

Expanding Technological Frames Towards Mediated Collaboration

Groupware Adoption in Virtual Learning Teams

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Abstract: This paper provides an in-depth analysis of technological and social factors leading to the successful adoption of groupware in a virtual team in a educational setting. Drawing on a theoretical framework based on the concept of technological frames, we conducted an action research study to analyse the chronological sequence of events leading to groupware adoption. We argue that groupware adoption can be conceptualised as a three-step process of expanding and aligning individual technological frames towards groupware: The first step comprises activities bringing knowledge of new technological opportunities to the participants. The second step comprises activities facilitating participants in articulation and evaluation of their work practices and use of technology. Finally the third step includes participants' commitment and practical enactment of groupware. One of the key findings is that in groupware adoption the alignment of the individual technological frames requires articulation and re-evaluation of experienced collaborative practice and use of technology, and that this activity cannot take place at the outset.

Keywords: Technological frames, Virtual Team, Groupware adoption, Learning, Action research.

1 Introduction

When adults return to universities to attend vocational education, they are often physically located in different places, thus needing technology to support of their collaborative learning. Applying groupware technology to promote collaborative learning in this kind of setting is especially relevant for education programs based on project work in groups with geographically dispersed members (Dirckinck-Holmfelt and Sorensen, 1999; Cheesman and Heilesen, 1999). Current research on teamwork in geographical distributed situations, referred to as virtual teams, has investigated important aspects such as trust, mutual knowledge, culture, media-stickiness, and time (Cramton, 2001; Maznevski and Chudoba, 2000; Huysman et al, 2003; Jarvenpaa, Knoll, and Leidner, 1998; Massey et al, 2001). In addition, researchers generally agree that technology plays an important role for the success of virtual teams (e.g. O'Connor et al., 1993; Hollingshead et al., 1993). In particular, research on groupware technology adoption shows that appropriate guidance for groupware adoption processes is crucial to establish continuing use of groupware (Karsten, 1999; Orlikowski, 1992; Grudin, 1994). Nevertheless, still little research (e.g. Majchrazak et al, 2000) has focused on the actual adoption process of groupware technology in virtual teams.

The purpose of this paper is to complement current research by presenting the results of an action-research project, which guide the groupware adoption process in a virtual team of adult students enrolled in a part-time vocational education program. Drawing on Orlikowski and Gash's (1994) concept of technological frame we investigate the changes of key-group actors' technological frames during two action cycles comprising the groupware adoption process. Technological frames comprise peoples' interpretations of technology related to the nature, strategies and use of a particular technology. Functionalities embedded in specific applications influence technological frames, thus it is important to investigate the technological factors influencing technological frames. Additionally, frames are affected by peoples' engagement in social settings therefore it is also important to investigate social factors influencing technological frames. Thus, our research question is: What technological and social factors influence the changes in virtual team members' technological frames towards adopting groupware?

To answer the research question, we analyse a series of events, which align practice and technology in a groupware adoption process. Specifically, we analyse how students change, expand and align their shared technological frames. By proposing that groupware adoption can be conceptualised as the expansion and alignment of technological frames, we argue that groupware adoption is a three-step process. The first step provides knowledge of new technological opportunities to the participants. The second step comprises guidance to articulate and re-evaluate concrete work practices and technology use. The third step comprises participants' commitment and practical enactment of groupware. Additionally, we identify technological and social factors influencing successful groupware adoption.

The paper is structured as follows. Following this introductory section, a related work section comprising previous research on groupware adoption is presented in section 2.

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Then the theoretical framework of technological frames is presented in section 3 followed by a description of the empirical case and the groupware technology in section 4. In section 5 the action research approach is presented including descriptions of the data sources and how the data was analysed. Section 6 forms the analysis of the empirical case related to the theoretical framework of technological frames. This is followed by the discussion in section 8, where the technological and social factors influencing the expansion of technological frames in the empirical case are identified. Sections 8 and 9 introduce the implications for research and practice, which include proposing a three-step model of technological frame expansion and finally we conclude.

2 Related Work: Groupware Adoption

To understand the adoption of complex technologies such as groupware we need to understand the realities of introducing technology at group level within specific organisational settings (Gallivan, 2001). Groupware adoption is here viewed as ongoing processes of aligning practice and technology to complement each other (Majchrazak et al., 2000). Majchrazak et al. (2000) argue that virtual teams may initially experience misalignment among pre-existing group practices and technology. In their study, the team first tried to resolve this misalignment by modifying the group practices leaving the technology unchanged. However, the team experienced a series of events causing them to re-evaluate their approach and further modify both group practices and technology structures. Finally, both group practices and technology structures emerge as different from both the pre-existing and the initial ones (Majchrazak et al., 2000). Groupware demands more effort and commitment from the people adopting the system than single-user systems (Grudin, 1994), however we still do not have in-depth understandings of which kinds of activities and factors that provide collaborative actors with the essential commitment. Therefore research on the organisational issues related to groupware adoption is required to improve groupware adoption processes. Moreover, success of groupware adoption is found to depend on how well the technology is embedded in the local context including the local work practices, thus a key role for groupware adoption is to adjust the technology to become well embedded (Karsten, 1999).

Users' capabilities to engage in successful groupware adoption are found to depend upon whether the users have a common ground and are ready to appropriate collaborative technologies (Olson and Olson, 2000). This suggests that the responsibilities for successful adoption lie with the users and their abilities to meet these challenges. Additionally, research in large organisations, has found groupware adoption to be dependent upon and driven by the users and their capabilities in communicating and transforming technology across different social worlds (Mark and Poltrock, 2003). Currently, we do not yet know, which factors that might support the users in becoming ready for collaborative technologies, neither do we know which factors that supports users in transforming technology across social worlds. However, it has been suggested

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that users' capabilities in adopting groupware increase when users are given a clear understanding of the mature use of the technological features at the beginning of the adoption process, while making sure that problems experienced early on are quickly dealt with thus preventing premature rejection (Grudin, 1994). The initial stage of adoption is especially important, since directions and actions taken immediately after initial introduction and installation are found to determine the path of technology use in the long run, and unproductive behavioural patterns concerning technology have been found difficult to change (Tyre and Orlikowski, 1994; Huysman et al. 2003).

Summarising, researchers generally agree that groupware adoption processes are influenced by both technological and social factors. Nevertheless we still need to identify these factors. In this paper we extend and supplement current research by investigating and identifying technological and social factors supporting the users in adopting groupware, thus we seek to improve the basic conditions for collaboration between geographical distributed participants.

3 Theoretical Framework: Technological Frames

To understand users' capabilities and perspectives with respect to technology we apply the concept of technological frame. People's frames of reference or mental models about their work and technology influence groupware adoption greatly (Orlikowski, 1992). A mental model comprises the individual frame of reference, as in how participants view their work, the organisation and the technology. Orlikowski (1992) finds that in the absence of mental models appreciating the collaborative nature of groupware, groupware adoption most likely will fail. Orlikowski further suggests that a particular essential factor supportive of groupware adoption is to ensure that prospective users have an appropriate understanding of the technology, and that their technological frames reflect their perception of the technology as a collective rather than a personal tool (Orlikowski, 1992, p. 386). All actions of individuals, including groupware adoption, are socially oriented and take place within a predefined social context (Lyytinen and Ngwenyama, 1992). The social context of a team e.g. in education is a conglomeration of pieces that people bring from various social contexts in which they exist simultaneously, such as family and work contexts. How people perceive technology depends upon the particular social context in which the technology should be applied. The social context provides a repository of rules and resources useful for participants to make sense of each other's actions including use of technology, to interpret collective activities while adjusting their own work accordantly (Ngwenyama and Klein, 1994). Members of a social group have individual interpretations but also possess a set of common core beliefs. Shared frames of references in relation to technology within a specific social group comprise similar assumptions, knowledge and expectation towards the role and nature of the technology. This includes the specific conditions and consequences the technology has in the particular shared social context. Technological frames comprise the individuals' perceptions of technology and shared technological frames emerge from an alignment

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process creating congruence of people's individual technological frames on key elements and categories (Orlikowski and Gash, 1994). Congruence does not mean identical but related in structure and content. Adopting groupware includes aligning the individuals' technology frames creating congruence while expanding the shared frame to include new technological opportunities. Congruence is in this way similar to the concept of ecology as suggested by Star and Ruhleder (1996). Ecology refers to the delicate balance (or lack of balance) between language and practice. Groupware adoption requires a balance between how participants perceive and articulate their technology-mediated collaborative practice and their practical enactment of collaboration and technology use.

The adoption of groupware is an alignment process of groupware and practice resulting in a transformed practice. Creating new and transformed practices both in terms of technology and work practice has been suggested to be main elements of groupware adoption and use (Berg, 1998). Further, Robinson (1991) gives evidence that computer support providing new capabilities is likely to be appreciated. The transformed practice provides new opportunities and capabilities for the users. It is however difficult, if not impossible, to anticipate which new capabilities groupware may provide prior to adoption, since technology transforms practice in unanticipated ways sometimes resulting in unintended social effects (Berg, 1998). When participants' appropriate complex technologies, actual use can be much wider than that the technology was designed to support (DeSanctis and Pool, 1994; Kiesler, 1986).

Orlikowski and Gash (1994) suggest three domains characterising the technological frames of participants: the nature of technology, technology strategies and technology-in-use. The nature of technology domain comprises peoples' understanding of the capabilities and functionalities of the technology. Technology strategies comprise peoples' understanding of the motivation behind the adoption decision. Finally technology-in-use comprises peoples' understanding of how to use the technology at day-to-day basis and the consequences associated with such use (Orlikowski and Gash, 1994, p. 183).

Since frames of reference are individually held, they form individual schemes constructed upon the individuals' existence in the various social contexts such as education, family and work. This means that factors located in the social contexts different from the social context of education might as well influence the expansion of individually held technological frames. However, in this paper we focus on the factors influencing the expansion of technological frames closely related to the adoption of groupware to support collaborative work in the social context of education. Even though we acknowledge the existence and influence of factors from participants' various social contexts, we here emphasis on factors directly located within the social context of education. We do not argue to have identified the complete number of factors influencing technological frame expansion, but we argue that we have identified a number of important factors located in the social context of education, which influence the expansion of technological frames to include groupware.

In this paper we propose a conceptualisation of groupware adoption, as the expansion and alignment of individual technological frames to include groupware taking all three

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domains suggested by Orlikowski and Gash (1994) into consideration. Expanding and aligning participants' shared knowledge about new technological opportunities includes gaining an understanding of the functionality of groupware technology: nature of technology. Moreover the functionality should be connected to the usefulness and motivation for adopting groupware in the specific setting: technology strategies. Lastly participants should develop an understanding of the consequences caused by using groupware combined with articulating the unanticipated consequences of their groupware use: technology-in-use. This means that we must examine the technological frames of key-group actors related to the three categories: nature of technology, strategies for technology and technology-in-use. The key-group actors of the empirical study reported upon in this paper comprise teachers, students and the action researcher. We include the action researcher as a key-group actor, since the technological frames of the actions researcher highly influence the groupware adoption process and the technological frame expansion of both teachers and students. Thus, the theoretical framework applied to analyse the empirical observations in this paper comprise key-group actors' (teachers, students and action researcher) technological frames related to the three domains comprising nature of technology, technological strategies and technology-in-use. For analytical reasons we have produced a table to capture the technological frames of the three key-group actors at different points in time during the groupware adoption process. We use this model to represent the stages of technological frame expansion during the analysis of the empirical data.

	Teachers	Students	Action researcher
Nature of technology	Which functionalities and capabilities is embedded in the technology?	Which functionalities and capabilities is embedded in the technology?	Which functionalities and capabilities is embedded in the technology?
Technology strategies	What are the reasons and motivation for groupware?	What are the reasons and motivation for groupware?	What are the reasons and motivation for groupware?
Technology-in-use	How should the groupware be use in practice and by whom?	How should the groupware be use in practice and by whom?	How should the groupware be use in practice and by whom?

Table 1: Technological frames of key-group actors

4 The Empirical Case

4.1 The Research Setting

The empirical investigation was conducted within a part-time master program (the Master of Adult Education at Roskilde University in Denmark), where the groupware adoption process in a virtual learning team was closely studied. The master' degree program is a three-year, part-time university program for people active on the labour market. To be accepted the students need a bachelor's degree and at least two years of job experience. Because it is a part-time program, each semester is stretched over a whole year from

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September to June, and each year, the program requires the students to attend five weekend seminars on campus in September, November, January, March and April. Over 50% of the program is based on problem-oriented project work (Dirckinck-Holmfeld, 2002; Olsen and Pedersen, 2005). In problem-oriented project work students negotiate a research question to investigate, locate relevant literature, conduct empirical work and finally co-author a joined project report.

The master's degree programme has a long tradition for vocational teaching of adults, but has no tradition for using technology in either teaching or to support collaboration within the student groups. Seeing the new millennium the teachers however decided in 2002, that they would like to employ technology in the master program especially to support the collaboration within the student groups between campus seminars. The teachers did however not have particular ideas about which kind of technology to use, by whom and for what purpose.

The project team investigated here consisted of three students in their mid-thirties: Emma, Thomas and Lisa. They all were in full-time employment, so study-time was reduced to weekends and evenings. The three team-members lived far apart, leaving little opportunity to meet face-to-face, apart from the five campus seminars. Due to different working hours, the team primarily collaborated asynchronously. Initially all group members had experiences with e-mail and phone, but no knowledge about groupware. This research was conducted during the group's last year of the master program. In the below table the initial technological frames of the key-actors are summarised.

	Teachers	Students	Action researcher
Nature of technology	No real considerations concerning the nature of the technology.	Had experience with e-mail and phone supporting group work, but no knowledge of groupware technology.	Groupware supportive of collaboration in project groups in education needs to have functionalities such as coordination, shared archive, version control and negotiations.
Technology strategies	Other master degree programs have successfully employed technology. Technology could support students in collaboration between campus seminars.	Experiencing difficulties in communicating and coordinating in earlier projects. Groupware might resolve some of these issues.	Geographical distributed groups have difficulties in collaborating, thus groupware can enable their opportunities for collaboration, reducing time for coordination while increasing time for learning and negotiation.
Technology-in-use	Not really an issue since teachers see themselves as providing the technology and then it is up for the students to employ it for their own benefits.	No idea.	By negotiating common working procedures including how to use groupware in specific situations, the group should be supported in negotiating how, why and when to use groupware closely connected to the subject matter of their project.

Table 2: Initial technological frames of key-group actors

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4.2 Groupware Technology

The groupware system used in this investigation was Basic Support for Cooperative Work (BSCW, further details at bscw.gmd.de), one of the most well known CSCW (Computer-Supported Cooperative Work) systems in the academic world (Bentley et al., 1997).

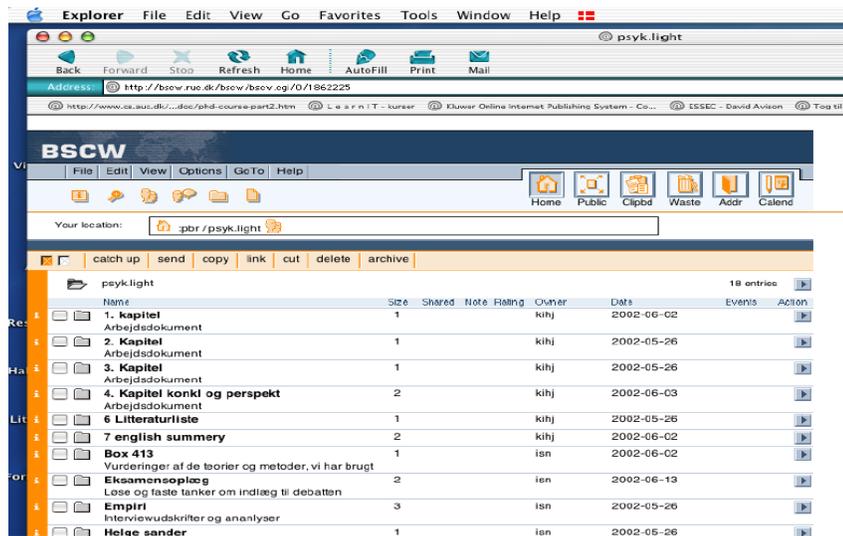


Figure 1: Screen shot of the folder structure at BSCW

The BSCW system is a web-based CSCW system, which supports file-management, asynchronous and synchronous dialogs, management of URLs, and calendar functions. The BSCW system also supports different awareness functions such as monitoring which documents, folders and notes are new, read, revised or moved. Moreover it is possible to get automatic e-mail notifications, when different events occur within the system. The BSCW broad functionality and versatility, which allow users to adjust the conceptual structures, makes it a strong tool, for collaboration and coordination.

The investigated group accessed BSCW through stationary computers either placed in their homes using dial-up connections, or placed at campus using broadband connections.

5 The Action Research Approach

Research on groupware adoption and use based on 'experimental settings' has produced confusing and inconsistent results, because it is impossible to simulate real-life collaboration (Davison et al., 1998). Instead, Davison et al. (1998) propose using action research to fully capture the complexity of groupware use and collaboration. By applying action research the researcher has the possibility to become actively engaged with the practical adoption process and therefore have the opportunity to intervene and positively influence the adoption process, thus providing theoretical reflections grounded in planned

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activities. In this way the chance of locating new relevant issues for groupware adoption increases.

The use of action research approach in the information systems community is well established (e.g. Mathiassen 1998, 2002; Avison, Lau, Myers & Nielsen 1999; Vidgen and Braa, 1997; Braa and Vidgen, 2000; Donnellan, 2003). The information system action research approach combines theory and practice through change and reflection in a problematic real-life situation. Action research involves iterative cycles of activities identifying problems, planning interventions, executing the actions, observing the outcome, reflecting upon the result while in all activities collecting data about the situation and actions (Davison, 2001). Different action researchers describe different cyclic processes, but the fundamental elements and issues are similar (e.g. Susman and Evered, 1978; Davison et al, 2004; Checkland and Holwell, 1998; Baskerville and Wood-Harper, 1996). The action cycles in this study follow the cycle presented by Davison (2001): problem diagnosis, action planning, action execution, observation and reflection.

The action research project presented in this paper involves an in-depth investigation of the how the groupware application BSCW was adopted into a geographical distributed project group conducting problem-oriented project work attending a vocational part-time master education. Initially the teachers responsible for the vocational part-time master program articulated the problematic situation in terms of their experiences of less active (sometime inactive) students especially between the campus seminars. This inactivity caused projects to begin late thus increasing the difficulties for supervising the students when constructing their projects. Introducing technology was seen as a possibility to increase the student activities between campus seminars, thus increasing the time-span for critical reflection and learning. There were two cycles in the study. One spanned the period from September to January and the other from January to April. In the below table all data sources is presented as related to specific activities conducted during the two action cycles of the empirical study.

Data sources of the case related to the various steps in the action cycles

Initial activities establishing contact and creating a contract agreement, September 2001, include:

1. Presentation of research interest to the teacher group
2. Document analysis of the teacher's project proposal for applying groupware to the master's programme made to the institutional board
3. Interview with the key author behind the project proposal
4. Presentation of research interest to the students at a weekend-seminar in September – one group volunteered to participate
5. Document analysis of the book: A different way to university: "Report concerning the master's programme in educational studies at Open University" [En anden vej til universitetet: En undersøgelse af den treårige universitetsuddannelse i Voksenpædagogik under Åben Universitet] (Christensen 2000)
6. Documents analysis of: Master's in Adult Education (Master i Voksenpædagogik), Roskilde University, Department of Educational Research

First action cycle: Problem diagnosis activities with the teacher group, September 2001, include:

1. Diagnosis of problems using mapping techniques

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2. Articulation of the pedagogical practice using Dead Sea Scrolls
3. Investigation of how IT might help resolving problems
4. Presentations on the possibilities for IT support of group work
5. Summary of workshop given by a teacher
6. Diary notes made by the researcher before and after the workshop

First action cycle: Workshop with the teachers' group, November 2001, includes:

1. Observation of their discussion concerning a new description of the master's program
2. Document analysis of the official rules and content of the master's program
3. Facilitation of discussion on IT use in the master's program

First action cycle: Planning intervention activities, November 2001, include:

1. Document analysis of the group's initial project proposal
2. Diary notes concerning the research purpose in general, the purpose of the first intervention activity, and specific planning activities
3. Technical preparations, including passwords etc. for BSCW

First action cycle: Intervention activity, November 2001, includes:

1. Presentation of the purpose of the activity for the group
2. Questions for the group to discuss, creating common ground while planning and coordinating the project, e.g.: "What are your expectations for this group work?", including decisions concerning time, collocated and mediated collaboration; "What are the concrete collaborative activities of the project?", including decisions concerning meetings, working papers, readings, empirical work, analyses, how often to log on BSCW and what it mean to logon; "Which kind of deliverables will there be, and when should they be finished?" and "How should structures created within BSCW support your work?"
3. Presentation of an example of a project contract, a project plan and different examples of folder-structures.
4. Document analysis of summary made by the group, including their plan and project contract and folder-structure
5. Hands-on introduction to BSCW
6. Tape recordings, drawings, pictures and maps were used to capture the rich activities
7. Diary notes made immediately after the session including evaluation of different interventions

First action cycle: Observation activities, December 2001-January 2002, include:

1. Observations of the use of BSCW
2. Diary notes

First action cycle: Evaluation, **Second action cycle:** Diagnosis and planning activities, January 2002, include:

1. Diary notes made before the session
2. Questions for the group comparing the decisions negotiated in November to the actual practice experienced between November and January
3. Facilitation of articulation of specific work practices
4. Tape recording of the session
5. Diary notes made immediately after the session
6. New planning for the project
7. New hands-on introduction
8. Revising folder-structure
9. Technical explanation document about the functionalities of BSCW

Second action cycle: Observation activities, January-March 2002, include:

1. Observation of the use of BSCW

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2. Status session in March 2002 in which the group received questions to articulate and in which they evaluated their collaborative practice from January to March
3. Tape recording of activity
4. Diary notes made immediately afterwards and as follow up questions using BSCW

Second action cycle: Reflective session with the group on the groupware adaptation process as a whole, April 2002, includes:

1. Observation of the use of BSCW
2. Diary notes made before and immediately after the session
3. Questions for the group
4. Tape recording of the activity

Second action cycle: Document analysis, May 2002, includes:

1. The group's description of the project period, including their engagement with the action research project officially handed in to the master's programme
2. The project report made by the group

Second action cycle: History interaction logs of the actions performed in BSCW, includes:

3. Calculation of the interaction logs comprising the number of actions made within each folder and sub-folders of BSCW, divided by month

Table 3: Data Sources of the Empirical Case

Theory plays an important role in action research, so even though some action research projects begin by being theory-free, explicit theorising is necessary if a grounded theory do not emerge during the diagnostic stage (Davison et al. 2004). During the actual conduction of the action research project reported upon in this paper the theoretical perspective was informed by earlier research on groupware adoption represented by researchers such as Grudin (1994), Karsten (1999) and Orlikowski (1992). However conducting the analysis of the empirical observations presented in this paper the research interest remained on groupware adoption, but the theoretical perspective was changes and now informed by the theory of technological frames (Orlikowski and Gash 1994), which influenced how the data material was re-examined and analysed. The theoretical standpoint forms the empirical observations and draws attention to specific aspects of groupware adoption. The action research approach during the data collection process brings in highly rich data material, thus providing the opportunity for additional analysis because the data comprise the practical situation viewed from different perspectives (documents, workshops, interviews and observations) at different points in time.

Analysing the empirical observations as presented in this paper was conducted by applying the theoretical perspective of technological frames as a lens for identifying technical and social factors influencing the expansion of frames. The analysis comprised re-examinations of all the audio-transcripts, field notes, pictures, drawings and observations collected during the action research process focusing on all aspects impacting groupware adoption as related to the nature of the groupware, the strategies for adoption and the technology-in-use at day-to-day basis. The focus for the analysis was to identify empirical observations related to how the key-actors groups changed, modified, aligned and expanded their technological frames concerning groupware.

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The action research approach applied in this paper began by creating a researcher-client agreement, formed two cyclical processes of action based upon the principles of change through action and learning through reflection, and finally was guided and informed by complementing theories both during data collections as well as during analysis. Thus, the action research approach applied in this paper meets the criteria for action research presented by Davison et al. (2004).

6 Analysing the Groupware Adoption Process

This analysis is divided in two main sections, one for each action cycle of the research project. For each action cycle we have sub-sections concentrating on the different stages of the cycle: problem diagnosis, action planning, intervention, observation and reflection. Finally each main section end by presenting the technological frames of key-group actors in the particular action cycle.

6.1 The First Action Cycle - September to January

The initial phase of the first action cycle, from September to November, involved the following activities: establishing contact with the organisation (the master program) producing a researcher-client agreement (Davison et al, 2004), understanding the problems experienced by the teachers concerning students' inactivity between campus seminars (problem diagnosis), planning the intervention including finding a student group willing to participate (action planning), conducting an introductory workshop with the group (intervention), and finally observations of the use of groupware and evaluation of the actions (reflection).

6.1.1 Problem Diagnosis

The master degree program has existed since 1990. In the summer of 2001 the teachers proposed a pilot project applying IT in the education. In their proposal addressed to the institutional board they argued that "applying net-based teaching supplementing other teaching activities would be obvious since the students live far away from campus and each other and the geographical distance is a barrier for the project work in groups. (...) IT-conferences-systems provide better and new opportunities for the students to establish a shared space, where all students can communicate with each other compared to email" (translation from the Danish proposal). The activities conducted for diagnosing the problems in the first action cycle were in form of interviews with the key author of the proposal and two workshops involving the whole teaching group at the master degree program. At the workshops we facilitated the teachers in articulating their experienced problems by using e.g. mapping techniques (Lanzara and Mathiassen, 1985).

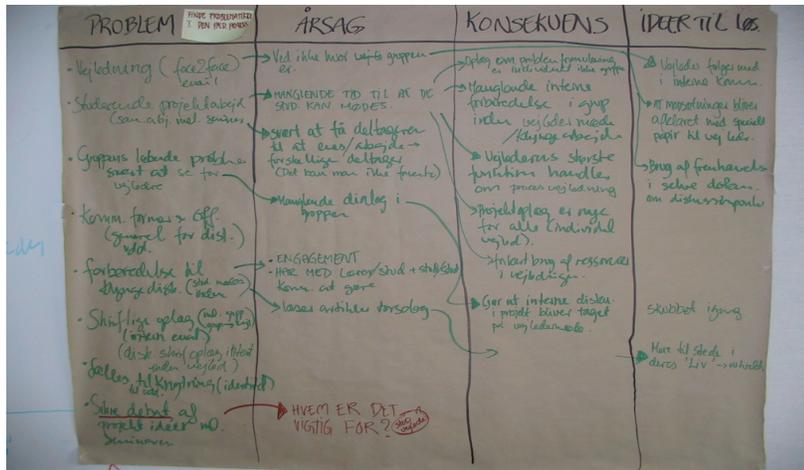


Figure 2: Diagnostic mapping of problems experienced by the teachers and articulated at the second workshop

The primary problem identified was that students were less active between on-campus seminars, thus causing project-related work to begin in April or even in May, when it originally was planned to begin in November. The immediate problematic situation identified by the teachers was that the groups began their projects too late thus increasing the difficulties for project supervision. The teachers wanted to change this situation and believed that an IT-conferencing system might contribute to the solution. Their knowledge about this kind of technology and its use was limited and the principle behind selecting the IT-conference system called Magenta¹ was that it was ‘simple and that both students and teacher did not have to invest time and effort in learning how to use it’. After examining the functionality of Magenta, we questioned their choice of the IT system, because even though the system fully lived up to the requirement of ‘very low functionality’, their choice did not reflect any ideas concerning which kinds of students’ activities the system should support. They had paid even less consideration as to how the system should resolve the problem of students’ inactivity between on-campus seminars.

The teachers agreed with the researcher on these matters, but they were unable to change the decision regarding the use of Magenta as the main supporting technology at that point in time. Instead the teachers decided that if one group would voluntarily participate in the adoption of another system which would support the group’s project work in a better way, we could facilitate that group in their adoption process. BSCW was chosen as the supporting technology because it was already available from the IT-department of the university, while being well suited to facilitate group work.

6.1.2 Action Planning

At the first on-campus seminar in September the action research project was presented to all the students of the master degree program, and one group volunteered to participate. The researcher offered to introduce and facilitate the use of groupware, including building a shared ground and providing on-going suggestions for improvements of their

¹ Magenta is a message board. You can write a text message and read others’ text message. There is no possibility to build up folder structures, attach documents, delete or move messages.

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collaborative process. In return the students should commit to participate in four workshops/reflective conversations. The students were free to reject the system at any time. The group members were asked to write an email about their individual experiences with IT, which was used to plan the first intervention in November.

6.1.3 Intervention

In November a six-hour workshop was conducted on a Friday evening between 6:00pm and midnight the day before an on-campus seminar. The aim was to introduce BSCW to the group by providing hands-on training and illustrating mature use of the functionalities for coordinating, communicating and exchanging documents. Additionally the group was facilitated in negotiating their common ground regarding the content and the goal of the project.



The workshop activities were recorded using wall-graphs (Simonsen and Kensing, 1997) and tape-recording. In addition, an entry was made in the researcher's personal logbook just after the session.

The results of the introduction activity were a contract between the students concerning how to precede the project work, a project plan, and a designed BSCW workspace comprising a folder structure based on the project plan. One student remarked that after this introductory workshop they all felt more on track with the project, than the year before.

“I think we all had a feeling of being far more on track than the year before. It was a relief to have an overview of the project and process even though it might have been an illusion. (...) The hard thing about this part-time education is that you sometimes lose your feeling for the project and then something like this [BSCW and plan] is extremely good to have.” (Group member in January 2002)

Thus, the November introductory workshop induced a feeling that BSCW would extend their capabilities for remote collaboration. At this workshop students were informed about new technological opportunities and how to relate the BSCW functionality to their actual practice. This new knowledge of technological opportunities expanded students' technological frames in relation to technology strategies. None of the members had heard about groupware technology before, and remarked that email 'had worked ok' in former projects, even though they had experienced difficulties in keeping track of various versions of specific documents. After the workshop the students perceived the primary motivation behind using groupware as decreasing the effort for coordination.

By creating the sub-folders in BSCW based on the group's negotiation of their project content and plan, the group was facilitated in embedding their future work practices into the structures of the groupware system. This process supported the alignment of the participants' understanding of how to deploy the system, thus facilitating the

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development of congruence between individual technological frames in relation to daily use of groupware. If their technological frames related to the nature of technology in respect to project work earlier consisted of email, now they included knowledge of groupware. Additionally, the group members' frames towards groupware were to some extent in balance since all participants actively took part in negotiating the folder-structures.

6.1.4 Observation

Within the first action cycle, the period from November to December was characterised by very low or almost no interaction within the group. Due to the members' daily work and family routines, the group did not engage in any kind of collaboration in this period. The members did logon to BSCW to 'see' if anything has happened and there were two small discussion-notes added but none were answered. Then between Christmas and New Year the group held a telephone meeting to "get the communication started again". The main purpose for this telephone meeting was to discuss and coordinate the production of a synopsis, which they should sent to their supervisor before meeting him in January. Using the telephone they also discussed how to coordinate and exchange different versions of the synopsis and they decided *not* to use BSCW, but e-mail instead. When asked in January why they took this decision a group member explained:

"The thing with the BSCW is that when the working process is not continuous (...) then nothing happens (...) so it becomes like a stranger out there" (Group member in January)

In part-time vocational education participants use their free time to study, thus the process will never be continuous, and this makes it difficult to achieve sustained use of groupware technology. The motivation to use BSCW decreased in December because the focus in this period shifted from learning how to use the technology to creating the content of the synopsis. Thus, the barrier of learning and enacting the functionality of groupware in practice was problematic. The result was that the group chose to rely on the more familiar email technology.

6.1.5 Reflection

In January a two-hour reflective session with the group was conducted using wall-graphs and rich-pictures (Checkland and Scholes, 1990), and the activity was tape-recorded. The aim of this session was to evaluate the use of the groupware system in the period from November to January, and the researcher encouraged the group to articulate the *actual* collaboration process as experienced from November to January. Knowing they had used email for coordinating the synopsis, the main question was whether this "more traditional" technology was successful. If it were then the inevitable question would arise as to the need for the groupware system. However, it transpired that the use of email for coordination had failed. The group did not actually realise this before the reflective session. They had emailed the synopsis to their supervisor two days before the reflective session and they all thought they shared a common understanding of both the content and

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the process by which the document had been produced. However, this was not the case. The following discussion took place at the reflective session:

Thomas: I think there is something missing here on the first few pages [pointing at a printed version of the document].

Emma: Is this not the last version you sent?

Thomas: No it is not.

Emma: The one you sent a couple of days ago?

Thomas: The one we mailed to Adam [the supervisor], the one we called version 4, the one Lisa had written on – unfortunately I don't have a printed version because my printer isn't working, but Lisa had put mine and hers together; it is about 6-7 pages long...(…) (Group discussion, January)

This discussion continues and they become increasingly frustrated about the situation. They lacked a printed final version, and in the end they decide to contact the supervisor to check if he have the right version. In addition they begin discussing the email coordination process, and soon realise that they miss a shared understanding of the process underpinning the situation. The group finds themselves in a new problematic situation influencing a change in perspectives of email, which in turn affects their perception of groupware.

6.1.6 Technological Frames after First Action Cycle

The technological frames of the teachers' group after the first action cycle has been influenced by the activities planned and guided by the action researcher – especially related to their perspective on the nature of groupware as in the functionalities and capabilities provided by the technology. Where they initially perceived that they needed 'low functionality', reducing time for learning the technology, they acknowledge that the technology also should support particular collaborative activities to be useful in the end of the first action cycle. Teachers' perspectives on the strategies for groupware became more explicitly articulated as in preventing projects in beginning late, thus improving the conditions for supervision in the end of the first action cycle. The day-to-day usage of the groupware system supporting group work was still perceived by the teachers as up to the students themselves.

The technological frames of the student group related to the nature of the technology were changed in the end of the first action cycle. Initial the group had no knowledge about groupware, but influenced by the intervention activities the group now had been introduced to the functionalities closely related to the proposed future collaborative activities. The students' primarily motivation for using the system was to decrease their effort in coordination. Still at this point in time the students did not have any experiences of technology-in-use, but guided by the researcher they had negotiated their collaborative activities also concerning the use of groupware. These negotiations were however not based on experience but on assumptions for future collaboration.

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The technological frames of the action researcher were not changed during the first action cycle, particular because the role of the researcher in this action cycle was to influence the technological frames of the student group by facilitating adoption activities and secondly to influence the technological frames of the teachers. So far none of the researchers' initial assumptions of groupware support of problem-oriented project work in geographical distributed groups were challenged by the technological frames of these two other key-actors groups. The below table summarise the technological frames after the first action cycle.

	Teachers	Students	Action researcher
Nature of technology	Technology must support particular collaborative activities between the students to be useful.	Support of coordination, shared archive and planning.	Groupware supportive of collaboration in project groups in education needs to have functionalities such as coordination, shared archive, version control and negotiations.
Technology strategies	The motivation behind groupware is to make the project begin earlier, thus making the supervision process easier.	Decreasing effort of coordination.	Geographical distributed groups have difficulties in collaborating, thus groupware can enable their opportunities for collaboration, reducing time for coordination while increasing time for learning and negotiation.
Technology-in-use	The use of groupware technology in the project groups is up to the students themselves.	Negotiated use of technology related to their subject matter, but no practical experiences with day-to-day use.	By negotiating common working procedures including how to use groupware in specific situations, the group should be supported in negotiating how, why and when to use groupware closely connected to the subject matter of their project.

Table 4: Technological frame of key-group actors after the first action cycle

6.2 The Second Action Cycle – January to April

The second action cycle began where the first one ended at the reflective session in January and ran to the end of the action research project in April. The second action cycle comprised problem diagnosis of the situation in January, planning of new actions to resolve the groups' experienced problems in using BSCW, intervention activities, observations of the effects of the new actions, and finally reflections on the new intervention activities in relation to groupware adoption.

6.2.1 Problem Diagnosis

When the group members and the researcher reflected upon the group's collaboration between November and January it became clear that the students' experienced problems were related both to email and groupware. The main problem with using email was found

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to be the difficulty of keeping track of the various versions of the documents they exchanged. This had also been a problem in previous projects. The reason for not using groupware was mainly the lack of motivation to make an effort to learn the groupware functionality during the process of constructing the synopsis. Because of the missing shared collaborative activities immediately after the initial introduction the students never became familiar with the functionality of BSCW while it was still fresh in memory. Thus, for adopting groupware the students needed to apply groupware immediately after the introduction of the groupware functionality on a regular basis before new time-pressure situations emerge.

6.2.2 Action Planning

The researcher and the group planned new actions aiming at solving the identified problems in groupware adoption. The new activities were intended both to facilitate the students in learning the functionalities of BSCW while ensuring regular use immediately. The activities included both concrete actions by the researcher and new commitments from the students. As one group member said:

“Now we need to get past these [feelings towards BSCW] and say; ok it is not that difficult and instead realise that this [BSCW] actually makes it easier to get access to each other. I think that what we need is to commit to the system.” (Group member in January)

6.2.3 Intervention

The first activity to support the group's BSCW adoption was a new hand-on introduction to the system's functionalities. The hands-on activity was structured around the individual group members' questions regarding how to do specific actions. In this process the group members realised what they actually remembered the functionality of the system quite well. In this way the individual technological frames towards groupware were not established in the second cycles but were instead expanded as the group learned more about the nature of the system.

Secondly the researcher produced one document describing the functionalities of the system, and one document describing three scenarios for using the BSCW for coordination. Moreover the BSCW direct notification function was turned on, to alert group members of relevant events occurring in the system. Last the researcher set up a discussion forum called weekly logbook, where group members could write notes about the project, together with personal information and other issues they wished to mention. The main purpose of the weekly logbook was to encourage regular use. The students were suggested to write an entry in the weekly logbook each week stipulating regular use.

6.2.4 Observation

Besides observing the actions in BSCW, a status session was also conducted in March. The aim of this session was to gather information about how the group perceived their collaboration and use of groupware at that point in time. The researcher was not present

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at this session, but had provided the group with a list of questions to discuss. The group recorded their conversations, and this data were later transcribed and analysed. The questions the group discussed were divided into two types. One type related to the evolution of the project itself and another aimed at understanding the role of BSCW. Examples of questions are: Which kind of documents do you have at this time? Are there documents not placed in BSCW? Describe what you have been doing in the past period and how BSCW or other kinds of technology (like phone and email) have been used?

Between January and March, the situation for the group had changed in two important ways. Firstly, they had managed to adopt BSCW into their collaborative practice and secondly, the group had developed a shared understanding of how the project was taking shape by using the actions within BSCW to interpret each other's individual activities. This was evident by the large numbers of actions within the system, e.g. revisions of folders, uploads and downloads of documents and weekly notes in the logbook.

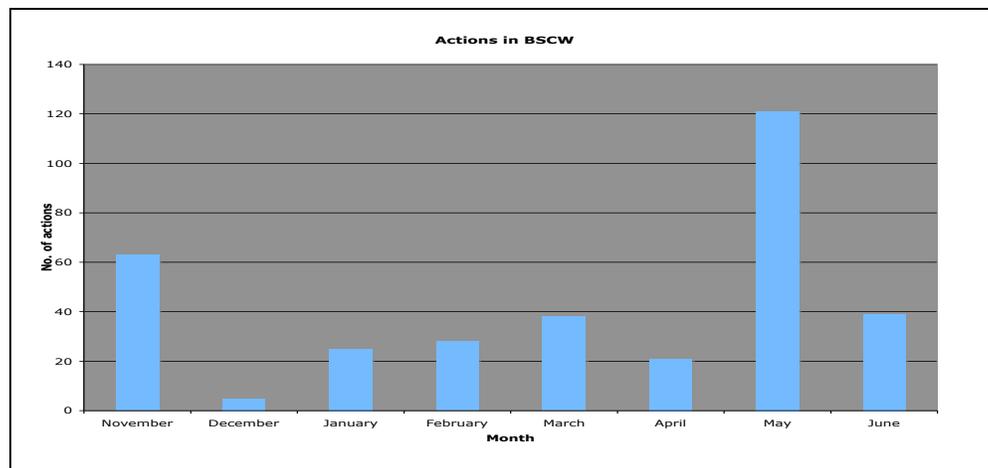


Figure 3: Number of actions made within BSCW illustrated by month

Actions in Figure 3 comprise creations, revisions and deletions of folders, documents, URLs and notes made within BSCW during the whole period from November to June. Actions do not include reading or downloading. November actions include the actions made within the hands-on introduction (37 actions), out of the reminding actions (25) made in November, the 20 actions was made by the researcher as notes containing technical guidelines in concern of how to perform particularly actions such as uploading documents or setting the version control. In November, the participants made only 5 actions after the first hand-on introduction. In Figure 3 we see the major difference between the numbers of actions made before and after the intervention in January.

The group had managed to reduce the effort required for coordination by using the groupware system. While in January almost all the time was spent discussing the status of the project, this was a minor issue in March. Surprisingly, a wider use of the system was also detected. In fact, the weekly logbook, originally established to encourage regular use of BSCW, had brought additional visibility to the social dimension of the collaborative situation by providing a social context for interpretation of each other' actions. This is showed for example by the following citations:

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Lisa: I think this weekly logbook has been very good, because I have had a good sense of where you all have been – especially you Thomas, who have written all about your illness.

Emma: It makes it much more captivating to go in and read stuff like this too.

Thomas: Yes (...) because it gives you a good feeling of what is going on. (...) The constant response. It is especially good in these kinds of distance projects.

Lisa: Sometimes you get hung up with work and lose contact with the project...

Emma: (...) you know you have it all in BSCW (...) it gives you a sense, psychologically, that there is a project forming.” (Group discussion in March)

The weekly logbook had bridged the geographical distance between the group members ensuring that the geographical distance did not lead to social distance. Social and people-centred issues have been found important when researching group collaboration (Steinfeld et al., 1999; Prinz, 1999, Tollmar et al., 1996; Schmidt, 2002). In collocated teams, the daily small interaction around the coffee-machine or water-cooler helps members to get a sense of each other. Lack of such information in geographically distributed teams can affect group morale due to the possibility of misunderstandings and misinterpretations (Cramton, 2001). The group had found that their use of groupware provided a new capability for their collaboration by mediating information similar to ‘information received when walking along the office floor’ (Prinz, 1999, p.2).

6.2.5 Reflection

The last activity conducted with the group was a reflection session held in April five weeks before the group turned in the final version of the project report. The reflective session was organised as a one-hour conversation, which was tape-recorded and later transcribed. The collaborative practice had been transformed by groupware. One example was that a telephone meeting originally planned between January and March had been cancelled because the group preferred using BSCW instead. When asked why they cancelled the telephone meeting, the group explained that it was too expensive. The cost of a telephone meeting had not been an issue between Christmas and New Year because they needed it for coordination, but after BSCW was adopted into their practice, the need for the telephone was reduced. Also the email direct notification feature transformed the practice. This feature supported visibility and awareness of the actions conducted within the BSCW system, since each time a member wrote, revised or moved objects within the system, an automatic e-mail was sent to all members informing them of the activity. Each member could therefore monitor when others had made a contribution. Participants made an entry each week in the weekly logbook, and all actions caused an email notification. This had a huge impact on the successful adoption, because it caused the group to use the system functionality regularly. The weekly logbook additionally facilitated spontaneous and informal interaction by being an informal discussion forum, with no prescription as to usage or content.

At this reflective session the group characterised the project work experience as ‘much more calm’ than earlier project experiences and they had a strong feeling of confidence

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that they would ‘finish on time with a good result’. Additionally they stated that the researcher’s interventions had influenced the process in a positive way. As one group member said:

“[Without the researcher intervention adopting groupware] we would not have come this far, especially in our heads. Maybe in respect to the written documents, but the feeling of coherence around the project would not have existed. This is the first time I feel, we are in control.” (Group member in April)

Aligning work practices and technology requires an understanding of the practice. Asking questions related to the collaborative processes initially as well as during their project helped the students to articulate their work practices. In this way two goals were achieved. First it supported the group in developing a common ground for their project and second it helped build actual technology-use-based work practices instead of speculation about the potential use of groupware in future work practices. The students perceived both goals as important for the successful project work process and the groupware adoption. The nature of BSCW was also vital for adoption. Besides providing a repository for the documents, BSCW additionally created a feeling of a ‘backbone’ of the project embedded in the folder structures.

The group was of the opinion that they would not have adopted BSCW without the researcher’s interventions. First of all none of the participants were even aware of the existence of groupware technologies, thus the intervention provided knowledge of the new technological opportunity. Furthermore one group member explained that his anxiety towards technology would have caused an immediate rejection if he had not known that someone was caring about their project and groupware use while also being available for questions. Additionally, two of the group members told they had been ‘bragging’ about their use of the system, showing it to friends, family and colleagues when asked about their project. They were proud of the system, which also affected their view of technology in their daily job. One group member was planning to adopt groupware in her collaboration with colleagues at her day job. Likewise another group member explained that she, at her workplace advocate that colleagues should remember to store common documents at the ‘X-folder’.

6.2.6 Technological Frames after Second Action Cycle

The technological frames of the teachers had not changed in the second action cycle primarily because there were no special activities arranged for the teachers in this period. However the particular teacher supervising the group adopting BSCW had ask the group regularly about how their use of groupware was going, and since the group was enthusiastic about the system and also wrote about their experiences in the official evaluation of the project, the supervisor informally expressed that he believed the master degree program should extend the use of technology.

The technological frames of the students change dramatically in the second action cycle. Concerning the nature of groupware technology, the students had expanded their view so now additional functionalities were included besides the possibilities of

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coordination and shared archive. The additional capabilities that BSCW provided the students supporting their collaboration were the visual representation of the project as embedded in the conceptual folder structures within the system and the possibility for mediating social relations. The expansion of technological frames related to the nature of groupware also expanded the category of strategies for adopting groupware. Now the students were not only motivated in adopting groupware to support coordination and shared archive, but also because groupware would provide them with new capabilities improving their collaboration by supporting exchange of informal social information and by being a visual representation of a project taken form. Moreover the students' understanding of the day-to-day use of BSCW was changed from being solo on a theoretical level to after the second cycle comprising concrete experiences with the groupware support of particular contextual collaborative situations.

The action researcher had highly influenced the technological frames of the students in the second cycles likewise the students' perspectives on groupware also influenced the technological frames of the action researcher. Concerning the nature of the technology the technological frames of the action researcher included not only shared archive and coordination after the second cycle, but the nature of the technology should now also provide a visual representation of the project and mediate social relations. This further expanded the technology strategies since the motivation for adopting of groupware now includes the possibility for developing social coherence between the geographical distributed actors by providing a platform for exchanging social information while being a visual representation of the project. Lastly, the action researcher's understanding of technology-in-use was based upon negotiation and re-negotiation between participants developing a common understanding of workflows and use of technology in particular situations.

	Teachers	Students	Action researcher
Nature of technology	Technology must support particular collaborative activities between the students to be useful.	Groupware functionalities include support for coordination, shared archive, visible representation of the project and mediation of social relations	Groupware functionalities include support for coordination, shared archive, visible representation of the project and mediation of social relations
Technology strategies	The motivation behind groupware is to make the project begin earlier, thus making the supervision process easier.	The motivation behind groupware adoption is to reduce coordination effort, having more effective collocated meetings, exchanging social information while being a visual representation of a project taken form.	The motivation behind adoption of groupware includes the reductions of coordination efforts increasing time for reflection and learning as well as the support for developing social coherence between geographical distributed actors by providing a platform for exchanging social information while being a visual representation of the project
Technology-in-use	The use of groupware technology in the project groups is up to the	Concrete experiences with use of groupware in particular collaborative situations of the	Enactment of groupware on day-to-day basis is based upon negotiated and re-negotiated understanding of

	students themselves.	group work.	workflows and collaborative activities developed through the participants' experiences of regular use and negotiation in reflective episodes.
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Table 5: Technological frames of key-actors groups in the end of the second action cycle.

7 Discussion

The factors influencing the expansion and alignment of participants' technological frames towards groupware are both technological and social. The technological factors comprise the nature of the technology in relation to the new capabilities offered. The unanticipated capabilities that groupware provided in this study were the visual representation of the project embedded in the emerging structures of BSCW and the opportunity for mediating social relations. The participants perceived both these new capabilities as positively influencing groupware adoption. BSCW had provided a shared workspace where social actions were propagated and 'objects-of-work' were operated upon (Ngwenyama and Lyytinen, 1997). This was perceived as a new useful capability supporting collaboration. The use of BSCW transformed the group practice by creating a representation of the project that induced the feeling that the project was taking form. The project was right "there" in all the folders and documents located in the group's common repository. Moreover the use of the weekly logbook provided the group with a sense of both task-oriented and social-oriented awareness related to their mutual work (Prinz, 1999). The logbook provided the 'group members with information helpful for making sense of others' actions necessary to interpret others' actions (Steinfeld et al., 1999: p. 84). The logbook contained extra socially significant information such as information about group members' health and family situations. Exchanging social information supported a feeling of coherence within the geographical distributed group. The weekly logbook also provided asynchronous casual social encounters by simultaneously hosting coordination activities and social interactions. Spontaneous communication has previously been associated with a stronger shared identity and more shared context in virtual teams (Hinds and Mortensen, 2005). This finding is also supported by our data. The groupware application in this study can be viewed as an artifact triggering the expansion of technological frames. For a technology to be a triggering artifact participants need to see, recognise and own the artefact (Mogensen and Trigg, 1992). BSCW can be viewed as a triggering artefacts, since through guidance the students ended up seeing BSCW as an resource for collaborative practice and not solo as a piece of software with folders and functionality, recognising BSCW as having potential relevance for their collaborative practice while owing BSCW by enacting the application in their actual collaborative practice. Thus, groupware adoption transformed the collaborative practice of the group resulting in unanticipated social effects and a much wider appropriation of BSCW than first intended (Berg, 1998; DeSanctis and Pool, 1994). We find evidence that the new

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capabilities of groupware were highly appreciated by the participants, in turn affecting groupware adoption positively (Robinson, 1991).

There were three main social factors influencing the expansion of technological frames. First the introductory session afforded knowledge about the new technological opportunities by introducing groupware functionalities. Here the functionalities were related to the future practice of the group. Second the initial negotiation of goal, aim and plan of the project supported the group in developing a common ground. The initial introductory session presented a new window of opportunities (Tyre and Orlikowski, 1994) by including negotiations of the goal, aim and plans of the project and by basing the first folder structures upon the insights from these negotiations. In this way the introduction to the technology was related directly to the project, which supported the group in understanding how groupware could be useful to mediate their distributed activities. This served as a link between groupware and practice. The third social factor influencing the groupware adoption was the reflective episode two months after the initial introduction. When the group attempted to collaborate using the system after this time lapse, their willingness to learn the new technology seems to have decreased. They rejected the groupware system and used familiar technologies instead. This observation suggests that the collaborative activities conducted immediately after the introduction session strongly influence for subsequent technology use patterns. This is also supported by earlier findings that changing technology-use patterns is difficult and that participants often get stuck in unproductive work patterns (Huysman et al. 2003; Tyre and Orlikowski, 1994). The reflective session provided the group with the opportunity to articulate their work practice experiences while re-evaluating both the collaborative practice and their use of technology.

Our empirical observations provide strong evidence that without a reflective session in January groupware adoption would have failed. The reflective session was a disruptive event since the group realised that their existing routines in using email for coordinating the project documents had not produced the expected results. The reflective session provided a new window of opportunity. This new window was exploited immediately by the new actions planned and executed by both the group and the researcher. Disruptive events often provide participants with the ability to critically evaluate their work practices thus increasing the willingness to revise, modify and adjust their work practices including their use of technology (Tyre and Orlikowski, 1994). Additionally the work practices immediately following the reflective session were characterised by activities performed within the groupware system, especially in the newly created weekly logbook, which were in stark contrast to the inaction after the initial introduction session.

Both socially related factors (e.g. the reflective session) and the technology related factors (e.g. the weekly logbook forum) supported the expansion and alignment of participants' technological frames leading to the adoption of groupware. Without these factors the group would most likely not have been able to enact groupware to mediate their distributed yet interrelated activities.

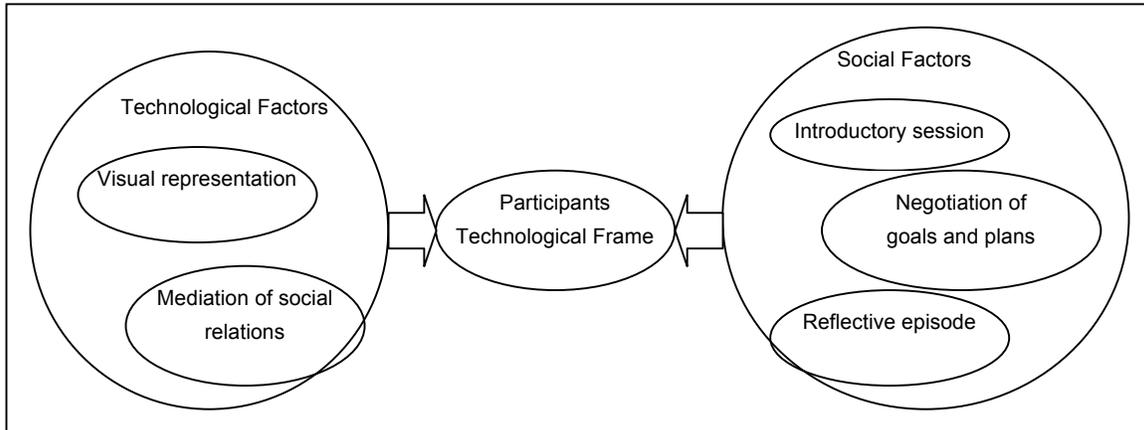


Figure 4: Technological and social factors expanding participants' technological frames

8 Implications for Research

By conceptualising groupware adoption as alignment and expansion of participants' technological frames we must focus on participants' particular interpretations of the technology and its role in settings including nature, strategies and use of technology (Orlikowski and Gash, 1994). The process of expanding technological frames must be understood as a continuum with varying degrees of technology adoption. Initially, in our group, the participants' technological frames were aligned and comprised the use of email and phone. The assumptions, expectations and knowledge about technological opportunities for mediating group collaboration did not include groupware. Then after the first intervention the technological frames were expanded in terms of the participants' new knowledge about technological opportunities including the nature and strategies of groupware. Still groupware was not fully adopted, since the degree of the expansion was only in terms of knowledge concerning new opportunities, even though the introduction to the groupware functionality was related to anticipation of future collaborative actions. It was assumed that groupware could support their collaboration and they expected it to do so, however it failed.

Participants' interpretations of groupware technology were modified in the reflective session in the first action cycle moving towards the next level of technological frames expansion. The reflective session provided a new window of opportunity for changing the unproductive patterns of collaboration (Tyre and Orlikowski, 1994). Here the technological frames towards groupware consisted not only knowledge about new opportunities, but included articulation of the non-use of groupware and the concrete experience of activities mediated by email. In this way non-use of groupware was related to previous practical collaborative experiences, instead of being related to proposed future collaborative activities. Therefore the technological frames were expanded from that of mere speculative knowledge about new opportunities to a degree of in-depth articulation of actual collaborative work practices and use of technology. Then in the problem diagnosis stage in the second action cycle the in-depth articulation of

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experienced practice was related to the possible future use of groupware. Here the articulation of concrete work experiences and use of technology facilitated the alignment of the technological frames of the participants.

The third level of technological frame expansion comprised practical enactment of groupware. Here groupware is appropriated and used to mediate the interrelated activities of the group. This step requires commitment from the participants and alignment of the individual technological frames on key categories. Here the technological frames of the participants are expanded from the degree of knowledge about the technology through the articulation of concrete work practices and technology use towards practical enactment of groupware. It was only during this third level of expansion of technological frames that the use of groupware became embedded into the social practices. At this stage the participants experience a balance between how they articulate their practices and their use of technology (Star and Ruhleder, 1996). These observations suggest that groupware adoption can be conceptualised as expansion and alignment of technological frames at three levels: knowledge of new technological opportunities, articulations of concrete work practices and technology use, and practical enactment of groupware.

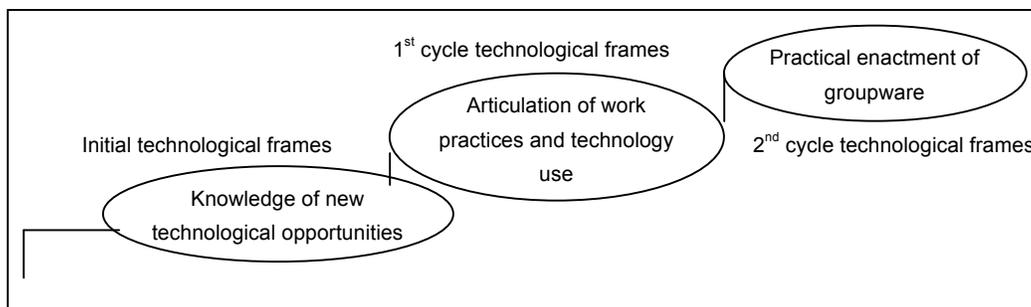


Figure 5: Expanding technological frames at three steps

The above figure illustrates the three levels of technological frames expansion and is represented as three steps towards groupware adoption. Initially in this research project we tried to take the first two steps at the same time, by trying to ensure that the introduction to the groupware functionalities were tied closely to the actual practices of the group. However our empirical observations illustrate that this initial connection between practice and technology was based on speculations about future work and not based on concrete experiences. Thus, the empirical observations suggest that it is difficult if not even impossible to introduce groupware functionalities to form a new practice with only limited experiences of group work practices. Until the breakdown of email coordination the group did not have a group work practice and the breakdown was a result of the first concrete group task, which the previous technology did not support in a proper way. The experienced breakdown provided the group with an understanding of how group work practice is something more than just email correspondence, which triggered the group's understanding of potential future work practices and the need for groupware, such as BSCW, to support it. Finally our empirical observations suggest that the third step of groupware adoption (practical enactment) should be taken immediately after the second step, since delays are destructive for the adoption process.

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One could argue that if the collaborative process immediately after the initial introduction had not been an interruptive period, but instead consisted of interrelated activities, the groupware adoption process would have looked different. However, we would argue with reference to Majchrzak et al. (2000) that in order to solve misalignment between technology and practices, it is essential to foster re-evaluation to help achieve groupware adoption. Thus, we argue that even though there were a large number of activities immediately following the initial introduction there would still be a need for reflective sessions providing an opportunity for re-evaluations of collaborative practice and technology use, since the links between groupware use and practice calls for articulation and reflection grounded in actual experiences.

9 Implications for Practice

Our findings in this paper suggest that teachers applying groupware technology in an educational setting must choose the groupware application based upon reflective and explicit considerations about the users and the collaborative practice. These reflections include understandings of the nature of technology (which functionalities are required), technology strategies (the motivation for adopting groupware) and technology-in-use (how should groupware be used in practice). Practitioners can use the three-steps model of expanding technological frames to plan groupware adoption processes. The model suggests that the first step would be to introduce the new technological opportunities for the participants at all three domains of technological frames: Nature, strategies and use. During these introduction activities time for negotiating the subject matter, planning and how to employ groupware related to the particular project is needed. The next step would then be to facilitate an evaluation episode after a period of collaboration, which includes negotiation and re-negotiations of the collaboration and use of groupware. Last the model suggests that immediate collaboration activities after evaluation are essential for groupware adoption. Conclusive the model presented in this paper support earlier research on groupware adoption (e.g. Grudin, 1994; Karsten, 1999; Majchrzak et al., 2000) stating that adopting groupware is not simply a process of providing the technology but must include a well-planned guidance supporting the participants in enacting the new system. While Orlikowski and Gash (1994) propose an analytical and systematic approach for examining the underlying assumptions, expectations and knowledge people have about technology, we have in this paper applied this approach as a systematic analysis method to identify how groups of geographical distributed group members changed their view on technology adopting groupware into their collaborative practices.

10 Limitations

Like other studies, ours too has potential limitations. An obvious limitation is that we only investigate one self-selected group of three participants. One could question if the group is representative for groupware adoption processes or if the participants are too interested and eager in learning about the technology influencing the success of the adoption process. However, we believe, that because the group at all times had the opportunity to retract from the project with no consequences for their education while did in fact rejected adopting BSCW between November and January indicate that the group members were critically reflective towards technology. Also one of the group members explicitly state that he easily was intimidated by technology, thus we would argue that the group investigated is representative for adult-master groups in general concerning their perspective of technology. Another potential limitation of our study is that we only focus on social and technological factors closely related to the social context of education therefore exclude other factors such as political and economical factors, which might as well influence the expansion of technological frames. We acknowledge that other factors might influence the expansion of technological frames, however to identify specific related factors we had to focus our study, thus excluding factors located in social contexts outside education. Therefore the model of steps in groupware adoption should be viewed as a proposed conceptualisation and not a finally stated fact. New research is required to fully investigate the conceptualisation of technological frame expansion including others factors located in related social contexts. New research is required to refine and test the conceptualisation. These new studies might expand our understanding and definitions of the different factors leading to successful groupware adoption, which is required for improving conditions for geographical distributed groups in education.

11 Conclusion

This paper enhances current research on groupware adoption in virtual teams by suggesting a conceptualisation of groupware adoption in terms of technological frame expansion. We have investigated the adoption process of groupware in a virtual team by perceiving groupware adoption as the alignment and expansion of participants' technological frames to include groupware. Based on our empirical observations we propose that groupware adoption is a three step process consisting of bringing knowledge about new technology opportunities to the participants, articulation of and reflection upon concrete work practices and use of technology, and lastly, practical enactment of groupware. Furthermore we argue that the adoption process is influenced by both technological and social factors. The technological related factors are identified as new capabilities offered by the technology. We have identified two important new capabilities influencing groupware adoption positively. Namely, the visual representation of the project embedded in the emerging folder structures and the mediation of social relations and encounters. There were three social factors influencing the expansion of

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technological frames positively. These were identified as the introduction session of the functionalities of groupware, clarification of goal, aim and plan for the project, and lastly the reflective episode including articulation and re-evaluation of actual practice and use of technology. We do not argue that we have identified the total number of factors influencing technological frame expansion related to groupware adoption. Instead we argue that this paper extend previous research, which have stated that proper guidance of groupware adoption processes is essential for success, by investigating important aspects of what this guidance comprises while identifying some of the influential technological and social factors expanding the technological frames to include groupware technology.

Finally this paper also contributes to practice by providing essential insights for groupware adoption in virtual teams attending part-time educational programs. Here our main contribution is that even though groupware may facilitate collaborative activities among students in the periods in between on-campus seminars, appropriate guidance of the groupware adoption process is vital for success.

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