information about their education, organization, or their position in the organizations.



### 7.1.2 Justification for the research topic

Also choosing the topic of research can be seen as an ethical question (Tuomi & Sarajärvi, 2002). The topic of the current study was to study and understand adaptive expertise in working life, and more specifically, in teamwork setting.

The justification for this study stems from the need to understand the phenomenon of *adaptive expertise* and *learning of expertise* because modern society and working life needs adaptive experts who in addition solid domain-specific knowledge possess diverse skills. This is because work tasks are becoming increasingly complex and multifaceted which require, among other things, skills in analyzing, conceptualizing, and synthesizing knowledge, progressive problem solving, innovativeness, flexibility, boundary crossing, ability to handle pressure and uncertainty, and make decisions based on ambiguous information. Also, as work is in increasing amounts done in teams, it requires social skills such as communication, collaboration, and teamwork skills.

The requirements of information society poses challenges for professional expertise as well as to educational systems that are expected to produce the future experts. Thus, it is important to gain more information about adaptive expertise, and especially about the social aspects of adaptive expertise which has been studied less than the cognitive aspects of expert performance and learning of expertise. Also, due to the challenging nature of expert work in modern working life and the fact that work is performed in teams, this context in itself is important to study.

### 7.1.3 Good scientific practice

The reliability of the study and the ethical decisions the researcher makes are closely connected as reliability is based on the researcher following “good scientific practice” (Tuomi & Sarajärvi, 2002) which is defined by Finnish Academy. In this study I have tried to make sure that I am careful, thorough, and honest in my research work, in storing the data and findings, presenting the findings, and in evaluating the results and the research process overall. Also, the work and findings of other researchers have been credited duly and referenced appropriately.

## 7.2 Validity and reliability

The overall credibility and quality of qualitative research can be addressed through the concepts of validity and reliability. According to LeCompte and Goetz (1982), validity is concerned with the accuracy and truthfulness of scientific findings of a research. Tuomi and Sarajärvi (2002) define validity more broadly as research addressing and studying the questions it promised to, whereas Schreier (2012) sees validity in qualitative research to apply to the instruments of data collection. That is, the instruments can be considered as valid to the extent the researcher succeeds in measuring what was intended to be measured. Reliability, instead, refers to consistency, stability, and ability of a research method to yield consistently the same results over repeated testing, that is, the research results can be repeated (Tuomi & Sarajärvi, 2002).

According to Tuomi and Sarajärvi, there is no single and straightforward instructions to evaluate the credibility of a research. However, they point out that a research can be estimated as an entity which emphasizes the internal coherence of the research report. Also, the researcher should give the reader as much information as possible how the research has been done for them to be able to assess the research results (Schreier, 2012; Tuomi & Sarajärvi, 2002). To make the study procedure as well as my reasoning transparent in my study, I have clearly stated what are my research aims and questions, and what is the need and justification for my study. Also how and on what grounds the study subjects were selected, and how the data was gathered and analyzed has been openly reported and described in detail. Analysis and conclusion in qualitative research has often been criticized for reporting only few exemplary instances and the summarized findings “losing” the original formats of the material (Silverman, 2000). Thus I have paid special attention in reporting the results of the interviews in a way that as much of the study participants’ own expressions are included (sited) as possible so that it would be clear for the reader on what grounds the conclusions from the interview data have been drawn.

The aim of the study was to gain more information about the social aspects of adaptive expertise, learning of expertise, and what kind of an effect teamwork environment has in it. I found semi-structured interviews to be a suitable method for collecting the data because interviews enabled the study subjects, that is, the adaptive experts, to express their experiences, ideas, thoughts, and perceptions (Gibson, 2010) about their work, learning, and working environment, and thus the data opening up the possibility of viewing the phenom-

enon from the adaptive experts' perspective, and through analyzing the data providing a possibility to understand the phenomenon more deeply.

Qualitative content analysis (QCA), on the other hand, I found to be the optimal method for analyzing the interview data because QCA is interpretative, that is, when the meaning of the material is less obvious, interpretation is required (Schreier, 2012). Also, as the teamwork context in ICT domain plays an important part in this study, QCA was suitable as it requires that the researcher takes all the context into account that is needed to know about in order to understand what the material means (Schreier, 2012). Also, as Schreier states, QCA is a method that allow the researcher to describe and classify a large amount of qualitative data, such as interviews, create at least part of your data in data-driven way (key concepts and categories emerge from the data), and lets the researcher describe the material in considerable depth. These are all important factors in gaining a deeper understanding about adaptive expertise based on the reports of the study subjects themselves. Thus I conclude that the data collection and analysis methods were suitable and valid for examining the phenomenon, meeting the aims, and finding answers to the research questions set forth in this study.

Checking for consistency between coders is one way to check and ensure the reliability of the coding frame (Schreier, 2012). To ensure the reliability of my research, another researcher coded two out of the six interviews using the categories I had created in my research (see table 4.) The Cohens K value was 0.78 which indicates that the other researcher was able to code the interviews and receive same kind of results, thus the reliability of this study being on a good level.

### **7.3 Limitations of this study**

There are some limitations to my study which I will address here. A common critique towards qualitative interview studies is that there usually are too few interviewees and thus the findings are not generalizable. However, both Kvale (1996) and Silverman (2000) point out that generalizability can be present already in a single case. As Kvale explains it, there are two main reasons why significant knowledge can be obtained already from single or few cases: quantitatively each case contains a large number of observations from a single case, and qualitatively a focus on single cases makes it possible to investigate the cases in great detail. Thus I regard the small number of participants in this study to be more a

strength than a weakness, allowing studying the individual cases in great detail and in-depth this way providing valuable information about the phenomenon of adaptive expertise.

Another limitation is that the data was collected using interviews as the aim was to understand the participants' experiences, ideas, thoughts, and perceptions. In interviews, however, there is always the risk that the participants do not answer the questions truthfully, try to give a better picture of themselves, or answer the questions they think the interviewer would like them to be answered. Observations in addition to interviews could give more reliable results on this kind of research as it could be observed how the adaptive experts act and behave in the teamwork environment, and if it corresponds to the findings from the interviews. However, observations were not possible in the scope of this study. Also, despite the possible limitations of interviews as a data collection method, I regarded it as having more advantages than disadvantages, and thus being a suitable and adequate method for my study.

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## APPENDIX 1

### **Criteria for selecting the participants for the study**

- Considered as experts in their organization
- Work in expert or specialist position in their organization (according to job role description)
- 10+ years of work experience in the domain
- Work tasks are challenging and often complex
- Adaptive problem solving skills
- Positive attitude towards new, challenging situations, and learning new
- Work in at least one team

## APPENDIX 2

### Interview questions

#### Background

- age
- education
- role in the current organization
- work experience from the domain (years)
- work experience in the current role (years)

#### Theme 1: Expert work

1. What are your main duties at work?
2. What are your most important work tasks?
3. Do you feel that you are an expert in these tasks?
4. Describe your typical workday.
5. Does your work include a lot of routine work? What kind of routine work?
6. Does your work include a lot of problem solving tasks? What kind of problem solving tasks?
7. How do you go about solving problems?
8. How do you feel about new or challenging situations at work?
9. Do you learn from them? Describe.
10. Do you apply what you have previously learned to new situations/problems? How?
11. How do you feel about learning new?
12. From what kind of things or situations you learn best? Why?

#### Theme 2: Expert work in team(s)

1. Do you work in at least one team or several teams, or are you in contact with other teams in your work?
2. Are your teams Finnish or international?
3. Describe yourself as a team member: how are you like or how do you act?
4. What kind of a role do you have when interacting in a team or with teams? Describe.
5. Does your role change when you work in this/these teams? How?

6. Do you feel that your knowhow is made use of in a team/teams? How does it show?
7. How can you yourself affect that your knowhow is made use of when working in/with teams?
8. What things have you considered as challenging when you have been working as an expert in an environment that consists of multiple teams?
9. What things make expert work easier in this type of environment? Why?
10. In what kind of a team do you like to work in?

#### Theme 3: Expertise and learning

1. Do you learn better alone or in teams? Why?
2. Do you feel that when working in a team you are able to learn new? What? Why?
3. Are you able to develop your expertise through teamwork? Why? How?
4. In what kind of a team do you learn the most? Describe. Why?
5. How do you maintain your expertise?

#### Theme 4: Expert work in teamwork environment

1. How do you find the working environment that consists of multiple teams? Describe.
  - Is the environment easy/hard to work in? Why?
  - Is the environment challenging/formative/what kind? Why?
2. What factors in the environment enable developing your expertise?
3. What factors hinder development? How?
4. What/how would you like to develop your working environment?