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Lars-Erik Jonsson

Appropriating Technologies in Educational Practices

Studies in the Contexts of Compulsory Education, Higher Education, and Fighter Pilot Training

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ABSTRACT

Title: Appropriating Technologies in Educational Practices: Studies in the Contexts of Compulsory Education, Higher Education, and Fighter Pilot Training
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Information and communication technologies (ICT) are viewed as progressive technologies. Normally this view entails general assertions – in the *future tense* – that ICT will be the solution to a wide variety of problems. The thesis argues that generic assertions about the benefits of ICT are insufficient for understanding the role of technology in educational practices. Therefore, the overall purpose of the thesis is to investigate – in the *present tense* – how technologies are *appropriated* i.e. how groups and individuals make use of physical and cognitive resources in their daily practices. Particularly, the thesis aims at describing the conditions of technology appropriation in the contexts investigated and at giving a theoretical account of the conditions of appropriation. The particular practices investigated are schools ranging from primary to upper secondary, higher education, and military pilot training. Methodologically a qualitative approach is applied. Data from participant observations, audio recordings, and informal talks are analyzed by means of computer assisted qualitative data analysis software (CAQDAS). The thesis is divided into three main sections. The first section, "Approaching the Field", is an introductory section in which the perspective of the research area and the methodological approach are presented. The second section, "Empirical Studies", contains the four studies. In the first of these, *Making Sense of ICT in Class*, it is argued that tools are adapted to existing practices rather than being agents of change. The main contribution of the study is a theoretical model showing how practitioners make sense of their practice. The second study, *Practicing Distance Education*, argues that even if cutting-edge technology is available, it will still be used for traditional teaching. The argument put forth is that instructional approaches are dependent on and must be considered in relation to educational content. The third study, *Disseminating ICT in Educational Practice*, contains detailed descriptions of eight educational practices. Still, it is mainly theoretical. An activity theoretical analysis makes possible the focus on crucial aspects of changing educational practices. Thus, it is a contribution to widened and new ways of viewing changing educational practices. The fourth study, *Conditions of Learning in Fighter Pilot Training*, analyzes the institutional practices of a military setting. Like the previous study, it contains detailed descriptions of the training practice and an activity theoretical analysis, in this case resulting in proposals for a changed practice. The last section, "Conclusions", contains reflections of how the characteristics of the different contexts influence the utilization of technology. It is argued that *appropriation will be dependent on the perceived affordances of the technology* and not on some inherent quality of the technology. Thus, the meaningfulness is not intrinsic to technologies. Instead, meaning arises in a process of *interpretation and interaction between participants and between participants and technologies*. The section ends with a model relating the theoretical concepts to the empirical findings of the four studies.

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During the the last year, I have spent innumerable lonely hours in front of my computer concentrating on finishing off my thesis. To those around me, particularly to my dear wife Anja, I know I have been a bore. My daughter Karin probably hit the nail on the head when she, trying to find a suitable birthday present for me, complained to my son Karl: "It's so difficult since he doesn't seem to have any interests besides sitting in front of his computer!"

However, I will not take the credit to myself for accomplishing this thesis; we are all members of supporting communities and therefore I would like to express my gratitude to a range of persons who have been particularly important for me. First of all, I would like to thank my supervisor professor Berner Lindström. Berner was the first one to see that my different projects could be turned into a dissertation project. He also appreciated my preliminary analyses – at least he said so – and that encouraged me to go on with my work. Berner's great knowledge of the research area has made him a demanding supervisor constantly delivering insightful comments, which have deepened my knowledge and forced me to revise my manuscript again and again. I have also benefited from his large network of contacts among researchers, organizations, and business people. Thus, I have been introduced to new and exciting environments, which has widened my view of educational practices considerably. I am very grateful for Berner's support.

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Sandared September 2004

Lars-Erik Jonsson

CONTENTS

PREFACE

From a societal perspective ICT is viewed as a progressive technology. In the majority of cases this view entails assertions – in the *future tense* – that ICT will be the solution to a wide variety of problems. Assertions are similar and they often converge into catchwords as better, cheaper, and more effective. To be brief, there are general solutions to specific issues.

By this thesis I want to show that generic assertions about the benefits of information- and communication technologies (ICT) are insufficient for understanding the role of technology in educational practices.

My assumption is that the realizations of ICT will vary between practices as a consequence of varying conditions. Therefore, I will investigate – in the *present tense* – how technologies are brought into and are realized in the contextual processes characterizing different educational practices. I venture to say that the resulting knowledge will be more valuable for the understanding of the domain of technology in education than mere assertions of anticipated outcomes.

Theoretically, I will start from a socio-cultural perspective. Fundamental for that perspective is an interest in the ways that groups and individuals *appropriate* (see for example Wertsch, 1998) and make use of physical and cognitive resources. Any individual acts on the basis of his or her knowledge and experiences and on what is viewed as requirements or offerings from the environment in a certain activity. Accordingly, what we do, and can do, must be interpreted relative to the conditions of particular contexts. The concept of appropriation, i.e. the contextual appropriation of technologies is the axis, or rather the hub, around which my contribution rotates.

Usually *context* is viewed as something that influences our actions. From a socio-cultural perspective this conception of context is unsatisfactory. There is not first a context and then an action. Instead, our actions are constituent parts of contexts i.e. we actually constitute contexts. Accordingly, all our

actions and our understandings are parts of the contexts and we are not just influenced by contexts (see for example Säljö, 2000).

Different contexts have developed particular ways of communicating and acting i.e. what is considered normal activity. In most historical contexts the interaction patterns are fossilized and viewed as the only possible way to interact. Therefore, any change or effort to promote, induce, or demand change, is likely to encounter resistance and conflict (Certeau, 1984; Wertsch, 1998). The empirical studies in this thesis are all from contexts with long communicative traditions and, accordingly, their patterns of interaction and their ways of utilizing physical and cognitive resources will resist sudden, revolutionary change.

From a socio-cultural perspective schools, universities, and air force bases are cultural institutions. This means that they are historically developed systems, *activity systems*, based on complicated forms of interaction between humans and their tools. Within activity systems individuals use the *structuring resources*, which are relevant and productive for certain purposes (Lave, 1988). Activity systems must not be mixed up with organizations, which formally regulate positions and doings among individuals, employees for example. Instead, activity systems are created by participants in cooperation. Accordingly, studying cultural institutions – activity systems – is not the same as studying organizational issues.

I have a dual knowledge focus. On the one hand, I want to *describe* the conditions of technology appropriation in the contexts investigated and, on the other hand, I want to explore the conditions of appropriation conceptually. To accomplish this dual focus, the first step is to produce descriptions that are close to empirical findings and the second step is to *conceptualize* the empirical findings.

Methodologically, I enter different practices and observe them. In this thesis the empirical examples are from educational institutions. Specifically, there are schools from primary to upper secondary level, higher education, and pilot training. The studies will constitute examples, or *facets*, of a complex reality. However, it is not enough just to observe and describe. The conceptualization focus requires *analytical tools* to make practices comprehensible. The practices, thus, will also constitute different examples of analyses of complex settings.

The analytical tools applied originate above all from the socio-cultural domain. The main theoretical frameworks applied are Activity Theory (AT) (Engeström, 1987) and Communities of Practice (CoP) (Wenger, 1998). The AT framework makes possible the study of practice as an integration of tool usage, negotiating, and the subjects' aims for specific objects. The CoP framework contributes to the understanding of how new artifacts and individuals are incorporated into existing practices.

Writ large, the thesis will invite the reader to a kind of narrative beginning with *Approaching the Field*, an introductory section surveying the research area. After that, the practices will be investigated on observational level as well as on conceptual level in the *Empirical Studies* section. The reader will encounter different practices, research approaches, and theoretical frameworks all representing different properties of the investigation purpose. Eventually, the *Conclusions* section will constitute a conceptual discussion of the findings, hopefully, adding relevant knowledge to the field.

APPROACHING THE FIELD

ESTABLISHING THE RESEARCH CONTEXT

INTRODUCTION

Today information technology is ubiquitous in daily life, at least in Western industrialized countries. Within the manufacturing sector robots can be programmed to carry out work that was earlier carried out by the human body. Likewise the continuous-processes production can be monitored, analyzed, and optimized by information technologies. Within the research- and education sector worldwide searchable databases, multimodal representations, and instantaneous communications have turned into indispensible tools. For private affairs it is now possible to manage bank accounts, pay bills, and make purchases via the Internet; it is also possible to fulfill civil duties like filling in the incom-tax return form via the Internet.

Whereas the manufacturing sector has utilized dedicated and highly specialized information technologies for quite a long time, the everyday utilization of the Internet with its comparably user-friendly interface is a quite recent innovation not being older than 15-20 years even in highly developed Western countries.

The apparent benefits of technologies are usually not hard to understand. If automation can relieve workers of bodily exertion; if dangerous industrial processes can be carried out without exposing the workforce to dangerous chemicals; if economic transactions can be accomplished instantaneously; if emails can be sent and information accessed worldwide in a moment the impact of technology is evident.

However, in her ethnographical work, *In the age of the smart machine*, Zuboff (1988) shows that to utilize the full potential of information technology in human activities it is not enough just to focus on technology and disregard psychological and institutional aspects. Zuboff describes how unanticipated outcomes occurred as consequences of introducing information technology

in some large process industries. Whereas technology initially was introduced as a neutral tool for controlling and enhancing production, it appeared to have a range of effects on the character of tasks, organizational structure, human relations, and learning conditions, thus, it could not be treated as a neutral intervention.

Unfortunately, there seems to be an either-or conception of technology and change. Either changes are seen as *technology driven* or they are treated as *socially constructed* assigning no particular significance to technology (see also p.21). In the first case technology is treated as something neutral, resembling an independent variable in experimental research and individuals' adoption, and eventually adaption, will be treated as the dependent variable. In the latter case, though, technologies are not seen as artifacts causing change; instead the agency is attributed to users in various contexs giving meaning to the technologies. The standpoint taken here is that neither position alone will be enough. Technology quite clearly has the capacity of bringing about change but such change can not be described without taking into account the varying contextual conditions.

When information technologies are introduced in education it is often done out of a desire to enhance educational practice generally. New technologies are commonly linked to visions of rapid change, self-paced learning, distance education, flexible learning, and multimedia presentations, all being issues in vogue of contemporary education. Even if the apparent benefits of information technology should not be denied, the argument for an introduction of information technology is generally not sustained by research taking different contextual conditions into account. As pointed out by a range of researchers, changes are not likely to occur in predictable ways as a consequence of just placing or installing information technology in a setting (Cuban, 1993, 2001; Jedeskog, 2001; Miller & Olson, 1994; Sarason, 1990; Schofield, 1995; Zuboff, 1988).

Comparing Processes in Practices

In most studies treating the introduction of information technology in educational practices, the *negotiation processes* are black-boxed. This thesis represents an opposite tack since its purpose is to explore how traditions, content of target activity, and available resources are renegotiated as a

consequence of ICT introdution. By exploring processes, this thesis will produce knowledge that is qualitatively different from effects of or with ICT.

However, between practices, negotiations of meaning will come out differently. Therefore the approach will be one of juxtaposing and comparing different practices with the specific purpose of making issues that are contingent upon different conditions surface. The investigations of this thesis are limited to educational practices. Still, conditions might vary a lot between different educational practices. Thus, to obtain variation among practices, primary-, secondary-, upper secondary-, higher education, and pilot training are chosen to represent the variation of practices investigated in this thesis.

Considering the variation, the *students* of the different settings may be mentioned first. The negotiation processes might have quite different characteristics if the students are young compared to adult students. Also the *number* of students, their *capacities*, and their motivation should be considered. Varying conditions may also be identified when *content* and *instructional mode* are focused. In fighter pilot training (see p. 146) the content is very *specialized* and marked by security concerns, thus it must be carefully *planned*. Conversely, the schools from primary to upper secondary can be characterized by a *general* content which is rather *explored* than strictly planned. Still another variation among contexts is the application of *technology* itself. First, one might investigate practices along the *indigenous-optional* dimension. In pilot training the technological tools are indigenous to the practice. This may also be said about the tools used for the training to become an engineer (see p. 70). However, the nice division between what is indigenous and what is optional is often blurred by the fact that tools like aeroplanes, flight simulators, and various measuring instruments are indigenous to their respective practices whereas tools for training of the targets skills (flight simulator f. ex.) also may be produced to be didactical devices. The didactic (i.e. optional) use of technology can be found in general schooling. But even in general schooling the indigenous-optional variable is often blurred by the fact that generic software like wordprocessors and spreadsheets can not easily be labelled optional in the same sense as software for training of specific skills in mathematics and spelling, which can be entirely optional (Figure 1).

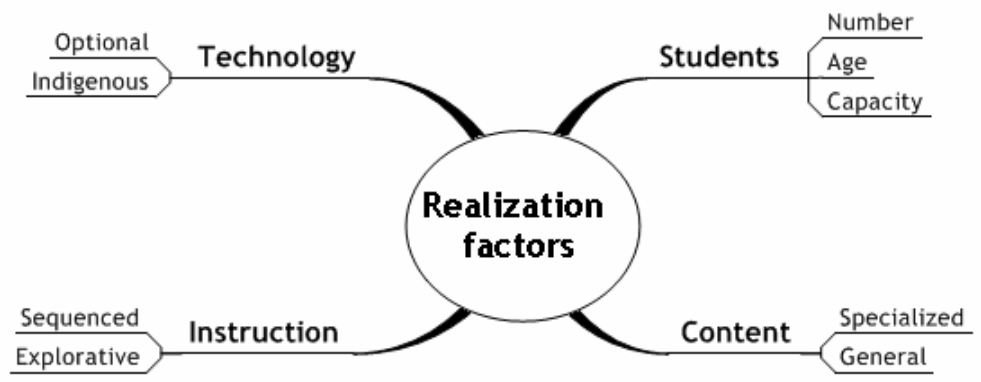

Figure 1. Factors influencing technology realizations in practice.

Theoretical Adherence and Unit of Analysis

The investigation of negotiative social processes requires theoretical frameworks with a capacity to encompass the dynamics of humans acting with their tools in context. Quite a few such studies have been carried out within socio-cultural, anthropological, and ethnographical traditions (Cole & Engeström, 1993; Engeström, 1996; Hutchins & Clausen, 1998; Lave, 1988; Lave & Wenger, 1991; Orr, 1996; Wenger, 1998; Zuboff, 1988). Positioning this study within these research traditions constitutes a line of demarcation towards individualistic and efficiency focussed studies.

A central concept describing the negotiation processes within the research traditions above is *appropriation* (Wertsch, 1998) (see also p. 30). It is also frequently used in this thesis. Appropriation can be considered as the gradual process by which participants successively become more proficient in using the tools of a social *practice* (see p. 32). Theoretically it can be compared and separated from mastery which may be used about the acquisition of a skill, to start the word-processor, open a new document, enter text, and format an index for example. Appropriation can include the skills just mentioned but, more important, it also includes a competence to use the word-processor for carrying out authentic tasks in a context. However, the difference should be viewed as a theoretical one. In the vernacular, mastery may be used in the context of a master and his/her apprentice. In this context mastery certainly denotes skills necessary for carrying out authentic tasks.

The studies presented above will require a *unit of analysis* which allows of actors and tools to be analyzed as an entity. The research traditions presented below will constitute some examples. In his book *Cognition in the Wild*, Hutchins (1995) describes the navigation of a large vessel as an issue of distributing cognitive tasks between humans and their artifacts as an indivisible unity. Pea (1993) uses the concept of *distributed intelligence* and according to Pea intelligence is accomplished in activity rahter than individually possessed. Granott (1998) introduces the *ensemble* as a metaphor for the unit of analysis. An ensemble is a group of people cooperating in a specific context. Within the ensemble the activities of different individuals are linked together and mutually dependent like in a musical ensemble. This perspective is also in agreement with Wenger's (1998) notion of a *community of practice*. Also Engeström's *activity system* is a unit to be analyzed in its entirety. One of the most well-known conceptualizations of a composite unit of analayzis is Wertsch's (1998) expression *individuals-acting-with-mediational-means*. By this is meant that individuals acting with tools for a specific purpose must be viewed as an entity and be analyzed together.

Methods

Following the research traditions presented above, this research undertaking will be one of *interpreting qualitative data*. The main empirical approaches are observations in the field resulting in ethnographical accounts. Generally, the observer has been introduced to the practices by persons with some managerial function. All practices are observed by way of *participatory observations* in which the participatory component is somewhat varying among the different studies (Hammersley & Atkinson, 1983). The focus of observations is emergent, meaning that initially anything might be worth observing. Gradually, though, the observations have become more focused when potentially interesting issues have surfaced. This is equivalent to what Blumer (1969) labels *exploration*. It does not mean that there is no direction to the inquiry; it means that the focus is originally broad but becomes progressively sharpened as the inquiry proceeds. The explorative phase enables the observer to feel at home in the area. It also lays the ground for the focused procedure that Blumer labels *inspection* by which the problem under investigation will be cast in a more theoretical form i.e what initially was called conceptualization (see p. 4).

All data are produced from *field notes* taken, in most cases, with paper and pencil. In some cases, though, *audio recordings* are included. In two of the studies (*Practising Distance Education* and *Conditions of Learning in Fighter Pilot Training*) two observers have contributed to the database. In all cases observation notes are converted into texts and entered into computer software for qualitative analysis (see p. 48 ff.).

The overarching approach taken to the qualitative analyses of the studies is *conceptualizing* (cf. *inspection*) which is meant to unveil phenomena not directly observable. Conceptualizing should be contrasted to descriptions which are closer to empirical findings. The issue of conceptualizing versus description is an issue of major importance within the Grounded Theory approach introduced in the sixties (Glaser, 2001; Glaser & Strauss, 1967; Strauss & Corbin, 1990). Even if the studies of this thesis neither qualify nor pretend to be studies within the Grounded Theory paradigm, the idea of conceptualizing i.e. to see and interpret phenomena indicated by data is strongly adopted (Coffey, Holbrook, & Atkinson, 1996; Lee & Fielding, 1996).

However, the analyses are not solely conceptual. To gain *credibility* (also readability) phenomena must retain their links to data. Therefore the analyses can be described as an emersion from the original scribblings in the field to the conceptual accounts. On the level between raw data and conceptual accounts there will be rather detailed *descriptions* of the investigated practices. These might be read out of pure interest but above all they will serve as links between practices and conceptual accounts of practices.

Eventually, the theoretical frameworks presented above will be used to make sense of the analyses. However, the analytical work only faintly resembles a step-wise undertaking in which theoretical considerations enter as a last step. The theoretical frameworks constantly cast their lights (or shadows) over the analyst and his data during the investigations. In fact, to a large extent they influence what is observed and what is not. This means that the theories are tools for *guidance*, *explanation*, and *generalization*, not something to be applied to data in the end. Thus, empirical instances cannot be directly deduced from theoretical concepts. Instead, theories are used as generic resources serving the purpose of enabling the researcher gain insight

and come up with ideas and arguments about the processes of appropriation.

The very last section of the thesis aims at pointing out how appropriation processes can be characterized as a function of the varying conditions in practice.

APPLYING TECHNOLOGY IN EDUCATION

The intuitive use of some kind of tools to support tuition and learning has probably always been going on in the intentional act of disseminating knowledge to less knowledgeable individuals. Whereas information technology generally, can mean anything from ancient handwritten texts and rock paintings to computer simulations and multimedia, most of us nowadays will think of various computer applications as educational technology.

Origins

The intellectual groundwork in educational technology started back in the 20s (Vaney & Butler, 1999). However, the early reports of the 20s reflect little research on learning theory. Still, educational experiments with audiovisual techniques, on the one hand, and educational psychology on the other, eventually laid the foundations for an academic research field. Vaney and Butler (1999)) point out that this alliance eventually led to lots of micro studies, which, though influential, lacked the ability to address the macro problems of learning. Today macro issues are addressed by constructive and collaborative approaches to learning and teaching.

In the 30s and 40s, according to Vaney and Butler, the rhetoric of research texts changed into a Deweyesque, child-centred approach often in contradiction to a social efficiency movement. Both movements, however, had strong faith in the Project Method meaning that students participate in purposeful, meaningful activity.

Mental measurements represented one branch of the social efficiency movement. One of its most influential proponents was Edward Thorndike who has become associated with the IQ scale as a means of social control (Thorndike, 1998). According to Thorndike, association between sense impressions (stimuli) and action (response) provide the ground for learning. Basically the same ideas on learning were further elaborated by Skinner and his followers into the well-known concept of programmed instruction, which built on proper reinforcement of desirable behaviours. These endeavours can be subsumed under the concept of behaviourism (cf. Skinner, 1993).

During World War II military and psychological discourses mixed into a combination of behaviourism and military training. Distinctive of the military training was that it must accomplish very specific objectives in a short time. Due to lack of time, it used both top- down and delivery strategies. Military training eventually influenced classroom practices and more learning in less time became a desirable goal for instruction.

One of the things highly valued during World War II was the preservation of democracy. Paradoxically, though, the methods for accomplishing this were undemocratic i.e. hierarchical and militaristic. Nevertheless, when the war ended these methods had proven their capacity in preserving democracy and there was a conviction that schooling should proceed down the same road. After the war this model was introduced both in textbooks, classrooms, and in teacher training programs. Vaney and Butler (1999) make the point that education was now reduced to instruction, which then was further reduced to training.

Finally, although the field of educational technology can be framed within the rhetoric of educational research, it is, according to the authors above, first of all machine and market driven, even though members of the academy often deny this fact. Today producers and distributors of hardware and software are the most influential actors in educational technology, not educational researchers. The discourse of educational technology is above all of industrial origin; it does not originate from schooling. Zoe contends:

> The computer is an educational technology that did not arise within the classroom, but was imported into it as a result of vigorous corporate and government efforts to commercialize and eventually domesticate a tool initially developed within military - industrial complexes (Zoe, 1998, p.29).

Vaney and Butler (1999) conclude that the troika of government, education and industry has been – and still is – the foundation upon which the scientific research on educational technology is dependent.

Envisioning a Better School

In Sweden The National Agency for Education (Skolverket) has the overall responsibility for the introduction of information technology in schools below higher education. Higher education is managed by the National Agency for Higher Education (Högskoleverket).

From the beginning of the 90's The National Agency for Education took over the responsibility for the computerization of schools from its predecessor The National Board of Education (Skolöverstyrelsen). Together these authorities have spent large sums of money on experimental school projects during the last 25 years. During the 80's and until the beginning of the 90's, large national projects were carried out. One of the most well known and also heavily criticized projects was the effort to introduce a Swedish computer, *Compis*, dedicated for schools. Riis and Jedeskog (1997; Riis, 2000) account for the efforts ranging from the end of the 60's till the end of the century. The researchers summarize: "*The computerization of schools during the 80's is an example of how governmental money has been spent for an unbalanced technical push embedded in pedagogical rhetoric* (Riis, 1997, p. 47, my translation)".

During the 90's also two parliamentary commissions were set up with the task of promoting information technology generally. Moreover, *The Knowledge Foundation* was established in 1994 by the Swedish Parliament. "The foundation aims to boost Sweden's competitiveness by supporting research and postgraduate programmes, competence development in industry, and school development and IT" (http://www.kks.se/aboutus/). From the start in 1994 till 2004 the foundation has spent about 5 billion SEK on various projects within the target sectors.

In 1998 the government announced an intention to spend 1,5 billions SEK during three years on the advancement of computer literacy among teachers and their students in public schools. The project, named *ITiS* (IT in School) aimed at raising the digital competence and awareness of educational research among teachers from primary to upper secondary levels all over the nation. As a bait, each successful participant (i.e among the adults) was given the opportunity to have a laptop computer at his or her disposal as long as the employment lasts. Also infrastructural support should be given to schools to enable Internet access and email accounts for staffs and students.

The visions of ICT in schools are mostly bright and the benefits are taken for granted. Persons questioning the meaningfulness are hard to find. Riis and Jedeskog (1997) state that among project proposals to the *Knowledge Foundation* there is a total lack of proposals aimed at investigating in what

way ICT would enhance education. Instead, proposals take for granted that ICT must be introduced to prepare students for a career on the labour marked, that ICT will change instruction, and that ICT supported instruction will be more efficient.

However, new technologies will not always lead to anticipated changes. What will come out from the implementation of computers in education is highly dependent of how the computers are received and treated in the school context. Therefore, according to Schofield (1995) it is necessary to investigate how the use of computers influences the social processes in classes as well as how the social processes influence the use of computers. Accordingly, the implementation of computer technology in educational practices requires more than just placing computers in classrooms.

Miller and Olson (1994) argue that it is a fundamental mistake to treat technology itself as the agent of change. Instead, reformers should try to understand how educational practitioners normally work so that the computers can be put into a context. Computer usage, then, will be constructed of teachers and students in normal work. Miller and Olson argue that reformers have been much too occupied with practitioners' resistance to changes and therefore a divide between practitioners and reformers has been created. The reformers envision ICT as something that will revolutionize practice whereas practitioners treat the computer as a tool to do what they normally do, but in an easier way (Schofield, 1995).

Also Cuban (1993; Cuban, 2001) rejects the idea that that schools will change just because they are given money to buy equipment. Schools are not like companies. In fact, they differ in two fundamental respects: a) there are cultural opinions of schooling and of relations between students and teachers; b) schools have a specific organizational pattern with students grouped according to age. These traits, according to Cuban, will influence all reform initiatives, which eventually will be adapted to the institutional and communicative patterns in schools.

A very explicit critique of school reforms generally is Sarason's book *The Predictable Failure of Educational Reform. Can We Change Course Before It's Too Late?* (1990). Sarason calls attention to the fact that most school reforms are carried out from a position of power. The powerful agents will impose their ideas on the less powerful very much like the treatment of an anaesthesized

patient, says Sarason. Instead, it is necessary to know the historical context when trying to reform. There is no reason to believe in success if failures from the past are repeated over and over again.

Realizations in Practice

Above the bright and somewhat uncritical prospects of information technology in education were alluded to. According to Stenseth (1999) there are participants in the public debate today who repudiate the educational history, based on a point of view, that the changes are so profound, that we have very little to learn from history. Still, with a minimum of historical knowledge in this domain, it is possible to recognize a recurrent pattern in which educational practitioners are blamed by proponents of educational technology for being reluctant to accepting the benefits of new technologies (Cuban, 1986).

Stenseth's (1999) general impression is that the learning effect of the pedagogical software on the market today, *as it is used in day to day work in the school* (my italics), is low. However, he also admits that there are examples of experiments where a combination of technology, staff, planning and working conditions give astonishing results.

Some reports indicate that one should not jump into hasty conclusions about the potential benefits of information technology as a tool for enhancing understanding generally. Interactive animations did not prove their superiority compared to static images in some studies by Schnotz, Böckheler, and Grzondziel (1999). Not even the often-cherished issue of collaborative learning with educational technology could be unambiguously settled. Interactivity combined with a collaborative learning situation actually resulted in a worse learning outcome compared to individual work.

Another study (Lowe, 1999) points to the risk that students will not focus conceptually important elements in dynamic animations. Instead, they tend to focus on what are most apparent, moving elements for example, and this will eventually lead them into false conclusions. The conclusion drawn by the researcher is that the students' background knowledge is of crucial importance. Without such knowledge the dynamic visualizations tend to yield unreliable outcomes.

Even if just two studies normally will constitute "poor evidence", they address general issues in education: animation and visualization, interactivity and collaboration, and student characteristics. Therefore the most general answer to a question about the appropriateness of educational technology for educational purposes must be: It depends.

In a recent study Cuban (2001) shows that no revolution has occurred in how teachers organize or teach in their classrooms. Even if teachers say that they have become more student-centred in their teaching they routinely lecture, review homework, work on assignments, and occasionally use overhead projectors and videos. Actually, when teachers adopt technological innovations, they typically maintain rather than alter existing classroom practices. Cuban summarizes this as "*maximal access, minimal change*".

One explanation offered by Cuban is the *slow revolution*. Technological changes take far longer to implement in formal education than in businesses because schools are citizen-controlled and non-profit. As systems they are many-layered, labour-intensive, relationship-dependent, and conservative. A second explanation is the *societal roles* that schools perform in democracy. Societal expectations and historical legacies influence what occurs in classrooms and contribute to the overall stability in teaching practices.

The blame-seeking approaches mentioned above often misjudge the particular conditions of educational practices. In Gibsonian terminology it can be contended that educational technology have different *affordances* (see p. 30) in different settings (Gibson, 1986). Analogous with Gibson´s example of the postbox which affords letter mailing in a community with a postal system it can be conjectured that ICT affords opportunities in educational practice. However, practices vary and affordances will be perceived differently among practices. Thus, participants will use the technology in accordance with the perceived affordances relative to their respective practices.

What is *realized* in practice might also be a matter of power. De Certeau (1984) contributes to the understanding of human action when faced with conditions beyond influence. When affected by external demands or by powerful opinions to act in certain ways, people normally find ways to cope with the pressure. De Certeau conceptualizes peoples' ways of dealing with the demands of more powerful agents as *tactics*. He distinguishes between

powerful *producers* who apply *strategies* and powerless *consumers* who apply tactics. Historically, the powerless have always resorted to tactics to cope with power. De Certau compares powerless actors to poachers and guerrilla fighters who always have to act in the territory of the more powerful. To do so, they must apply tactics dynamically since they are devoid of both a territory of their own and of time i.e. someone else will decide where and when the next move will be made.

A variety of realization processes are described by Bruce, Peyton, and Batson (1993) as either *consonant change* in which case the innovation facilitates, extends, or perpetuates existing social practices, *dissonant change* in which case people may resist the innovation or use it in ways never intended, *resistance to change* in which case innovations succeed in pilot tests and then fail to have any lasting impact, *cascades of changes* in which case changes beget other changes or have unanticipated effects, or *redesign of the innovation* in which case the innovation is realized in unforeseen ways and developers may learn things that guide a revision of the innovation. In the last case development becomes a cycle in which innovations are repeatedly evaluated and re-created.

Bruce, Peyton, and Batson (1993) also identify the two conflicting discourses briefly touched upon in the introduction**.** One is *innovation focused*; it talks of changes in social systems brought about by an innovation. Its stance is essentially that of the engineer. The tone is often visionary, rejecting current practice as being too conservative. The second discourse is *social system focused*; it emphasizes underlying social, cultural, economic, or political processes that undermine innovations, or, more often, precluding any change at all. Rather than revolution, it finds reemergence or reinforcement of established patterns. The authors argue that neither discourse alone can account for important aspects of technological and social change; rather, an integrated model is needed.

Therefore, to fully understand the transformations, which will inevitably be the result of changing conditions in a cultural setting, one needs to explore the relationships between human action, on the one hand, and the cultural, institutional, and historical contexts in which action occurs, on the other. In Cuban's (2001) words, investigators of educational change should adopt an *ecological* approach in which technologies, individuals, networks of social relationships, structures, and political actors are taken into account.

Technology and Educational Approaches

Contemporary educational trends and the technical advancement of information technology are mutually influencing each other. Below an attempt is made to relate four contemporary developmental trends in education identified by Andriessen and Sandberg (1999) to instructional modes, and to educational technology development.

The authors identify a contemporary emphasis on *open domains*. It represents a development away from traditional education with its emphasis on procedural tasks in closed domains. Ideas of what should be learnt and how to do it changes. Increasing importance is attributed to open learning tasks that can either have a well-defined or an ill-defined outcome. Such tasks have no fixed series of steps to accomplish and the outcome can be reached in many ways. The knowledge required in open domains is flexible; it may be personal and intertwined with aspects of context.

Not only what people learn is important but also the *learning environment*. Learning does not take place in isolation. The learner interacts with many different resources in the environment. An open learning environment also transfers responsibility from the instructor to the learner. Although it is clear that many characteristics of situations affect learning, it is still not clear how to arrange situations in specific ways to best promote learning.

Much of contemporary education is concerned with enabling the student to acquire knowledge as a result of *collaboration* with fellow learners, or different media (cf. Koschmann, Hall, & Miyake, 2002). Increasingly collaborative and social processes have become more important. Collaboration allows the learner to see learning activities modelled and provides opportunities to articulate and revise one's thinking. The computer can support this collaborative learning in many ways. A network may provide a shared problem presentation and easily accessed data regardless of student location.

One of the greatest assets of information technology is its potential to store information in *databases*. Effective use of this capability is quite another ability than reading an already surveyed textbook. Learners therefore have to acquire adequate search strategies both in terms of defining what they need to know and in accessing the right information. Besides they have to decide what to do with the information once found.

The trends above offer new challenges to the educational technology since it has apparent difficulties to cope with some of these new trends, particularly issues not connected with individual tutoring. The only solution to these challenges appears to be a new role for the computer i.e. as a cognitive tool instead of a tutoring device, which can take over the burdensome lower-order tasks thus allowing the user to concentrate on higher order thinking (see also p. 26). To provide a frame of reference for thinking about these issues Andriessen and Sandberg (1999) sketches out three different scenarios of educational strategies:

A *transmission* scenario implies that knowledge can be more or less directly transmitted to students by some medium, be it textbooks or lectures. Scientific knowledge is treated as accurate representations of reality. The individual student should acquire this knowledge and failure to do so is attributed to the student's misconceptions, lack of ability, or simply to bad instructors. The most common form of transmission is telling i.e. you learn by being told. The transmission scenario is not applicable to any of the above-mentioned trends.

The main idea behind the *studio* scenario is that most of the responsibility for learning should reside with the student. The more constructive efforts, the more he will learn are the underlying ideas. Learning in this case becomes contingent on existing knowledge and metacognitive skills. Since students differ in many respects they should be allowed to proceed at their own pace following different paths. The role of instruction is to provide opportunities for learning, give feedback, support, and evaluate students' progression. The role of learners is to plan, evaluate, and monitor the ongoing process. Still, even if students are encouraged to be in command of their learning efforts, the learning goals are fixed and well defined. Only the different ways to reach the fixed goals is open to exploration.

In some domains it is difficult for an instructor to possess full knowledge; in some domains even no correct knowledge exists. The goal of education in these circumstances is not to acquire a set of fixed goals but to be able to participate in discourses of communities of practice (Wenger, 1998) (see also p. 33). Participating in professional groups implies the ability to understand the important debates and problems and to use the right language to examine and influence the ongoing debate. Learning in this case means

learning to produce and comprehend discourse. Gradually the discourse becomes more like that of professionals. The *negotiation* scenario seems very suitable to be acted out in electronic environments where ongoing dialogues and debates can be supported in long term learning processes.

Whereas a transmission approach focuses on the computer as machine for individual drill and practise, a constructivist approach applied in studio scenarios tends to view computers as tools for learning and transferring problem solving strategies. The latter issue has sometimes been described as the inverse orders i.e. students teach machines instead of being taught (Papert, 1993). Still, from a constructivist perspective the computer per se is not in focus; what matters is individual responsibility and the activity directed to learning. The negotiation scenario has interaction itself as the focus of attention i.e. how tools are made use of as resources for individual or social learning in specific contexts (see p. 3). This means that the use of tools must be treated as the use of tools in a particular practice, and that tools as well as existing practice mutually influence each other. Therefore, when new ICT-tools are taken into use in educational practices there is not just a process of institutional transformation but also a process of tool transformation.

A quite straight forward way to conceptualize technology and educational scenarios is suggested by Stenseth (1999) as *Skinner*, *Piaget*, or *Rosseau*. In the Skinner approach education is planned as a predefined sequence of knowledge packages of a targeted body of knowledge. Stenseth contends that this approach has been found uninteresting in the Nordic pedagogical tradition partly because its connection to economic savings and a desire to replace the teacher. The Skinner approach is of course most closely related to the transmission approach above (p. 23). The Piaget approach differs from Skinner in its intention of making open learning situations. Students should have the freedom to act, experience and learn after their own plan. This approach substitutes motivation for control. The Piaget approach is closely related to the studio scenario above. The characteristics of the Rosseau approach is the absence of control. Stenseth points out that we can neither predict nor control what will be learned nor in which sequence it will be learned, because technology for learning can neither be separated from technology for communication generally nor from entertainment technology. Thus, the question whether technology should be used for

learning will be meaningless since technology is ubiquitous whether we like it or not.

Koschmann (1996) introduces still another way of conceptualizing technology and education in the paradigms: *CAI* (computer-aided-instruction, *ITS* (intelligent tutoring systems), *Logo-as-Latin*, and *CSCL* (computer-supported-collaborative-learning). The *CAI-paradigm* is built on behaviourist principles. Learning is a matter of acquiring well-established knowledge and teaching; consequently, it is a matter of transferring this knowledge. In order to transfer knowledge as smoothly as possible it is necessary to identify specific goals, divide them into simpler goals, and design a sequence of tasks that can fulfil the goals. The *ITS-paradigm* is built on theories of artificial intelligence. The underlying idea is that machines be programmed to simulate intelligent cognitive activity. The machine is meant to work as personal tutor modelling student behaviour and giving feedback. Instruction therefore turns into a purely cognitivist and individual endeavour. Both CAI and ITS build on the epistemological assumptions that knowledge is fixed and that the instructor (man or machine) knows what is worth knowing. The somewhat strange name *Logo-as-Latin* goes back to Simon Papert and Logo programming (1993). Briefly, Papert and his colleagues conjectured that by teaching the computer (i.e. through programming) a kind of self-organization of the mind would arise and this could then be transferred to many other situations. The main underlying principle is a personal construction of knowledge. The *CSCL-paradigm* differs from the paradigms above in the importance it attributes to the social context of learning. Within the CSCL paradigm knowledge is considered socially constructed. Learning is considered as process of gradually entering a community of practice (see p. 33). Consequently, instruction within the paradigm must aim at helping learners to become members of knowledge communities. Learners learn by way of activity, engagement and collaboration together with instructors and other knowledge resources.

In sum, the role of ICT has undergone a change from being teaching machines for individual students to being resources in a social learning context. The next section will touch upon some of the dilemmas that arise in education when technology, content, educational trends, and everyday conditions intersect.

Dilemmas in Educational Practice

Rather often classroom practices are viewed as the realization of educational theories and models up to which educational work can measure either positively or negatively. This also applies to using the proper tools, information technology in this context. However, the simplified idea that a practitioner's task can be fully described as one in which technological tools are taken into use for the application of theoretical models can be questioned. Instead, the practitioner has to handle a multifaceted reality by trying to find optimal strategies for handling situated events (Carlgren, 1997). It is an understatement, that in most classrooms, at least on primary and secondary levels, there are lots of factors obstructing educational intentions.

By tradition, the issue of how to utilize cognitive tools in cognitive activity is somewhat problematic in educational practice. The offloading of, or rather distribution of, cognitive work onto cognitive artifacts, *distributed cognition* (Pea, 1993), is thus far a rather strange idea in conventional schooling, which – as characterized by Resnick (1987) – is individualistic, primarily mental, concerned with the manipulation symbols, and generalized. The dilemma arises when conventional schooling is contrasted to the learning in workplaces and everyday life. These are considered to be social, tool-based, contextual, and situation-specific. This issue is often conceptualized as *school learning* vs. *authentic learning* (Brown, Collins, & Duguid, 1989). The educational practice is replete with issues of this kind, which often cause animated debates.

One example often discussed in traditional schooling is the use of hand-calculators. Should young students be allowed to use hand-calculators or must they first learn calculating with pen and paper? Pea (1993) conceptualizes this issue as an issue of *trade-offs*. He argues that trade-offs are inevitable in designed artifacts. An artifact should be viewed as one of many possibilities, which means that some possibilities are left out. In case of educational artifacts, the tool may grant access to participation at the expense of low-level understanding, whereas tool unaided participation may grant deeper understanding at the cost of blocking many individuals from being engaged with the task.

Another conceptualization of this issue is brought forth by Salomon, Perkins and Globerson by treating the tools as *partners in cognition* (1991) enabling

the user to benefit from technology i.e. making the user capable of carrying out tasks *with* the tool, which s/he could not carry out without it. In their view this is a systemic issue, which must be separated from the issue of effects *from* technology i.e. the potential of increasing the user's cognitive capacity generally.

When it comes to applying theoretical models various interpretations of constructivism (cf. Bruner, 1986; Glasersfeld, 1991) i.e. what is represented by *studio scenario*, *Piaget*, and *Logo-as-Latin* above (see p. 22 ff.), is the theoretical perspective most often referred to among educational reformers today. Constructivism emphasizes activity and personal construction of knowledge as the most important elements for learning.

This perspective has led to a major shift in educational thinking since it moves the focus from the instructor to the student. This shift challenges traditional teaching as it – at least in common understanding – dispossesses the teacher of control and hands it over to the students. Not very much imagination is needed to see that less control for the teacher and more for the student may evoke dilemmas for experienced instructors (and even for students) should it be applied to student groups and domain knowledge generally.

Commonly, people understand a transmission approach as the business of teaching; the one who knows tells those who do not yet know and it works in most cases. As a matter of fact, the transmission scenario can be viewed as a solution to the frustrating task of teaching many students at the same time since it will guarantee at least some knowledge to everyone in a heterogeneous group where the teacher can adjust the questions to the students' level of knowledge respectively.

The transmission mode can also be viewed as a means of *control* when faced with the task of teaching many students at the same time (Denscombe, 1985). In fact, lecturing interspersed with questions to the class is one of the oldest and still working strategies to be in control of *knowledge* as well as *order* in a heterogeneous group of students.

Actually, the application of *question-answer-evaluation* sequences, the so-called *Recitation Method*, is of historical origin (Hoetker, 1969). It can be inferred that this approach will survive as long as students are organized in

large heterogeneous classes. Still, even if lecturing in the classroom may be considered highly flexible relative to timing and cognitive level of each student, it is more often disparagingly labelled inflexible and boring depending on its transmissive characteristics.

The strategic distribution of questions and tasks to the students is also a powerful means for classroom order (Doyle, 1984). Whereas individual, routine, and low cognitive level tasks normally are beneficial for attaining a calm and silent class, group work, open-ended assignments and cognitively demanding tasks will in most cases result in a noisy and turbulent classroom.

In higher education control of order is not the primary objective; instead control of content is most important. Lecturers may want to have control of instruction sequences because they possess expert knowledge that will lead up to presenting content in a planned sequence or just for planning reasons i.e. to get done within time limits. Probably there is also a conception – also among students – of how higher education teaching should be carried out in the most effective way.

The constructivist approach also gives rise to a dilemma of individual versus collaborative work. The individual conception of constructivism purports that by way of active exploration of new knowledge domains the individual will gradually tie new knowledge to already existing knowledge. The social conception of constructivism – referring to Vygotsky's zone of proximal development (Vygotsky, 1978) – emphasizes the advantages of learning together. The different ways of interpreting constructivism result in a somewhat paradoxical situation for the organization of technologically mediated learning: on the one hand individual success is cherished, and, on the other hand, learning together is considered desirable (c.f. Dillenbourg, Baker, Blaye, & O'Malley, 1996).

All this eventually boil down to educational dilemmas. On the one hand, teachers in various educational settings by tradition and experience adapt teaching to the prevalent context and, on the other hand, current didactic approaches clamour a change of approaches. The methods for coping with daily practice whether it concerns technological tools, educational methods, or simply a reasonable work order are likely to come into conflict with the vision of the active self-managed learner working with technolgogical tools

out of a desire to learn as much as possible. The realization of daily practice may not give the students opportunities to explore actively interesting tasks of free choice. Instead the image of the silent but bored student doing typical schoolwork and learning the smartest ways to pass exams is projected. The practitioner, thus, will experience a dilemma between what is considered good pedagogy and what actually works according to his experience.

INTELLECTUAL CONTEXT

> A perspective is not a recipe; it does not tell you just what to do. Rather, it acts as a guide about what to pay attention to, what difficulties to expect, and how to approach problems (Wenger, 1998, p. 9).

Definitions

The concept of *affordance*, which was somewhat carelessly used in one of the introductory paragraphs above (see p. 20) is meant to denote that a resource offers something for individuals (Gibson, 1986). However, an affordance is neither entirely a property of the resource nor entirely a property of the perceiving individual. Instead, individuals perceive the affordances of events, tools, and places as a consequence of their previous experiences. Thus educational practitioners will perceive the new technologies "with the eyes of" educational practitioners and not with the eyes of computer scientists, company managers etc.

When focussing on the influential processes in evolving practices the concept of *appropriation* will give an explanation of the tension between what is well known and what is potentially new (cf. Wertsch, 1998). When new artefacts are at hand they will eventually bring about change but not necessarily in that linear way that is often advocated in public debates. Instead, new artefacts might contribute to changes in quite unforeseen directions. A well-known example is the glass fibre vaulting-pole, which originally had nothing to do with sports but still dramatically changed pole vaulting. The unforeseen and unexpected change, in fact, may be a better characterization of evolutionary appropriation than mere prescriptions of goals to attain (see p. 21). Generally, appropriation of an artefact can be said to denote an increasing ability to use it the way it is used in authentic practice in a historical period. To further clarify the meaning of appropriation, Wertsch compares it to the concept of *mastery*. Mastery differs from appropriation in that it is just mastery, for instance mastery at the computer keyboard. The one who masters the keyboard knows were to find the different keys and will perhaps also be able to key in the alphabet in a few seconds. Appropriation on the other hand, denotes a situation in which an individual gradually will change his way of doing things and increasingly make use of – in this example – the keyboard for carrying out authentic tasks.

Now, the keyboard is a rather interesting example since carrying out authentic tasks will look very much the same as the mastery just described. The politician preparing his speech by rapidly typing with his two index fingers does very much the same operations (compare operations from an activity theoretical perspective on p. 34 f.) as the person who types in the alphabet in less than five seconds. Still there is a tremendous difference because the politician uses the computer to accomplish an authentic task whereas the alphabet typing is just meant show a skill not necessarily connected to accomplishing authentic writing tasks.

When technologies are introduced in practices they are gradually appropriated by their users meaning that they initially use the new tools in agreement with their preconceptions of normal practice. This is sometimes expressed as *incremental* changes. To change something incrementally is about the same as doing the same things but in another way preferably a little faster, for instance the usual looking up of words in a dictionary can be accomplished a little faster with the computer but it is essentially the same task as before. In common talk the incremental attitude is reflected by the expression "computer supported education". In schools practice and drill programs may be used to train basically the same skills as earlier was accomplished with paper and pencil. Thus, computers – at least – initially are new artefacts that will be used for well-known tasks.

But the concept of appropriation also comes with the notion of change. It can be conjectured that publication strategies increasingly will use the digital format. Conjecturally, what is not available in digital format in the future might become almost nonexistent. In higher education the digital resources will gradually change the habits of visiting the library physically and on a conceptual level we will re-allocate our time in favour of intelligent research strategies and strategic reading since we can access in a few moments more than we can ever read.

The appropriation of the word processor in schools means that the writing habits will gradually change, for instance the need for a total rewrite of a manuscript will disappear since editing can just as well be done in the original manuscript. In the future, one might hypothesize, the need for handwriting will diminish, since printed texts in most cases are more

functional. Eventually, young students might start learning to write using the keyboard prior to learning to use the pen.

The concept of *practice*, originating from the Marxist tradition, is a central concept within socio-cultural research. Without pretentions to base the present account on expert knowledge of Marxist philosophy, practice is used to counter a rigid structuralist view in this thesis. Here, it denotes the dynamic creation and recreation of structures in human practices.

Practice is described by Wenger (1998) as a *process* by which we can experience the world as meaningful. The processes of making the world appear meaningful, the *negotiation of meaning*, is accomplished by two complementary processes, *participation* and *reification* (Figure 2).

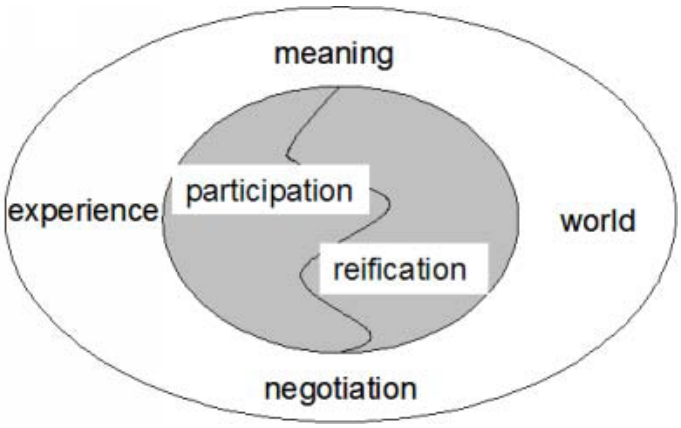

Figure 2. The mutually constitutive relationship between participation and reification in which meaning is negotiated in a process where one individual's experiences meet the world i.e. others' experiences (after Wenger).

Participation refers to a process of taking part and relating to others. In Wenger's words it is both action and connection. Participation in social communities shapes our experience and it also shapes the communities. Participation is not something we can turn on and off. The complementary concept, reification, literally means to make something into a thing. However, in this context it does not exclusively denote the creation of physical artifacts. Instead it is a process of giving form to experience into

"thingness". Reification means creating points of focus around which the negotiation of meaning becomes organized.

Any practice produces abstractions, tools, symbols, stories, terms, and concepts that reify something of that practice in a congealed form and educational practices are no exceptions to that rule. The words and concepts of our language are probably the most powerful and most frequent reifications of daily life. The creation of reifications serving as points of focus for the comprehension of educational practices, which are introducing information technology, will be a powerful approach serving the overall purpose of this thesis.

Another concept, also based on Marxist philosophy, is *activity*. In its simplest terms, an activity is defined as the engagement of a subject toward a certain goal or objective. In most human contexts, however, activities are *mediated* through the use of culturally established instruments, including language, artifacts, and procedures (cf. activity theory on p. 34 ff.). By Vygotsky (1978), this is labelled *tool mediated activity (*Figure 3*)*. In this context information technologies might be considered to be tools of prime interest but conceptual tools like language, plans, or methods must not be neglected.

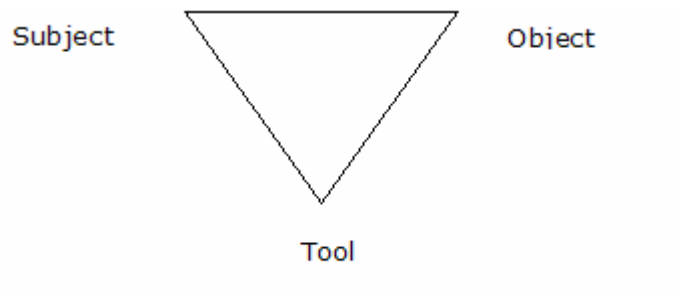

Figure 3. Vygotsky's depiction of tool-mediated activity.

Communities of Practice

The processes of participation and reification will at the same time occur within as well as create a *community of practice* (CoP). According to Wenger a community of practice is predicated on humans having a *joint enterprise* which can be paraphrased "what we are here to do", *mutual engagement* meaning "what we want to accomplish together", and a *shared repertoire*

meaning “what we know and can together”. These three conditions will all be applicable to the educational contexts described in this thesis (Figure 4).

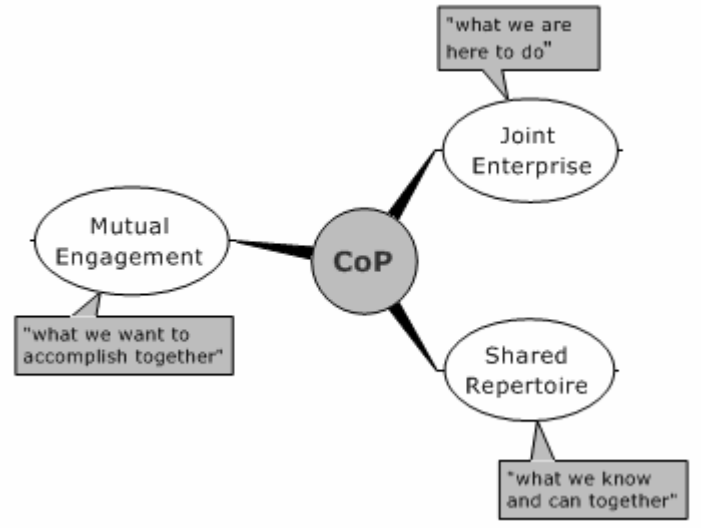

Figure 4. The characteristics of a community of practice.

Activity Theory

The vehicle for the evolution of practices in Activity Theory (AT) is labelled *expansive learning* (Engeström, 1987). Below a short overview of the concepts required for expansive learning will be presented.

The agency of a subject, individual or collective, is taken as the point of departure for an analysis of an activity system. Any activity, in which human subjects are involved, is motivated by a specific *object*. Actually, the concept of object is contained in the concept of activity; there is no such thing as an objectless activity (Leont'ev, 1981). A phenomenon becomes an object of activity as it meets a need of the subject. Thus, it gains motivating force that gives shape and direction to activity. In human activity objects are molded and transformed into *outcomes* with the help of mediating tools, which might be physical as well as conceptual.

Leont’ev introduced three analytical levels hierarchically arranged: *activites*, *actions*, and *operations* (Figure 5). Any activity is constituted by chains of actions which in turn are realized by operations. However, overt actions of

similar appearance may belong to quite different activities (cf. the authentic tasks mentioned on p. 31). Actually, it is the activity with its particular object that makes an action comprehensible. In class, a particular action can take on quite different meanings for teacher and student; in other words, they belong to different activities. Operations can be viewed as the automatic and often unconscious steps that are needed to accomplish an action. They are dependent on the the conditions in which the action is performed. Originally the automatic operation were conscious actions. In case we meet with problems the operations may revert to conscious actions.

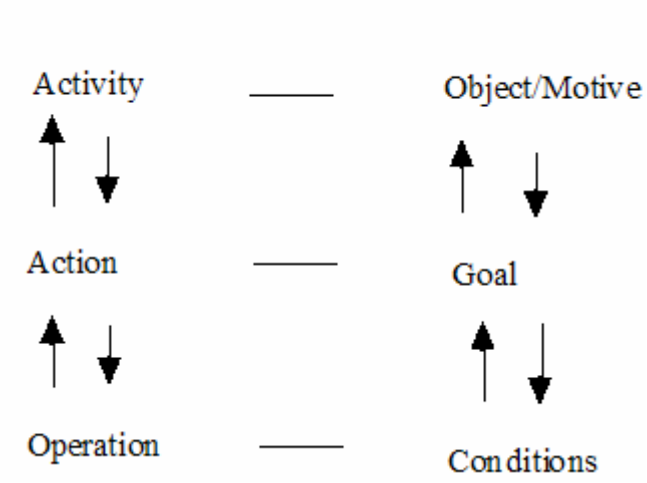

Figure 5. Hierarchical levels of an activity according to Leont'ev

Even if the gaze may be focused on individual actions, no activity is carried out in isolation from a surrounding community. The community comprises multiple individuals or groups who share the same general object and who construct themselves as distinct from other communities. Different subjects, due to their different histories or positions in the community, construct the object and other components of the activity in different and sometimes conflicting ways.

The relations between the participants in an activity system are mediated by *tools*, *rules*, and the *division of labour*. This is graphically shown in Engeström's well known triangular representation (Figure 6).

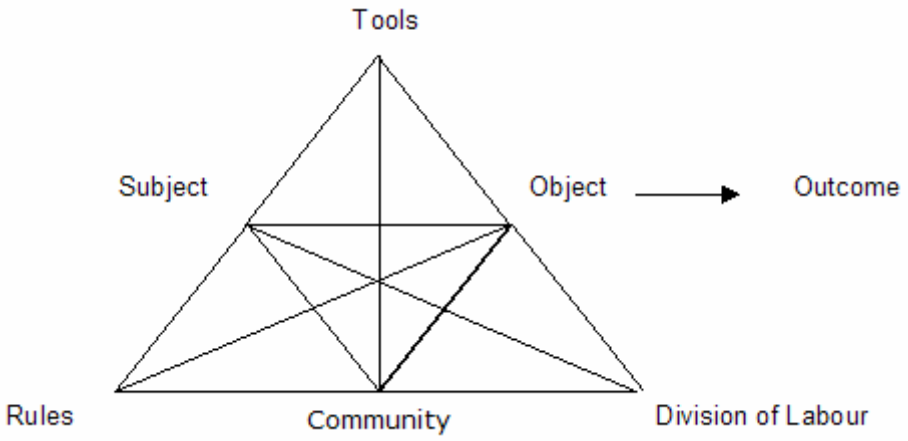

Figure 6. Graphical representation of an activity system.

For the practitioner working in an educational practice, the day-to-day work will be subject to the concepts identified by Engeström. Most conspicuous may be how the available tools, be they computers, aeroplanes, or books, will mediate how the work is carried out. But the practitioner is also a member of a community of practitioners and thus the practice has established certain rules and ways of dividing labour among the participants, which also will mediate the day-to-day activities. The rules of an activity system refer to the explicit and implicit regulations, norms, and conventions that constrain actions and interactions within the activity system. The division of labour refers to both the horizontal division of tasks between the members of the community and to the vertical division of power and status.

In Engeström's graphical representation of the activity system the subject-tool-object relationship constitutes the *production* section of the activity system. Moreover, any subject accomplishing tool-mediated object-oriented acitivity in a community will have to follow certain rules (or better will benefit from) for *exchange* within the community. The distribution of who will do what in a community constitutes the *distribution* subsection of an activity system. Finally, the last subtriangle which is constituted by the surrounding three subtriangles is what is labelled *consumption* in the activity theoretical model (Figure 7).

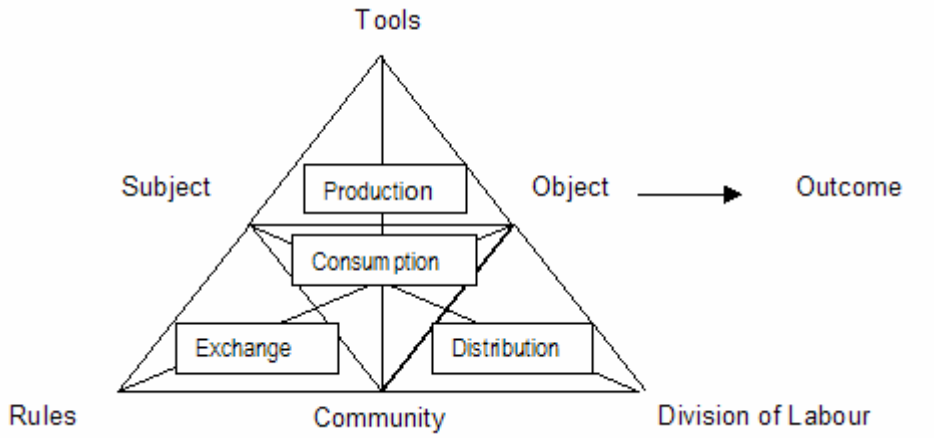

Figure 7. Activity system with subsystems of production, consumption, exchange, and distribution.

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Dilemmas

Central to an activity theoretical analysis are the concepts of *dilemmas* or *conflicts* adhering to different levels in the activity system. In short, dilemmas can arise in one or more of four levels. *First level dilemmas* arise within a specific location in the activity system. For example, individuals experience dilemmas when forced to choose between alternatives which both have desirable as well as undesirable outcomes. Likewise, similar dilemmas may arise concerning tools, rules, or division of labour, not to mention different opinions of the very object of an educational practice.

Second level dilemmas arise between different parts of the activity system. For, example, individuals may feel uncomfortable using a particular (prescribed) method, may not like to be pushed into a group of colleagues, or would rather use their competence for other duties. Eventually such situations will end up in a *double bind* situation (Bateson, 2000, p. 201), which cannot be individually resolved. In the same way, any point in the activity system may be taken as a starting point for an analysis of dilemmas related to the other nodes (tools-object, rules-object, rules-community etc.).

Third level dilemmas arise between the object of the central activity (i.e. what intructors want to accomplish with the students) and the object of another activity, which is considered superior. Generally, the national endeavours to introduce information technology in education could be considered to be

third level dilemmas. If an activity in one school, for example, is motivated by a desire to teach the students to do their homework carefully and pass the tests (the object) in order to eventually succeed on the job market (outcome), then, in comparison, this object might be considered inferior to that of applying problem-based-learning in order to be self-contained and successful as an adult.

Fourth level dilemmas arise out of comparison with others. These comparisons are not only restricted to the comparing of outcomes between different activities. Instead the outcome of other activities can be compared to the central activity (i.e. our activity) taking into consideration any point of the central activity. Another activity might produce "better" students, "better ICT skills, "better" division of labour etc (Figure 8).

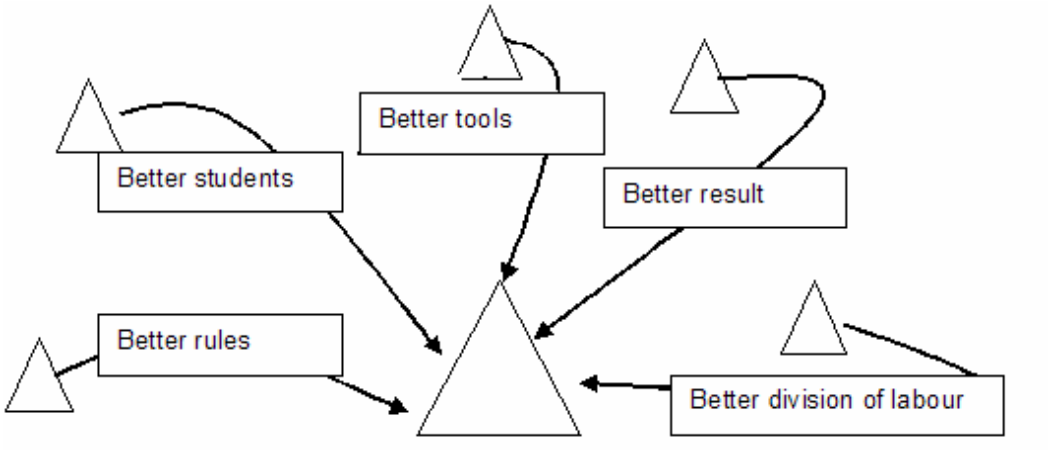

Figure 8. Fourth level dilemmas. Central triangle represents the central activity (own activity). Small triangles represent other activity systems whose results will be compared to the central activity.

In the practices under investigation, tensions on many levels are likely to occur when new artifacts are introduced. Some examples will clarify this. The tools are likely to create tensions between practitioners who feel competent in using the new tools and those who feel incompetent. New tools require new knowledge; subsequently arrangements to acquire that knowledge must be made. Schools compare to other schools and the economic decisions may be redirected to new objects in order to keep up and so on.

Initially, AT may be used to sort the overwhelming richness of impressions in a natural setting into different boxes like a chest of drawers. The actions undertaken in education may be studied with various foci as long as the bonds to the activity are kept in mind. Educational practitioners and students encountering *individual* dilemmas (first level dilemmas) may be held in focus. Other foci may concern methods and *tools* applied to certain purposes and goals (second level dilemmas). In focus might also be the *entire activity system* and the dilemmas and conflicts arising out of comparisons with other activity systems (third and fourth level dilemmas).

Out of a need to handle these dilemmas, practices evolve through *expansive learning* meaning that a *need state* in an activity system eventually builds up to a *double bind,* which cannot be settled by the ordinary means of a practice. The creative act of finding out something completely different is what ideally drives evolution i.e. the expansive learning. Engeström labels the unconventional solution a *springboard*. The outcome of applying the springboard to solve the *double bind* situation will be expansive learning.

Also AT utilizes a conceptual pair, *internalization* and *externalization* built upon the well-known dialectic relationship, thesis-antithesis-synthesis (compare participation/reification, p. 32). Mainly, internalization can be viewed as the normal way of doing things in a practice. However, within AT the conflictual character of human acitivity is emphasized and different desires will create insoluble dilemmas ending in *double bind* situations. The creative "solution" of a *double bind* is what figuratively will change direction of a practice into something different i.e. *externalization*.

To sum up, activities are historically and culturally developed in response to particular cultural needs that are the focus of workplace activities. Individuals or groups engage in *activities* to accomplish meaningful outcomes. Activities are *mediated* by tools, rules, and division of labour.

Comparing CoP and AT

The similarity between a *community of practice* and an *activity system* should not be overemphasized. Even if the joint enterprise in a community of practice resembles individuals of an activity system acting to accomplish an object and a shared repertoire resembles the tools, rules, and ways of

dividing labour in an activity system, it is wiser not to map one onto the other. What might be the most interesting component, though, is the mutual engagement or put in other words, a desire to participate and accomplish something. Engagement or rather *desire* – as pointed out by Pea (1993) - often leads to action and may be considered a driving force behind human action be it viewed as participation in a community of practice or as acting in an object motivated activity.

For an orientation in a wider theoretical landscape, Wenger provides a conceptual map of grand theories and their interconnections. He describes his theory (CoP) as a social theory of learning located at the intersection of two main axes, between theories of *social structure* vs. *situated expericence* and between theories of *social practice* vs. *identity* (Figure 9). Without entering deeply into the historical evolution of different theories, some reflections will be valuable for the present study.

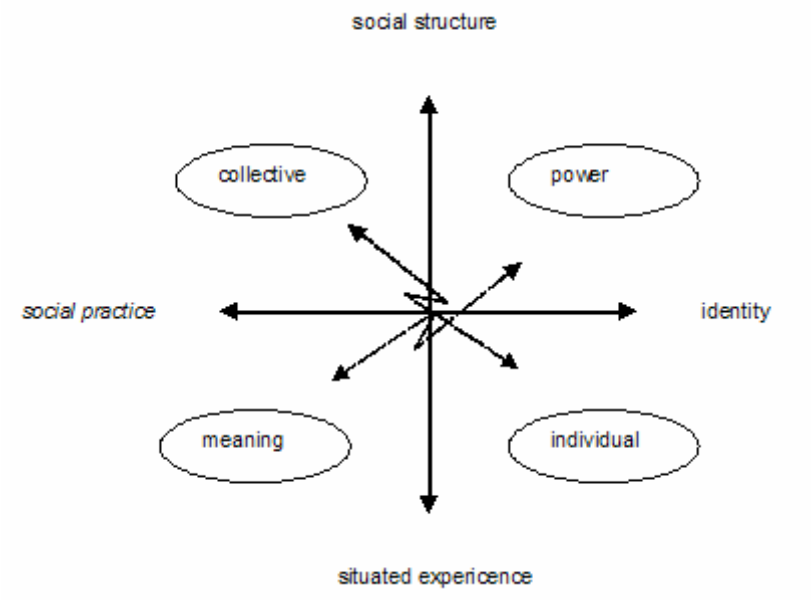

Figure 9. Theoretical landscape as depicted by Wenger. Broken arrows represent tensions between collective/individual and power/meaning respectively.

In brief, theories of social structure see action as realizations of social structures (compare Cuban's socital roles on p. 20), whereas theories of situatedness applies to a close coupling between organism and environment

as in perceived affordances (see p. 30) or in symbolic interactionism (see p. 42). The theories of social practice all go back to Marx's concept of "praxis" and a materialist approach to social theory. Theories of identity are concerned with the social formation of the person. Issues of class, gender, and other social categorizations are dealt with in an attempt to understand individuals as formed through mutual constitution between individuals and groups.

Even more purposeful for the present thesis are the tensions, introduced by Wenger, between *individuals* vs. *colllective*, and between *power* vs. *meaning* production. The tensions between the collective and the individual are highly relevant for contemporary educational trends particularly within compulsory schooling where information technologies are used as the tools for collective and collaborative efforts as well as for purely indiviualistic efforts (see also p. 22). In fact, the issue of collectivity versus individualism is one of the most conspicuous and lively debated issues in contemporary politics. The other tension, the one between power and meaning is even more salient in this thesis. The concepts of strategies and tactics described by de Certeau (1984) are instances of this tension (see p. 20). In educational practice, practitioners constantly must navigate between situated factors and normative decrees. This is what converges into educational dilemmas (see p. 26 ff.). Likewise, the whole endeavour of reforming institutional activities might be experienced as an issue of power and meaning (see Sarason's vivid metaphor on p. 18).

Wenger's map also makes possible to postion his theory in relation to activity theory. With communities of practice in the middle of the map, activity theory with its systemic and developmental perspective on socio-historic activites will find its position more to the left in the system of co-ordinates. Vertically, though, an activity system can be said to focus issues of collectivity as well as issues of meaning. This does not imply that issues of collectivity can be dealt without taking the individual into account neither can issues of situated meaning be dealt with without taking the power of social structures into account. Still AT does not focus individual development or power structures specifically. Hence, AT will primarily occupy the left part of the system of co-ordinates.

PURPOSE AND APPROACH

A general foundation of this research endeavour may be found in the symbolic interactionist argument saying that human individuals confront a world that they must interpret and not only respond to in order to act. Their meaningful actions are built upon what they *indicate* and how they *interpret* what they indicate (Blumer, 1969).

The main purpose of this thesis is to explore and theoretically sustain the following issues:

How do practitioners introduce and make use of technology in their respective practices? How can it be described and conceptually understood?

The research issue may be considered as a response to an unsatisfactory argumentation concerning technology in education. The domain of information technology is imbued with visionary, rhetorically strong, but mostly poorly sustained claims of how information technology will influence education.

The arguments in most cases focus on the effects of introducing technology anticipating this and that. Even if it would be unwise to deny that something eventually will occur, in due time, when new tools are introduced, it should not be taken for granted that conclusions can be drawn from practices generally. On the contrary, the results from the research presented above all point to the importance of the particular conditions in practices.

Therefore, to anyone who wants to understand processes of change instead of gambling on the result, it should be an urgent business to understand the processes of change. What can be observed? What are practitioners' experiences? How can the processes be conceptualized? What are their properties?

Thus far, it seems evident that technologies fulfill a number of roles and that a number of factors will influence its use. Therefore the realization of technological artifacts in practice can neither be uniformely described nor uniformely investigated. Accordingly, it will be necessary to approach different settings theoretically as well as methodologically with a variety of investigator tools.

Depending on prior research experiences or personal inclinations, some people might feel slightly uneasy substituting dynamic, transient social processes for solid measurements and concret objects of analysis. Therefore,

some clarity may be gained from a couple of metaphorical descriptions. In qualitative research the navigational term triangulation is frequently used (for a description of navigational triangulation see Hutchins, 1995). The implicit meaning derived from the concept of triangulation is that a researcher by utilizing different methods or perspectives will succeed in delimiting and establishing the true properties of the research object. A similar "detective" metaphor is used by Blumer (1969) when he describes the scientific endeavour as one of "lifting the veils" that obscure the processes going on. Both metaphors, however, seems to lead the thought inwards to an anticipated uniform object located at the intersection of bearings or behind veils.

Then, the *facets of a turning crystal*, seems more appropriate, since it will lead the thought outwards to each facet reflecting a new property of the unit of analysis. The crystal metaphor also implies that the unit of analysis can only be provisionally described. There will always be something new to discover as the angle and rays of light changes i.e. each new study will add something to our knowledge of the unit of analysis. Different research approaches may be considered as examples of theoretical sampling i.e. choices of research methods and settings that can add further to the knowledge of a certain area (Glaser, 1992; Strauss & Corbin, 1990).

In this thesis the investigation of instructional events in schools and university, the dissemination strategies in institutional practices, and of the learning conditions in a military practice are all facets of the issue of appropriating technology in educational practices.

METHODOLOGY

The ambition to explore the processes of educational practices supported by the theoretical framework presented above, will put demands on research methodology. Since the aim of this study is to give an account of how the participants of educational practices appropritate resources relative to context, the investigation cannot be be concentrated on finding laws or lawlike behaviour. Instead the research should be an *interpretative* endeavour in search for meanings.

Representing reality

Doing interpretative research is very much the opposite of experimental research. The researcher enters the field in order to understand what is going on "out there". To the layman this might seem quite straightforward: enter the field, find out what is out there, and finally write up the findings. However, for the researcher living in a post modern era "what is out there" has gradually been blurred and any account may be criticized on various grounds (Denzin, 1995). To make a long story short, interpretative research has gradually changed from producing rather self-confident accounts of "the others" to accepting the fact that interpretation is always influenced by the conditions of interpretation. Thus, today the naive realism meaning that it is possible to report what actually is "out there" is largely abandoned within qualitative research (Denzin & Lincoln, 1994).

Historically, accounts have changed from realist to more interpretative accounts (Coffey et al., 1996). Today, reflexivity (see p. 55 for a reflexive account), meaning that the researcher must come to grips with his or her preconceived ideas is a necessary condition in all interpretation (Hammersley & Atkinson, 1983). Further, there is also a recognition that data cannot just be picked from the field but instead are subject to construction according to some theoretical perspective i.e. observing from a certain perspective will result in data different from those of another perspective. In fact, some phenomena, which are quite obvious from one perspective, may not be observed at all from another perspective.

Finally, even language itself has become an object of inquiry in qualitative research. This is due to the fact that the stark separation of logic from rhetoric is no longer upheld (Coffey et al., 1996). Therefore language cannot be viewed as a transparent tool for reporting, "how things are" in a realist sense. Instead interpretative accounts view language as a mediational means thus influencing and even being a part of the account. Accordingly, the representation of a phenomenon and the writing conventions are part of the interpretation (Atkinson, 1991).

The focus on language as an inseparable part of interpretation challenges the realist way of writing. If the naive ontological realism is abandoned then also realist-writing conventions become a problem. Therefore new genres such as fiction, narratives, drama, and even poetry may better convey the result of the research (Beach, 2001; Richardson, 1994).

Data Production

To explore how participants appropriate resources at hand it will be necessary to enter the practice and scrutinize thoroughly what participants actually choose to do with educational technology. Koschmann indicates a possible approach here that attempts to capture what can be labelled "*thinking practices*" (Koschmann, 2001). This kind of research has the advantage of studying what is observable and embedded in joint activity.

The data from the empirical contexts presented in this thesis are produced from field studies. Observations, informal talk, occasional interviewing, and document studies are the methods applied. On a practical level, data have been managed by computer assisted qualitative data analysis software (CAQDAS) (see p. 48 for a description).

Entering the field

Generally, any observation will be guided by research questions. However, what to focus on in particular cannot be decided upon in advance. Initially, therefore, participant observation might be quite overwhelming and the observer will soon find out that it is not possible to observe everything (cf. exploration p. 12). On the other hand, any field notes might prove valuable later on. Some researchers (Taylor & Bogdan, 1984) recommend checklists of recurrent aspects in naturalistic settings such as *what is the setting like?*, *who are the participants?*, *what happens here?*, *is it a recurrent situation?*, *is the activity unplanned or surprising?*, *etc.*

Data for the four studies of this thesis are produced by way of participant observations (see also 12). Even if the procedures vary in some respects according to the respective practices the overall procedure is generally similar. Here, these general aspects will be described whereas what is typical for the respective studies, will be described in that context.

Generally, the procedure started with a first contact. In the school studies an email addressed to the contact person at the schools respectively was sent as a first introduction. The email briefly presented the aim of the observation as well as the observer in the very first letter. Normally, there were also some information saying that the observer would soon make a call so that a suitable time for the observation could be agreed upon. During subsequent observations, the same procedure was applied but then information about

the project and observer was omitted. In the higher education study, the observers were introduced to the instructor and the participants of the distance education course by the professor who was the manager of the project. At the fighter pilot training site, an introductory meeting was held with the project managing professor from the National Defense College, a consultant professor, the two researchers, the airforce officer resoponsible for the pilot training, and two other fellow officers.

Typically, a first visit to any of the settings described in this thesis, included some information and a guided walk-around. In the schools, the headmaster/mistress, often volunteering to guide the observer initially, took the opportunity of advocating the school's policy and success stories; later someone who was particularly assigned the responsibility for ICT development acted as a guide. At first, all the practices were free to show what they considered important. Later on, when the settings gradually became more familiar and when specific research questions had been formulated, the observer on his own initiative made agreements with particular persons of events to observe.

Observing

Normally each school observation was carried out within a time frame of one day (see p. 54). The distance education observations lasted about one and a half to two hours each (see p. 75). During the fighter pilot training observations the two observers stayed at the site during the weeks and observations were carried out every day (see p. 150). In the case of simulator instruction several consecutive two-hours shifts would be observed. Pilot instruction in classes normally lasted about an hour; they were observed in their entirety.

During observation, field notes were taken. Occasionally, observation periods had breaks for note taking. In many cases, though, information had to be remembered and written down afterwards. Direct observations were interspersed with informal talk in which the observer could ask for additional information. Few formal interviews with questions prepared in advance were undertaken but some face-to-face sessions in secluded areas often covered themes that had come up during observation. In the fighter pilot training study, some formal interviews and a number of simulator instructions were audio recorded.

With the help of a laptop computer the, sometimes hardly legible, field notes were transferred to texts. During writing, the field notes were fleshed out with details. Actually, the work at the keyboard called forth lots of details that up to then could not be remembered. The writing often took a timeline – from morning to afternoon – as a point of departure. A lot of seemingly uninteresting details were recalled such as the colour of school building, the weather, the reception, peoples' clothes, furniture and so on. In addition, feelings and conjectures were also added separately. Strictly speaking, this might be viewed as the first steps of a tentative analysis. While doing this, details queued up; one detail leading to another in an unbroken chain. When conjectures and emergent themes had been written down, the returning to field notes ensured best possible coverage of the observed events. The method of using a timeline as an organizing structure gave the account a somewhat narrative character. Actually, the construction of the account was a quite stimulating process and not just a tedious and boring work that had to be carried out.

The data production process for the fighter pilot training study was greatly enhanced by the fact that two researchers observed virtually the same activities and therefore two sets of data could be compared continually.

Analysis

Educational settings are replete with theoretical concepts ready at hand. This will constitute a risk that data are forced to fit preconceived concepts in an interpretative account (Glaser, 1978, 2002). Avoiding preconceived concepts means trusting that new concepts eventually will emerge from data. The analyst's general schooling and his theoretical knowledge in relevant areas will make him sensitive to emerging concepts grounded in the data. The analyses in this thesis represent attempts to characterize educational practices by using concepts that point to processes and away from effects of interventions, cherished methods, and individual cognition, which traditionally are the most ready at hand concepts in educational research.

The primary aim of the analyses is to establish a recognizable connection between emerging concepts and data. This must not be understood as pure inductivism meaning that only empirical observations that can be traced directly back to data are valid. In fact, it is not data per se but phenomena

that should be grounded in data. Phenomena may not be perceptually visible to anyone. Instead, the ability to see phenomena is predicated on the researchers ability to make use of prior scientific knowledge, on the one hand, and the ability to be open-minded and creative, on the other (Aubusson, 2002). The conceptual leap needed to see phenomena (i.e. "unobservables") indicated by data is accomplished not only by induction but above all by abduction (Haig, 1995; Kinach, 1995).

Analyzing with computer software

The observational accounts were entered into a computer program for qualitative analysis (ATLAS/Ti. See http://www.atlasti.de/). Shortly, the following steps were undertaken: reading the whole material several times, selecting important parts of the material, coding the material for relevant themes, writing of commentaries and memos. Eventually these procedures yielded the result that is presented in the result section.

However, a qualitative analysis is not a mechanical undertaking and the intellectual work involved is not evident from the short description above. To begin with, the growth of Computer Assisted Qualitative Data Analysis Software (CAQDAS) has aroused fear that qualitative analysis might turn into some standardized procedure in which data are neatly shuffled into different boxes without being subjected to analytical examination. In fact, qualitative research might be given a scientific gloss similar to more rigorous statistical procedures instead of inarticulate or ad hoc methods (Coffey et al., 1996; Lee & Fielding, 1996).

On the other hand, computer software is superior to manual data management (not analysis) since it can handle large quantities of data very fast. Browsing hundreds or thousands of pages of text can be accomplished in fractions of a second. Furthermore, coded data can be instantaneously retrieved and browsed again and again. Modern software also permits hyper linking, relational network building, and different data formats such audio and video. In sum, the computer software used in this analysis has been used for managing data but not for the conceptual analysis, which still is a very intuitive, and researcher dependent endeavour.

The first step when using the Atlas/ti software was to create a "space" for the upcoming work. In Atlas/ti this is called a "*hermeneutic unit*". It can be

thought of as the container needed to hold all the material to be used for a project. After that, the data, the "*primary documents*" were entered. The actual analysis started with the reading of the documents. Eventually, segments of the documents were marked as "*quotations*". Quotations then could be assigned codes and/or be grouped under a specific code. A code or a category may be expressed literally in data – "*in vivo coding*" – but more often a theoretical concept – "*open coding*" – is connected to segments of text (Strauss & Corbin, 1990). These concepts may be used in an emerging theory. While comparing data to existing and emerging codes it was possible to reduce or group data under meaningful codes. Actually, the Atlas/ti software is built around the Grounded Theory approach and the different quotations may be viewed as properties and dimensions of emerging categories. A sample of Atlas/ti interface is shown below (Figure 10).

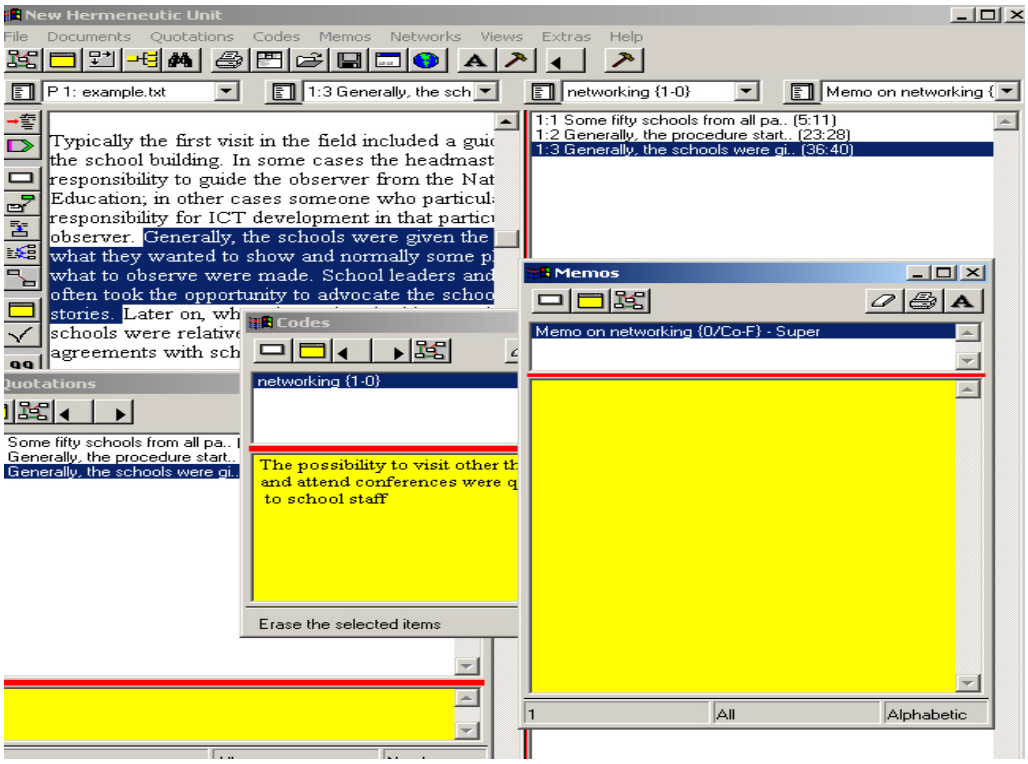

Figure 10. The Atlas/ti interface showing an example of a primary document with a selected area and the different windows for quotations, codes, and memos (no memo written).

Ideally, the categories (theoretical concepts) eventually become saturated meaning that data have made possible ample description of the scope of a concept. If concepts cannot be exemplified with existing data the researcher should return to the field to search for the data needed for the emerging theory. This "*theoretical sampling*" is quite different from the sampling procedures in quantitative research where different ways of random or systematic sampling are applied (Strauss & Corbin, 1990). However, theoretical sampling procedures often interfere with contextual constraints concerning the overall conditions of a project i.e. in many cases it will not be practically possible to revisit the setting for data completion.

Referring to the discussion above, the analysis is an intuitive endeavour and therefore the coding must be accompanied by frequent writing of memos in which emerging ideas, conjectures, and comparisons to existing theories are written down. These emerging accounts constitute a substantial part of the final results presented in this thesis.

EMPIRICAL STUDIES

MAKING SENSE OF ICT IN CLASS

INTRODUCTION

Information- and communication technologies (ICT) have become absolutely necessary tools in business as well as in societal activities today. It goes without saying that also educational institutions will make use of the new technologies according to their needs. However, the enticement of ICT has also resulted in a constant push from external actors for an increased utilization of technology in education. The arguments are often focused on *faster*, *better*, and *cheaper*. Accordingly, the issue is not focused on exploration of the actual needs of teaching/learning practices i.e. why this practice?

Recent educational trends concerned with the application of ICT in education maintain that lecturing and transmission of knowledge be replaced by individual, inquiry-based, and self-managed learning. The change from a lecturing mode to such a constructivist mode will inevitably affect the teacher role and there is a general belief that the teacher using ICT will become an advisor and a guide instead of a lecturer. The new teacher role is sometimes condensed into the catchphrase: "*From the sage on the stage to the guide at your side*". However, there are reasons to believe that prevalent teaching practices should not be viewed as the consequences of undesirable and outdated strategies, which now can be replaced by proper use of the new tools.

Nobody will deny that the computerization in societal activities has been beneficial and much work will probably be carried out faster, better, and cheaper with computers than without them. Also education will eventually benefit from computers but it seems difficult to make inferences from general experiences to specific practices. Thus, talking about educational practice it is not possible to predict in advance in what way more ICT will change that practice.

Quite contrary to mere predictions based on general conjectures and sometimes just upon wishful thinking of what will happen, thorough studies

of actual practices are needed to get an understanding of a teaching practice. Therefore, in the present study we will step down from the general concepts and the fancy rhetoric outlined above and focus on how ICT tools are used in teaching practice. Accordingly, this study is not primarily preoccupied with efficiency. Instead, it will constitute an effort to open the "black box" of teaching practices to see what is inside. To do so, the study explores and describes how teachers make use of ICT during normal class work.

Purpose and Research Question

Human *practice* is described by Wenger (1998) as a process by which humans experience the world as meaningful (see p. 32). Put simply, humans act toward things based on the meanings the things have for them (Blumer, 1969). It is reasonable to believe that experienced practitioners act accordingly i.e. they make use of ICT in ways that appear meaningful to them. Therefore, the purpose of this study is to explore the characteristics of teaching processes when ICT tools are used in everyday practice, thus contributing to a conceptual knowledge of such processes. To accomplish the purpose an answer to this question will be sought:

What characterizes the educational practitioners' usage of ICT in class?

METHODS

The data used in this particular study originates from observations in classes (see p. 46). The headmaster informed the teachers that an observer from the National Agency of Education would visit their school. Those teachers who volunteered to take an observer were listed. In a typical observation session the observer was introduced to the class, which was told to be cooperative and answer the observer's questions. Often they were told to show already accomplished and successful projects. Overall, the observations were carried out from the position of an external observer who did not participate except for walking around and talking informally with different student groups and teachers (Hammersley & Atkinson, 1983).

Data Construction and Analysis

Data for this study were produced within a national project funded by the National Agency of Education in Sweden. The project named *Skola i utveckling* (transl. Schools under Development) targeted eight themes. The theme in focus for this study was called *IT i undervisningen* (transl. ICT in Education). Some fifty schools from all parts of the nation participated in ICT in Education. The major idea behind the project was to support development within the respective areas not by offering money for elaborate projects but by supporting network building. In practice, this meant that teaching staffs were given the economic opportunities to visit other schools and to attend conferences in order to learn and build networks.

The schools in the ICT group were divided into five groups and each group was assigned an observer with the mission of visiting his or her group of schools and make a report of what was going on. The instructions particularly emphasized descriptive accounts. Among the ICT schools, eight schools ranging from primary to upper secondary constitute the research group for this study. Observations were made on 42 occasions equally spread out among the schools during a two-year period (Table 1).

Table 1. Statistics showing properties of participating schools.

Name	Type	Number of students
East Gate Hill	Upper Secondary	2250
Forest Ridge School	Secondary	487
Flat Rock Elementary	Elementary	260
Burgher Senior High	Upper Secondary	1600
Chestnut Grove Comp	Secondary	475
Spring Creek Comp	Secondary	368
Fox Dale Elementary	Elementary	295
Dockyard Elementary	Elementary	350

Normally, the entire observation session lasted one day (two days on a few occasions) each time the observer visited the school. The actual data production in most cases was accomplished the same day on the train. With the help of a laptop computer the fieldnotes were transferred to texts. The extent of the database produced from observations and locally produced

school documents amounts to approximately 250 pages of A4-size when converted to print.

Reflexivity

Referring to the intricacies of representing reality in qualitative research treated in the general methods section of this thesis, the issue of *reflexivity* should be attended to briefly (see p. 44 f.). Hammersley and Atkinson (1983) points to the fact that it is impossible to escape the world that we study, thus the researcher cannot avoid having an effect on the social phenomena under investigation. Instead of engaging in futile attempts to eliminate the effects of the researcher, it is wiser to show one's cards in order to make the researcher position evident. Therefore an account of of the changes during the last decade will be presented below. It is based on the observer's experiences of some 25 years in educational practice. Thus, according to the discussion above, it should not be read as an objective account of educational changes. Instead, it should be viewed as an interpretation of school practice seen from the dual position of a former educational practitioner and a present educational researcher.

During the last decade, a strong local administration by the municipality replaced the national regulations in Swedish schools. This meant, among other things, efforts to cut costs and organizational experimentation, often lead by a new cadre of hard-working but inexperienced persons as leaders and headmasters.

Several different national curricula were born and implemented during the 25 years. From the perspective of a teacher, the latest one brought about the biggest differences. Rhetorically, the didactic decisions were now handed over to the teaching-staff since most of the national regulations were abolished with reference to their inappropriateness in a modern knowledge (or information) society. In reality this meant that a lot of issues that earlier had been subject to national regulations were now transferred to the local level, thus causing teaching staff as well as managers a lot of new – and sometimes unwanted – tasks.

The new situation coincided with what might be labelled an "individualistic movement" in economics and politics starting in the late 80s and continuing during the first half of the 90s. Even if schools both rhetorically and in

practice always have favoured the individual student, the responsibility should now be manifested in individual plans, which were to be made up in cooperation and agreed upon among teacher, student, and parent. The success and pass rate of students were now explicitly stated as the responsibility of the school, which resulted in a responsibility to carry out lengthy discussion sessions concerning each individual's progress. In upper secondary the responsibility to walk every student through the obstacles to the final pass grade, gave the teacher the burdensome task not only of keeping a record of the progress of every student but also of being available for examination of single students who have not yet passed.

Being locally focussed on their students and the day-to-day activities, the school practitioners are vulnerable to public rhetoric and what is considered new and powerful didactic methods. Quite a few of the rhetorically and commercially cherished issues find their ways straight into the everyday practice of schools be they about learning styles, mixed-ages grouping, problem-based-learning, inquiry-based learning, collaborative work, integration of staff groups, or methods concerning remedial teaching.

However, problems arise as a consequence of teachers' lack of argumentative experience. When "new methods" are presented they are often taken as "scientific evidence" that can be directly implemented in practice. Thus, teachers might require students to turn the textbook upside down as a treatment for reading disabilities, to jump the trampoline as a method of enhancing mathematical ability, to do their assignments sitting under a table with reference to learning style, or to “find information on the Internet” with reference to methods currently in vogue. If teaching staffs were trained to interpret educational research and discuss it, they would be able to see that a primary school student’s desire to read in darkness under a table must not necessarily be an instance of learning style, just to take one example.

The issue treated in this study is just another one in a series of the ever-changing educational practice. Practitioners take over the arguments of more skilled rhetoricians and consequently they are constantly worried about their insufficient knowledge of ICT, which makes it hard to “jump onto the train”, “prepare their students for the future”, or even for being the up to

date supervisor. Eventually, the practitioners may surrender and leave their students in front of the computer to get lost on the Internet.[1]

RESULTS

The results of this study will be presented in three sections. First, four different categories will be exemplified and fleshed out by empirical examples in **Properties of Practices**. In a second step, in **Relating Categories**, the analysis is taken further and the categories are put in relation to a superordinate category. In the third step, **Integrating Categories**, the findings will be integrated into a coherent theoretical model.

Properties of Practices

The four categories *Instruction*, *Monitoring*, *Cooperation*, and *Exploring* will be elaborated below.

Instruction

Quite a lot of the time in class is dedicated to helping the students handling the computer. The very *procedures* need to be familiar to the students. The instructions are also tightly connected to the actual *content* of education generally.

The very young students need instruction to get started. Teachers assign exercises meant to train specific skills such as mouse tracking, saving, and shut down procedures. Older students are often given work sheets with the same tasks, but in this case, tasks are meant to be accomplished individually. These procedures often are very time-consuming.

> They /two students in the 7th grade/ are occupied with an exercise book. I sit down beside them and ask what they are doing at the moment. Well, they are going to enter numbers into tables. They also practice the names to be used in spelling out difficult words during telphone calls /in Swedish: Adam, Bertil, Cesar …/. The two boys say that actually they know how to do this but since the teacher wants them to do it, they'll do it anyway. (Observation from Chestnut Grove 971118)

[1] This view actually finds strong support in a recent report showing the problems of letting even very young students find information on the Internet (Alexandersson & Limberg, 2004).

Even if students seem to do well on their own, the teachers will be there to prevent them from doing time-consuming mistakes. The teachers judge it wiser to tell the students in advance what to do so that they will be able to finish their tasks within time. The opinion that the human contacts are indispensable is very strong among the practitioners.

> A seemed to believe it was an excellent program. She did not reflect much; she just thought it was good. In class the students do as they are told. They expect the teacher to tell them what to do. (Observation from Dockyard Elementary 970915)

The instructor also supervises the content. When teaching younger students, the teacher selects the appropriate software and specific tasks according to what s/he judges appropriate for each student. It seems that teachers for very young students are convinced that programs for training of specific skills are beneficial. The remedial teachers are very much in favour of software targeted at specific problems and generally they are convinced that such software is useful.

> The program they are going to use is Lexia. The teacher picks an exercise targeting rhyming words. It has three squares out of which two will rhyme. The user is supposed to move rhyming pictures depicting rhyming words into their proper boxes. The boy makes some inarticulate sounds during work. Comments loudly. /…/ A girl sitting at another computer is occupied with a mathematics program. /…/ The first boy guesses what might rhyme. When he cannot find out, he just guesses. Then he finds out that he can move the picutures to see if it is right without actually caring about the rhymes. (Observation from Fox Dale 970916)

> She /the remedial teacher/ says that the computer is appropriate for drills. Besides, the students can be occupied for themselves and she doesn't need hanging over them all the time. Moreover, the computer will give her time to engage with students individually. And that is important! The computer will never replace real human contact, she says. (Observation from Chestnut Grove 971118)

Computer work as described above is very much the same as traditional seatwork since the computer is used for doing prescribed tasks either from printed work sheets or from drill and practice programs. Furthermore, the sessions in class have a clear distribution of roles, delimited time slots, and specific tasks to accomplish; in other words, the instructor handles a prescribed content for a group of students during a scheduled period.

Monitoring

Normally the teacher monitors *order*. This monitoring is also connected to *content*.

In almost all cases the teachers organize the computer work in some way. Particularly among young students, the computers are so attractive that a free choice of computer work would result in severe turmoil. Besides, rigorous planning is needed among the teachers in order to get access to computer labs. The monitoring also includes the order in computer labs. Since students tend to frame computer work more like recreational activities, they are reminded not to eat and drink there and they are constantly asked to take off their jackets and caps.

> While E is talking the students are waiting for the signal to start making their ways to a computer. But E decides who will use the computer and who will use pen and paper. E decides what each one should do. (Observation from Flat Rock 970923)

> It is necessary that a teacher unlocks the doors and accompanies the students in the computer lab. Students cannot be left unattended in there, they say. If they are on their own the balls will be taken out from the computer mice. (Observation from Forest Ridge 970129)

> There is no ruining of computers. Why should they? It is so exciting! I believe this is the key to why they do not ruin the computers. There is no reason. This is the best they can get! /…/ If they just were allowed to do some word processing and other traditional school related tasks, then it would probably would be of less concern to the students. (Observation from Spring Creek 971117)

To most teachers it is a quite new situation not beeing able to be in control of content like before. A few teachers, though, express their appraisal to the fact that computers are inherently motivating and therefore they are relieved of the burdensome task of motivating the students in order to keep them on task. Others feel uncomfortable and refrain from using the computers if possible.

> M says that normally you do not have control. One will soon realize that it was a mistake to tell the students: "Go ahead and find it /on the Internet/! After that we discuss some about the information on the Internet. Some is good and some is bad. We are agreed that it will be quite time-consuming to make mistakes. (Observation from Chestnut Grove 971007)

> At one computer workstation, there is a student searching information on the Internet about rain forests. He has found a page that he seems interested in. The teacher explains that they normally use a site from the National Agency of Education as their starting point. It strikes me that the boy from the 5th grade is particularly interested in what he finds. He doesn't seem just to be interested sitting at the computer. When he is

satisfied with his searches he requests permission to print all of it on an ink jet printer. (Observation from Flat Rock 980316)

Many teachers are very occupied with the problem of how to prevent students from watching and downloading inappropriate material from the Internet. Success varies here. Some schools have succeeded in making mutual agreements with the students resulting in openness and trust whereas other schools actually fight the students with repressive methods something that often results in ruined computers and sabotage in general.

We start talking about freedom and censorship. /…/ There must be freedom as to the Internet, he /the teacher/ says. In this school we just do "appropriate" things. If the students want to download violence, pornography, and formulae for explosives they must do it at their home computers. I intimate that sometimes it might be difficult to decide what is appropriate and what is not. B looks back in a thoughtful manner and says: If you see six or eight students who are totally absorbed in front of a computer screen, then you should be suspicious about the appropriateness. He concludes that students know quite well what is appropriate. (Observation from Spring Creek 970415)

Cooperation

The possibility for the practitioner both to feel and to be viewed as a collaborator is predicated on *self-esteem* and *authenticity*.

As a rule practitioners consider themselves quite incompetent in using computers when compared to their students. This feeling gives the teacher a defensive role generally. On the other hand, when a teacher literally steps forward maintaining his professionality as an educator the problem of "who knows the computer best" vanishes. On the one hand, the confident teachers readily admit their lack of certain skills when faced with an authentic problem and the student may be able to show them how to solve the specific problem. On the other hand, from the perspective of an educationer they clearly realize that the skills just demonstrated by the student pertain to a very narrow segment of skills. The confident practitioners also do not run into problems with didactic decisions should they not be what students prefer.

A says that the teachers should be in command and one step ahead of the students. He exemplifies this by telling about the ready-made reports that can be found on the Internet. He usually shows his students where to find these reports and asks them to cite them using normal referencing procedures. This is the way it is, he says, we teachers must learn to handle the situation. (Observation from East Gate Hill 971021)

In those cases when students treat their teachers as knowledgeable (not necessarily of computers) persons they will be trusted as co-operators. Students will turn to their teachers to discuss various matters and not only about computers. The necessity for self-esteem as a prerequisite for cooperation is very much a general observation, though, which is not directly dependent on ICT in the classroom. Still, the ability to handle ICT issues will influence self-perception.

> I think if you are going to discuss with students in their knowledge domains it is necessary that they consider you as a person who is knowledgeable of something they consider important. (Observation from East Gate Hill 971021)

The new tools also will make the teacher's job more "real" viewed from the pupils' perspective. Particularly, teachers teaching music, utilize ICT both in order to be updated within a field that young people normally consider very important but also for creating music and teaching students with dedicated software. By using computer technology the practitioners can also carry out measurements for instance in physics and astronomy, which eventually make the profession more authentic. The teacher, consequently, will be less of a schoolteacher with all its connotations for students and more like professionals external to schools.

> A says that the music teachers are very interested in the computers. They use a program called Cubase (which I think is one of the most well known professional programs for music). (Observation from Chestnut Grove 961016)

> Within physics teaching, the computers are quite common tools. They demonstrate how they use the computer for measuring. By using appropriate software they are able to do continuous measuring of the decreasing temperature in congealing stearin, for example. / …/ this is the way measurements are done out of school today, they say. (East Gate Hill 961009)

Finally, practitioners will also have collaborators among colleagues. Today teamwork is almost mandatory in educational institutions; still, it is not unusual that it becomes merely an organizational issue. However, project work supported by ICT involving a lot of practical issues (contacting persons, budgeting, time scheduling, and so on) seems to promote authentic teamwork among colleagues.

> What P wants to talk about at the moment is a project connecting computer science, media, an several other subjects. /…/ They are going to form a project group consisting of P from computer science, L from media, C from Swedish, and A from drama and social sciences. Also students will be included in the group. (Observation from Spring Creek 970414)

> I meet K and two other teachers in the coffee room. They are discussing the further financial conditions for a project, which they have already received some money for. They need additional money for some boat trips to the Sound where they will collect water samples. /…/. They divide the tasks among them. They are going to make telephone calls to potential sponsors. I ask them what makes them pursue the issue. They mean that it is their interest of doing something new. Also the pupils need something concrete. They are not like they used to be, they /the teachers/ say. (Observation from Burgher High 971124)

Exploration

The explorative trait in teaching practice is indicated by two properties *transcending* and *metaknowledge*.

An element of experimentation as a consequence of the new tools has arisen among teachers. In some cases the experimentation implies a threat to what feels safe and well known. In most cases, though, the staffs are fascinated by the possibility to communicate and publish on the Internet. At least in theory, they can all have access to a global village.

> K was quite enthusiastic of another idea. She wanted to use her new skill to make a home page for teachers of the Italian language. Thanks to the ICT project she had made new acquaintances, ML at the East Gate Hill was one of them. They both wanted to create a home page which could be hosted by the National Agency of Education. K showed me a lot of letters she had already written for this issue. (Observation from Burgher High 970319)

> One of the teachers has found a site called KidPub where she and her students have published some documents. They have received an answer from Canada. It is marvellous to see the eyes of the kids when they receive an answer, she says. (Observation from Flat Rock 971103)

Eventually, they also become interested not only in using ICT among their students but also for personal use. On some occasions, in-service-training sessions were observed in which the participants eagerly wanted to learn how to download, decompress, and install software from the Internet. It can be conjectured that also educational practitioners will be caught by technological fascination. Together with access to a widening context obtained by the Internet many practitioners are transcending the confines of ordinary work.

> During the presentation a vivid technical discussion breaks out whether it is possible to view something that requires Shockwave. Someone seems to store the program on a diskette. /…/. In this connection someone asks how to download software. (Observation from Flat Rock 971103)

Students may also be given the opportunity to work from their homes. At least they can download their assignments when for some reason they cannot attend school. Some teachers try out different possibilities for assessment and grading via the Internet.

The discussions about how to utilize ICT for didactic purposes will eventually lead up to a certain consciousness among school staffs. Among the issues observed are many direct questions like: "What is a reasonable level of ICT use?" "Do we eventually reach a level where we can say it is enough?" "What is reasonable from a school perspective?" "What would happen if every student had a computer?" "What will the consequences be for the teacher role?" All those questions indicate a kind of *metaknowledge*.

Relating Categories

In the analyses of classroom practices it was found that practitioners are mainly occupied with *making sense* of their instructional practice when new tools are taken into use. Such a general category has the capacity of getting together or unifying more specific findings. The unifying category in this case resembles what is labelled a "*core category*" within Grounded Theory analyses (Glaser, 1978). Below the properties of this category will be elaborated (Figure 11).

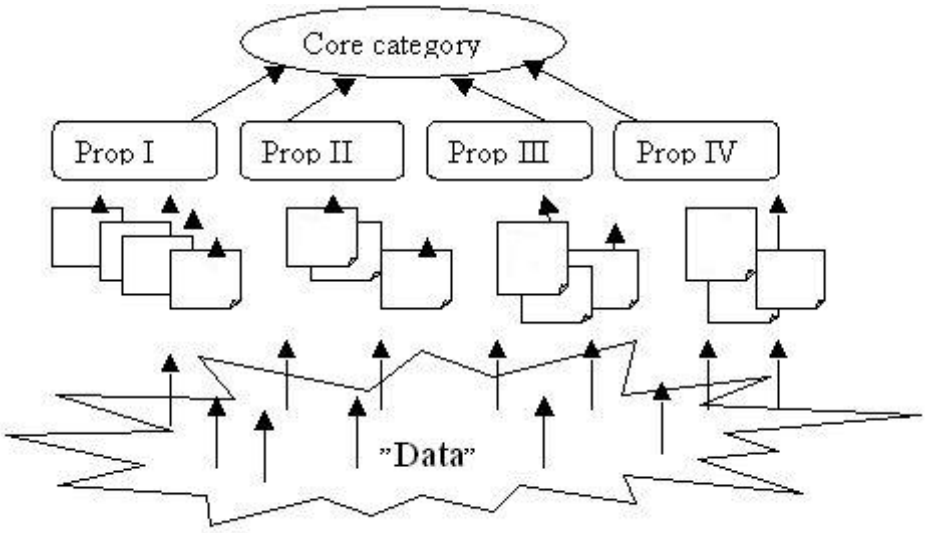

Figure 11. Outline of relationships between data, multilevel concepts, and core category

The four properties that lay the ground for the core category are further predicated on properties on lower levels as far as to the data level. This will result in a kind of hierarchical relationship, which is also the underlying idea in the Atlas/ti software used in the analysis (see p. 48 ff.). However, in reality the analysis is never a linear issue. The relationships between the categories and concepts are outlined below.

Integrating Categories

Before building the theoretical model, it is necessary to pay some attention to the method used in this study. The study aimed at generating a widened conceptual understanding of a well-researched field. Therefore it took a stand against preconceived concepts and favoured exploration and interpretation.

All research is subject to issues of validity. Probably, qualitative research will be even more questioned than quantitative research because of its researcher dependence and its somewhat indistinct methods. As pointed out elsewhere in this thesis (see p. 47), analysis is an intuitive endeavour. The abductive leap, which figuratively means to leave description and conceptualize phenomena not previously perceived, may be subject to discussion as well as to objections. However, representing reality is not just a matter of casting it in the same old mould. Instead, the aim in this study has been to refine and extend the existing conceptions. Also researcher influence will be an issue of validity. Being basically critical to much of the contemporary rhetoric concerning ICT in education, it is quite easy to find research and produce results supporting that attitude. On the other hand, the resulting problem will be of the same kind for researchers in favour of contemporary rhetoric. The validity, in both cases will be an issue of recognition, usefulness, and explanatory power.

The main distinction, here labelled *Old* and *New* practice respectively, might, still, be a concession to preconceived categories in education (Figure 12). Rhetorically strong visions of the benefits of ICT as a vehicle for changing education into something different, have frequently been brought forth and therefore Old and New might not be good examples of innovative categories. The issues are dealt with in the passage "Envisioning a Better School" (see p. 16 ff.) However, the properties of Old Practice: Procedure

and Order (even if commonly used words) will yield explanatory power when related to the research presented in this thesis.

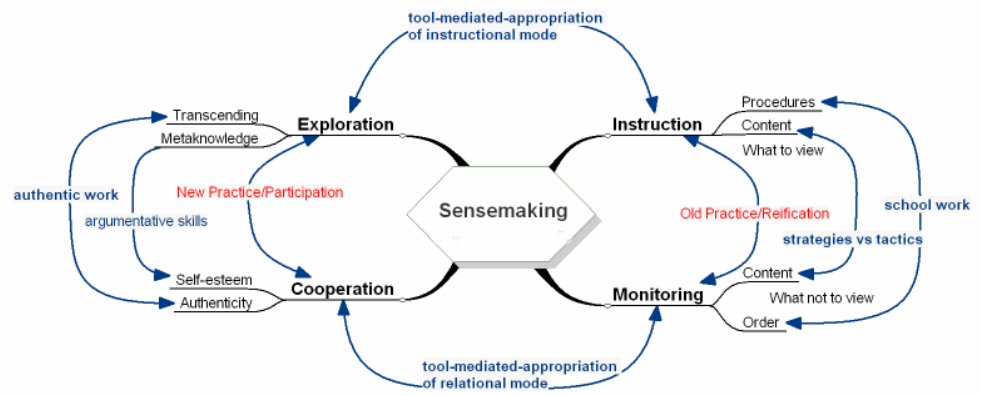

Figure 12. Schematic view of how the Sensemaking category is related to its constituting concepts.

The general category mediates between Old and potentially New Practice. The tension between Old and New can be described as a dual *appropriation* concerning *instructional mode* as well as *role relations* in class (see p. 30). For analytical reasons the categories might also be cast in Wenger's terminology, *participation* and *reification* (see p. 32). The reification component then would be indicated by *Instruction* and *Monitoring* whereas the participation component would be indicated by *Cooperation* and *Exploration*. However, it should be pointed out that such a configuration should be viewed as a snapshot of an ever continuing evolution in which reifications are created continuously during participation.

Procedure and *Order*, which are properties of Instruction and Monitoring respectively are strongly supported by the literature presented in this thesis. Computer usage will be constructed by teachers and students in normal work and such work is seldom revolutionary or even innovative. This line of argument is strongly supported by the studies presented in the "Realizations in Practice" passage presented in this thesis (see p. 19). Moreover, from a classroom perspective, the dilemmas arising from the task of managing large heterogenous groups also entertain the need for procedures and order. These issues were treated in the "Dilemmas in Educational Practice" passage (see p. 26).

The *Content* property of Old Practice is characterized by a distinction between what is appropriate and what is inappropriate i.e. "what to view" and "what not to view". In Old Practice teachers are constantly inventing *strategies* to prevent their students from downloading inappropriate web pages from the Internet whereas students incessantly apply *tactics* to circumvent the repressive strategies that will prevent them from exploring the potential thrills of the Internet (cf. de Certeau's poachers p. 20).

The Content property makes the tension between Old and New particularly evident. The school practitioners are struggling to supervise content whereas their students make use of the new tools to *transcend* the traditional confines of school content. This situation should be compared to what Andriessen and Sandberg labels open domains (see p. 22). With the advent of Internet in schools, content can no longer be kept solely in books. This issue is also attended to by Stenseth conceptualizing the change as *Skinner*, *Piaget*, and *Rousseau* (see p. 24). According to a *Piaget* approach, which basically is another label for constructivism (see p. 27) or the studio scenario (see p. 23), students should have the freedom to act, experience and learn after their own plan. Eventually, it will neither be possible to control content nor to store it in traditional books and that is what Stenseth calls a *Rousseau* paradigm. The exploration of unlimited and uncontrolled content will eventually turn practice into some *New Practice*.

To describe New Practice is, roughly speaking, to look for opposites. New Practice is predicated on *Exploration* and *Cooperation*. The concept of Exploration differs from Instruction in that it enters previously unknown territories or rather *transcends* the borders of *instructional modes* as well as the position of a supreme *knowledge relation*. Both these findings are in harmony with the educational trends identified and described in the passage "Technology and Educational Approaches" (see p. 22).

From the possibilities afforded by the changing conditions (tools, modes of instruction, and relations) it can be conjectured that what is labelled schoolwork might undergo a change into more *authentic* work. These issues are dealt with in the passage "Dilemmas in Educational practice" (see p. 26). However, this issue will need some further reflection here. Implicit in "authentic" work is a notion of educational work as non-authentic. From the socio-cultural perspective underlying this thesis (see p. 3), the activities of

educational practices are viewed as authentic no matter if they need to be changed or not. That is not to say that educational practices are without certain characteristics, which might be brought forth and changed. Till now, the distribution of cognitive work onto cognitive artifacts, has been rather absent in conventional schooling but the results of this study points in the direction of more frequent use of tools. These tools not only make the work easier; they also change it and make it accessible to new groups (see p. 26). The properties of New Practice as found in this study address this issue and shows how new tools can *mediate* change (see p. 33).

One might also take into consideration the *metaknowledge* and *self-esteem* found in this study. Above (see p. 55) educational practitioners were described as virtually powerless against contemporary educational policies because of a lack of *argumentative skills*. The result of this study indicates the possibility of a growing awareness mediated by technology. The result of an increase of self-esteem and metaknowledge among educational practitioners will probably be – if not revolutionary – so at least evolutionary.

CONCLUSIONS

The focus in educational settings when teaching very young and adolescent students, is primarily on *educational methods* and how to make use of technology when teaching general content without either inherent structure or a fixed instructional design.

Thus, technologies are applied according to their affordances. Normally, this will mean that teaching staffs instruct and monitor their students and they will do so even after they are supplied with computers. Compared to Koschmann's (1996) paradigms above computer usage will be more like computer-aided- instruction (CAI) than computer supported collaborative learning (CSCL), the latter treating the technology as a resource among others (see p. 25). *Adapting the tool to the existing practice is a pronounced characteristic.* This is also supported by Cuban (2001), Schoefield (1995), and Stenseth (1999).

Another characteristic, realized in the exploration and cooperation categories, is the *interaction between people*. This is partly due to the ratio of computers to students forcing several students to share the same computer

but also to practitioners exploring contemporary ideas of collaborative work in front of the computer screen.

The instructional processes described above could be viewed from different perspectives. On the one hand, they could be conceived of as outdated strategies meaning that the practitioners have not yet grasped the benefits of information technology. On the other hand, they could be viewed as necessary efforts based on practitioners' interpretation of the situation. By experience practitioners know that a vague structure in combination with many alternatives will result in many students learning very little while spending a lot of time. The contemporary inclinations for letting even inexperienced students find information on the Internet has been shown to result in very little conceptual knowledge (Jedeskog, 2001). Besides it will create a messy classroom (cf. Dilemmas in Educational Practice p. 26 ff.).

Compulsory schooling today is under a strong pressure to change its practice; national efforts as well as public debate both contribute to this state. Rhetorically, most school practitioners have accepted the need for changes; on some occasions this will cause practitioners, in moments of aberration, to throw away decades of experiences in favour of methods in vogue. In most cases, though, changes will enter school practices in an evolutionary way. Concerning this issue, Cuban lends support to understanding: we should not expect rapid change in societal organizations but it will most likely occur if we have the patience to wait (2001).

Summing up, the application of a contextual process approach in the investigation of educational practices had the capacity to produce an *integrated* conceptual understanding of the practices investigated. The model makes possible the understanding of evolving educational practices be it in schools or elsewhere. It gives interpreters the possibility to view practices in context. New Practice does not arise out of nothing; to a degree it is always a carry-over from the past. The results of this investigation show that when new artifacts are introduced in existing practices, the practitioners perceive their affordances and act accordingly.

As a final remark, it might be argued that even if most of the empirical results of this study viewed separately are in harmony with and support already existing research, the main contribution of the investigation is the *integrated model* showing how appropriation mediated by ICT can be

conceptualized and integrated into a dynamic model with a capacity of explaining the relationships between the constituting concepts.

PRACTICING DISTANCE EDUCATION

INTRODUCTION

The expectation that computer mediated education be accessible to everyone and everywhere is realized in the generic concept *distance education*. Under this heading a range of other concepts such as open learning, flexible learning, open distance learning, e-learning, web-based training, and mobile learning can be subsumed. They can be assumed to represent more or less varying forms of distance education, all competing on the educational market.

Even the word distance lends itself to many interpretations. Intuitively, one might think of distance in *space*. Students can be taught from remote locations with proper technology. However, distance also applies to *time*. In the extreme case, the students can start and finish the course at any time, and take as much time as they want. This could be a kind of self-study, when no communication exists between students. In a somewhat more common scenario, students start and finish the course at the same time but they can still choose when to study. In other cases, the computer-mediated communication takes place at the same time (*synchronously*), like video conferencing, or at different times (*asynchronously*), like e-mail or forum systems. In the first case, the teacher is able to give the students immediate answers to questions (low degree of distance in time), whereas in asynchronous communication the feedback is delayed. Finally, distance could be applied to theoretical concepts such as *transactional distance* (Moore & Kearsley, 1996). The concept describes the psychological distance dependent on structuring and dialogue in a course. If course material and instructions are fixed the transactional distance will increase. Likewise if dialogue between teacher and student is encouraged this will reduce transactional distance. Varying degrees of structure and dialogue and their combinations will yield quite varying student conditions (Fåhraeus & Jonsson, 2002).

A growing trend in contemporary distance education is the change from *single mode* to *dual mode* meaning that institutions today more likely will offer both campus and distance education at the same time. Offering both kinds of education will put new demands on traditional educational institutions. Whereas experienced single mode distance education institutions (Open University UK for example) have the competencies necessary for the delivery of distance education, traditional universities normally have a good grasp of the subject to be taught but may lack the experiences of distance delivery. Therefore they must experiment to find out how to best deliver their courses in the new mode.

In many cases institutions begin distance education believing that it is a way of saving money or being up to date. Accordingly, they start with a short planning period, with teachers who are ill prepared for their mission, or with enthusiasts who are willing to spend lots of time on something they are interested in. However, researchers warn that the distance education undertaking may become something like a Trojan horse, i.e. it will take a lot more time and need a lot more planning than could be expected (Laurillard, 1993; Rowntree, 1999).

Models

A distance education course can, on the one hand, be described with reference to how content is organized and treated as well as to how teacher participation varies. On the other hand, courses could be characterized according to underlying pedagogical models. Normally there is a covariation between organization and pedagogical models.

Mason (1998) describes three models of on-line courses. In the first one "*content+support*" model, the content is exclusively produced for a special course and teachers are only remotely present as graders. The delivery of courses in this mode gives good opportunities to teach a great number of students since most of the job is done in advance. Consequently, an increase in the student/teacher ratio will only marginally increase the workload of teachers. Another model, "*wrap around*", uses already existing material. This way of presenting a course will demand more of teacher participation. Also the number of students will be more important since teacher workload is likely to increase with the number of students to supervise. In the third model presented by Mason, "*integrated model*", the content is emergent.

Students and teachers will use various resources and the content will develop during the course. This model will increase dramatically teacher workload and the demands on students. Accordingly, it will only be possible to teach a limited number of students.

Roughly, the course models above can be related to three pedagogical models, *instructionism*, *constructivism*, and *interactionism*, which is but another wording of transmission, studio, and negotiation mentioned above (see p.22 ff.). Instructionism deals with content that can be delimited, sequenced, and transferred to the students. The focus is on the instructional material and how that can be organized. Better instructional material is thought to bring about better learning. Constructivism, on the other hand, focuses primarily on student activities. Learning occurs when students are motivated, active, and involved in search for personal meaning. Both instructionism and constructivism are fundamentally oriented towards individual knowledge. Interactionism, finally, focuses on social relationships and the emphasis is on students' participation in learning activities together with peers **and** cognitive tools.

To sum up, any new way of teaching is practically never quite new. Contemporary distance education can be traced back to well-known pedagogical models and to times when assignments were sent in by ordinary post, depreciatory called "snail mail" today. Any cherished application can be located within an educational paradigm, which in turn makes it a descendent of prior applications.

This study investigates a carefully prepared and well planned dual mode course called "*Teaching Numerical Methods for Partial Differential Equations with the Internet*". The course was offered as a course for doctoral candidates at The Chalmers University of Technology in Gothenburg (CTH) in collaboration with The Royal Institute of Technology in Stockholm (KTH) (see also: A Jaun et al., 2001). Modern video conferencing techniques and web based interactive material were used to accomplish the course objectives. It should be viewed as an example of experimental teaching.

Purpose and Research questions

The purpose of this study is to analyze one part of the instructional events in which intruction was carried out face-to-face in class with the aid of

information technology. Specifically, the following questions are investigated:

What is the role of technology?
What educational models guide course design?
What is the role of physical presence?

The study is delimited to investigating how the instructional events with technological resources were were carried out in this particular setting. The specific content – the numerical methods – are no objectives for this study. The study is carried out in the CTH setting.

COURSE DESCRIPTION

A detailed description of intentions and content of the present course can be found at http://www.fusion.kth.se/courses/pde/ and a brief description of the content, structure and experiences from courses carried out earlier is given in a paper by the course leader and his co-authors (André Jaun, Hedin, & Johnson, 2000):

> Short common lectures appropriate for video-conferencing outline the concepts and introduce more detaliled studies that are carried out individually with interactive web documents. This enables every participant to work at his own pace, to study and test the properties of finite difference, finite elements, Fourier-, Monte-Carlo and Lagrangian schemes. Practical examples include the advection, diffusion, Black-Scholes, Burger, Korteweg-DeVries and Schrödinger equations; in each case, the analytical derivation is given with a pointer into the JBONE source code and can directly be executed on-line in a java powered web browser. Experience shows that the students rapidly acquire the technology for the electronic publishing of the home assignments by context. News groups provide the framework letting not only teachers, but also the students answer questions and discuss relevant topics.

During two weeks introductory lectures were held by the course leader as a foundation for a consecutive week of self-paced work with assignments and a concluding one-week project. After a stipulated date the course was ended as far as the course management was concerned. Still, the participants could use news groups for collaboration and help if they preferred to do so.

The participants consisted of two groups of doctoral candidates following the course from Stockholm and Gothenburg respectively. The lectures could be given from either location. The number of participants taking part in the

lectures varied somewhat during the course but was on no occasion more than ten in either place. Due to varying reasons not investigated here, some participants left the course without finishing it.

Technological set-up

What dominates to the first-time observer in the video conference room are two big projection screens. There is a projection of a computer's desktop in one of them and a video link to the participants in Stockholm on the other one. In one of the desks in the front of the room sits the lecturer, his back towards the audience. On the desk he has a computer screen of normal size with the same desktop as the one projected on the big screen. Mixed into the video screen is a little screen where the lecturer's face can be seen by the participants in the same room i.e. the lecturer turns his back towards his audience and his face appears only as a projection in the mixed-in screen.

Every student's desk is equipped with a microphone, which can be turned on and off. In on-mode a red marking glows on the microphone to show the on-line status. When the microphone is on-line, it will be searched by one of two video cameras, which are fixed to the wall in front of the room next to the projection screens. Furthermore, there is a network connection and a socket for power supply at each desk.

The room is furnished with fixed desks and chairs, which are made of relatively expensive wood. On the floor, there is a soft carpet. Very little of what is going on outside the room can be heard. There is no daylight and therefore the room is lit up by lamps in the ceiling and by the two screens. It is relatively cool in there.

METHODS

Methodologically this study can be placed within the ethnographic (Atkinson, 1991; Beach, 1995; Fetterman, 1990; Hammersley & Atkinson, 1983; Zuboff, 1988) realm even if it will not qualify as pure ethnography depending on too short a time in the field (see p. 43 ff.). Two observers, the author of this report and a researcher from a pedagogical unit at the CTH, were assigned the task of being present during the campus sessions and report their observations afterwards. Since there was an agreement with the

course leader that the distance course would be evaluated, there were no problems entering the field. A professor at CTH served as a gatekeeper and introduced the observers to course leader and students.

First the observers surveyed the objectives and structure of the course by reading relevant parts of the course description from the web pages (available at http://www.fusion.kth.se/courses/pde/). A conference paper on previous experiences from a similar course named *Teaching Numerical Methods for Partial Differential Equations with the Internet* was also studied (André Jaun et al., 2000).

Then, during two weeks, either one observer or both at the same made observations on five occasions (see also p.46 f.). Normally, the observers just sat in the room watching what was going on and taking notes. These notes were elaborated and transferred to digital files soon after the observational event[2]. Since none of the observers had domain knowledge of the numerical methods it was not possible to participate in the mathematical discourse that was going on. The observer role therefore can be labelled what Hammersley and Atkinson (1983) call *observer-participant*. The most extreme observer role described by Hammersley and Atkinson is when the observer is unknown – a fly on the wall – to the participants. This was not the case here since the observers now and then participated with meta-comments on what was going on or asked direct questions to students and teacher.

On two occasions the participants were interviewed. The first interview was somewhat spontaneous with questions constructed during an observation session. The final interview with participants, course leader and the professor from the CTH was carried out on the very last day of the two weeks and it was structured around the following themes: *general comments, comments on learning style, comments on equipment, comments on material used, comments on learning objectives, comments on participation from evaluation sheet*[3], *more comments*. Due to some overlap between these questions and those of a digital evaluation sheet issued by the course leader, some modifications were made before the interview.

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[2] Essentially, the field notes taken by the author of this report were elaborated and used for this analysis. The other observer, a senior researcher, was above all an invaluable discussion partner for this analysis.

[3] The course leader provided a digital evaluation.

Analysis

The field notes i.e. field notes taken by the author of this report, were transferred to computer files and further elaborated. The files were eventually entered into a computer program for qualitative analysis, ATLAS/Ti (see p. 48). However, field notes taken by the other observer were not entered into the analysis program. Instead, they served as aids for memory in oral discussions.

Briefly, the first part of the analysis consisted of the general steps described above (see p. 47 ff.). In the second part of the analysis, the commentaries and memos were entered into the group of primary documents (see p. 49) and the whole process started all over again.

The analysis resulted in a qualitative account. In this case it means that it is not an account on "how things really are" mainly because the research object is very much open to different interpretations. Thus, the account is built on findings from observations and answers from interviews as these meet the observers' general knowledge of education. The researcher's awareness of his own influence of the account s/he makes is what ethnographers label *reflexivity* (Hammersley & Atkinson, 1983) (see also p.55). Eventually the analysis yielded the results presented in the next section.

RESULTS

First, the *role of technical facilities* is described. Then, the *underlying pedagogical assumptions* are described. The *content and structure* of the course are then elaborated. Finally, an account on the issues of *physical presence and collaboration* is given.

Role of technical facilities

The videoconference room (see description above) is set up for teaching. The projection screens, the fixed rows, and the technical equipment at the desks are the dominating features. The lecturer is constrained by this technological setting. When lecturing, he splits his attention between the camera in front of him, the computer desktop on his table, and the projected computer desktop on the screen where his cursor movements can be followed. By pointing, he can direct the spectators' attention to relevant parts of the

screen. The students, on the other hand, split their attention between the paper version of lecture notes and the screen in front. No one seems to take notes with a pen.

The technical arrangements also exert influence on students' overt participation. Thus, it is not possible just to ask a question into the air and get an immediate answer. Instead, it is necessary to switch on the microphone and wait for a camera to focus on the speaker. There were indications that the participants experienced these arrangements negatively. In a technological environment like this, the environment structures the actions of the students. This means that their natural behaviour is constrained by the arrangement. On the other hand, this is very much like taking turns in a big group of people where you have to wait until you get the permission from the chairman to talk.

To minimize the time spent on waiting for the camera, the participants eventually huddled together in the middle of the room. After that, they did not have to wait so long for the camera to detect them when they wanted speak or ask a question. As a matter of fact, it is possible to speak without the camera focusing on you, but it is difficult to detach your attention from the camera's movements and focusing actions. Normally, you feel reluctant to speak until you have a perfectly focused picture of yourself on the screen.

Of crucial importance are the interactive lecture notes adapted to common web browsers with java facilities. Java applets let participants explore the numerical methods taught by way of manipulating the parameters, which in turn affects the graphical displays in real time. Even the layman can see that the java applets are great assets. They will let participants try out different solutions without risks (cf. *partners in cognition* p. 26). One can only speculate in the possible advantages of the immediate feedback you get when you change something. As one of the participants said: "*It would take a teacher a very long time to describe what's happening. But now the solution is just a few mouse clicks away!*"

Even if the participants are put in the position of pupils they do not feel bossed about by the lecturer: "*Definitely we were not rigidly put to answer certain … there were sort of recommended exercises … we could have answered more if it was to our interest, that's how I understood it.*" When they are off

lectures they can work whenever they want but they are supposed to use the newsgroups as a medium for understanding.

Underlying assumptions

A general assumption is that the material can be brought, taught, or transmitted to the participants in ordered steps. There is a fixed content to be learnt or acquired. Accordingly, ontological suppositions concerning the subject area give rise to instructions engineered on the basis of subject matter. Lecturing in the sessions observed disseminates information. The participants are explicitly told how to best use their time during lectures, days and weeks. Thus, the set-up can be viewed as an example of the *transmission scenario* mentioned above (see p. 23 f.).

On the other hand, the students are supposed to work on their own or together with the online material between lectures. Thus, there is also some adherence to constructivism. Expressed in another way, the sessions can be viewed as examples of both *instructionism* and *constructivism*. This means that your reward after having laboured hard with learning either alone or together consists of personal knowledge firmly (or unreliably) stored somewhere in your head.

Even if the group of doctoral candidates can be supposed to constitute a fairly homogeneous group, the task of presenting the same content to a group of people with different experiences inevitably raises the issue of differentiation of instruction. Here the course leader expressed a rather clear-cut view. He is there to maximize what he can transmit. He is not there to maximize the number of passing participants. If people do not understand, they should not be there is the implicit message. It is no use wasting time if you are not capable of doing this.

His intention behind the lecturing is "*to bring to everyone / ... / something, knowing that the best will need a lot, because they are pretty advanced and therefore* /it is necessary/ *to bring something really complicated and I wanted to bring also to somebody who is new in the field something, so it's intentional that somebody who is new will be at the very edge of what he can do and will be suffering with it. I am not trying to maximize the number of persons* /passing/ *I'm rather trying to maximize what I can transmit*".

It may be possible to think like that in a course for doctoral candidates. But put into a more general context it points to the differentiation issue, which is pertinent in all teaching. It also give rise to the question whether distance education is beneficial or detrimental in relation to this issue.

Content and structure

The course leader describes the actual content as demanding. However, the Java applets used in the interactive web material make hands-on experience and visual exploration possible (cf. p.26). The material is furthermore meant to be suitable for participants from different research areas, and the general assumption is that most engineers have to master these kinds of numerical methods. The overall objective is that engineers should know how to properly apply the different numerical methods in authentic situations.

Accordingly, there is also some uncertainty about the level of difficulty among the students: "*I was just having to hang on learning as much as I could doing all the exercises and I think that is always like that in intensive courses*". Another one says: "*I was afraid it would go over my head in a sense. It's been very long since I really dealt with differential equations or deep mathematics so to speak. It has only been on two occasions in ten years, but I found it to be very good as a refresher and I got further*". Some of them felt pressured by the demanding content: "*It is hard but I am working hard. I think it is a short time. The stuff is large /... / I think we need more time*".

An equally important objective is that the students learn to communicate by way of newsgroups on the World Wide Web. To this aim, the participants from the outset are given the assignments to set up a web page and use newsgroups to get information about the task. The overall objective here is to teach the students how to use the World Wide Web and the newsgroups as collaborative tools that give access to researchers all over the world and to their findings (cf. participating in *communities of practice* p. 33). The issue of real life collaboration among the participating students is not explicitly addressed.

The numerical tasks and the networking tasks are different in character. For the students it is a demanding task to master both areas since their experiences of networking and computer platforms are quite varying. Even if it is an objective of the course that the participants learn the networking

operations by context, for some of them the networking seems to take time from the more demanding numerical methods.

Physical presence and collaboration

Some online courses are self-instructive meaning that you log on to a web site and follow the instructions you find there (see "Models" p. 71). You post your questions to newsgroups or other kinds of virtual learning environments and you hand in your assignments. The observed course has all the technical facilities that would make this possible. Still, the participants gather in a special room to attend lectures. This puts the issue of physical presence in focus.

Here are some voices: "*I didn't participate at the first three lectures and I think it worked quite well to read the material ... but of course I sit in the same room so I could discuss with her* /another participant/". "*I think the lectures made it a bit more easy to understand the text because there w*/ere/ *a lot of formulas. If you just read it without any background before … the lectures are good for that ... it's easier to read the material…*" Another advantage of actual presence is that you might get unexpectedly interested. One of the participants says: "*I was just gonna sit in, I wasn't gonna do the exercises …* /but/ *... well it was just difficult to let it be … It was a really great opportunity also because I could lean on them* /the fellow participants/ *… so I found it so interesting … I was gonna just find out that I wasn't a complete imbecile when it comes to numerical solutions and partial differential equations and I wanted to go into it a little deeper*". Still, others touch upon the issue that it might be easier to focus when you are there.

The issue of physical presence can also be viewed from an instructor perspective. In the very beginning of the course, the instructor gives an orientation of where to find the material and how to handle that material. Then, he explicitly gives advice on how to treat the assignments, what to handle first and what to handle next. He also gives advice on specific issues telling students in advance about potential mistakes they will probably make. Finally, he warns the participants not to get overloaded with work and he explicitly tells them to delimit their work.

A closer examination of the actions reveals that he shows, exemplifies, and inspires; he demonstrates, informs, and urges; he reminds, refers, and summarises. He construes his own role as a guide who takes the students

stepwise through the relevant material. The students perceive the teacher in the same way. In a participant's words: *"I think the personal interaction is always fun so I don't think … it will never be the same really/without a real person/".* Another participant declares: *"I thought the web browser worked very well as lecture notes, it's really an optimal way of doing it but when you have somebody … it's just like you are trying to learn something on a computer you can try to sit and do it for yourself whereas if somebody is standing over your shoulder who has done it to show you how it works … that's much better".*

Generally the instructor is there to teach the participants what there is to know. To this mission he will stick to the curriculum he has planned. The students, on the other hand, are there to find out what the teacher has planned i.e. what you need to know. Neither part will therefore question the subject matter. Shortly, they are there to be taught in a well-planned sequence of tasks. This means that they are neither expected to be accountable for content nor for sequence; however, they are accountable for their self-paced work and for carrying out the mandatory assignments.

As to submitting messages to news groups, interaction does not occur the intended way. The course leader attributes the partial failure to the number of participants. *"If there were hundred people it would work much better".* It might be that he has set up for a scenario peopled by a large group of researchers located all over the world because he wants the participants to appropriate the actual tools for such cooperation. In this case, however, they are far too few to find it really beneficial, if judged from the number of messages posted. One explanation given by the course leader is that newsgroups work under conditions of "critical mass". If the number of participants is small, newsgroups might seem less important as a collaborative tool. Still, most of the planned cooperation takes place in the news groups and they do not really discuss things at length during lectures.

To sum up, the mastering of new tools – both the numerical methods and the newsgroup facility – can be viewed as important tools that one has to master in order to be a participant in a sociocultural practice where these tools are used and transformed. Framed in that way, it might be quite meaningful for the potential user of these tools to focus temporarily on "learning" those tools – that will enable his participation in a sociocultural practice – regardless of if it happens by instruction, individual activity, collaborative work, or all together.

DISCUSSION

This investigation aimed at studying the following three issues: 1) What is the role of technology? 2) What educational models guide course design? 3) What is the role of physical presence? They will be treated in turn below.

Technology

As to technology the overall impression is that the room where the course is run is a very special place. One might say that it is primarily built for teaching. The first impression is that you are in a churchlike room where you are not invited to participate but to listen. The ”pews” are fixed in a forward position and you should submit to the contextual set-up. This arrangement results in a lack of spontaneity since any spontaneous question is effectively blocked by technical problems. Unless you will ask a very local question you have to switch on the microphone and wait for the camera to detect you. This will take some time and the one who asks will probably feel that he is wasting the others' time. As a consequence, almost no spontaneous and knowledge seeking dialogues appear. In her attempt to generate a teaching strategy for the effective use of educational technology Laurillard (1993) argues that the reflective dialogue between teacher and students is the most important means for a successful teaching strategy. The videoconferencing facility could have been used for such discussions.

How did the designers of this room think? Hypothetically, they might have been reasoning like this: The technique makes it possible to communicate irrespective of distance. So let us design a room where it is quiet and technologically adapted for listening and participating in discussions between people in remote locations. For this you need to have people sitting in an orderly manner to let the camera catch you. You also need microphones and therefore you must have one within close distance. This set-up will evidently reduce your possibilities to move and talk in an unplanned manner; on the other hand, if you just sit still and listen and ask questions in an orderly manner you will be both seen and heard with good quality.

Summing up, the technological setting heavily influences the actions of both tutor and tutees. Furthermore, the students explicitly say that they experience the restricting conditions negatively. On the other hand, the cognitive tools make it possible to experience and manipulate the

mathematical content in a way that could hardly be done without the technological tools. Thus, there is a situation that makes it possible to trade in some losses for some benefits (see p. 26).

Design

Any distance course builder will inevitably run into design issues. On the one hand, there are issues concerning appearance and navigation, and on the other, there are the general issues of how to design for successful learning.

The distance course under scrutiny can be placed somewhere between "*content+support*" and "*wrap around*" (Mason, 1998). On the one hand, the online material is exclusively produced for the course and it could probably be handled by another instructor with proper knowledge but on the other hand, it is by no means meant to support mass education. Quite conversely, it is demanding and rather heavily dependent on a knowledgeable instructor (see p. 71).

The concept of learning might seem quite simple to persons who have given it little thought. Traditionally, learning has been indicated by what can be reproduced i.e. if you try to memorize a hymn or a set of numbers and then afterwards can say the numbers or the hymn without reading from the book we generally infer that learning has taken place and eventually become knowledge. Normally, we also locate the knowledge inside the head of the learner. In institutional education knowledge is often viewed in this way (see Resnick, 1987). Due to a strong and sustained influence from this theoretical paradigm, people generally consider this view of learning quite natural. That's the way it is!

With few exceptions this view of learning is connected to ontological beliefs concerning the material to be learnt. The teaching and mastering of skills relies heavily on the assumption of well-defined knowledge objects. Consequently, there is no doubt of what could (or should) be taught. This in turn, often influences how you go about teaching. The intuitive way to teach is to transmit the information to those who do not yet know. If you can find a method, which guides the learner through the material with as little risk as possible to walk astray, then do that. Design the material so that you literally put handles on both sides of the road. If you are successful in designing your

material, you could even put the material in the hands of a layman since the material itself contains all the knowledge to be learnt and the best way to transmit it.

From a theoretical perspective the fixed content, the sequencing, the transmission of well-established knowledge can be viewed as an instance of the *transmission scenario* (see p. 23) with its roots in instructionism (Andriessen & Sandberg, 1999). On the other hand, the focus on self-directed work with hands-on experiences from exercises and assignments can be framed within the *studio scenario* (see p. 23) with its roots in a constructivist paradigm saying that knowledge and understanding emerge as a function of a meaningful activity. However, the issue of new, enhanced or expanded understanding seems subordinate to the specific objective here i.e. to master the different numerical methods.

In sum, there is an unambiguous content of which the relevant aspects are unproblematic and as a consequence it can be transmitted to the participants. The instruction focuses on content matter and considers the learner as something to be filled by way of adapting to the structure of the material designed for the purpose of instruction.

Participation

The students come to *learn* the material presented in the course. The general assumption is that there are certain tools that you need to master. These you cannot explore for yourself since it would be far too time consuming. Instead a knowledgeable person tells you what is worth knowing.

The setting actually puts the participants in the position of pupils listening to their knowledgeable teacher. Under such conditions it is perhaps wiser not to ask too many questions but to listen and learn instead. This might be in accordance with a rationalistic attitude; you do not actually question scientific knowledge brought forth by knowledgeable persons. Their quietness might also be due to their coming from different areas of research and consequently they are very much focused on comprehending subject matter. However, during the two weeks the social talk among the students seemed to increase. This is of course self-evident in any occasion where people who do not know each other meet. It is a well-known fact that people who do not know each other very well do not want to appear ignorant. Still,

it remains to be proven if this trait is something pertaining technological institutions dealing with widely accepted relatively indisputable scientific knowledge or if it is an effect of the actual educational setting.

Conclusions

By common standards (even if not by mathematicians), the partial differential equations, must be considered a *specific* content and it is considered very demanding both by the course leader and the students. It is carefully sequenced and planned. The educational *content* tends to come into *focus* in quite a different way compared to the content in general schooling.

It should be noted, though, that the distance course was described as an example of experimental teaching. Thus the content from another perspective could be considered a general content, i.e. how to instruct in a distance education setup. However, the suppositions underlying the instructional design are not elaborated; they are more or less taken for granted. Moreover, it may be argued that when teaching a well-established content with inherent structure, educational methods tend to come second, whereas a content vaguely structured will require an explicit emphasis on educational methods.

Because of the dual focus of transmitting a specific content and of exploring the distance education issues, the categorizing of technology might fall into both an optional and an indigenous category. The choice of a distance education technology is optional i.e. the course could have been carried out in class. The interpretation of the indigenous category, however, is not just as easy. The doctoral students participating in the course are engineers, not mathematicians. Therefore they are primarily interested in a mathematical tool that they can apply as engineers. As one of the participants said: *"It would take a teacher a very long time to describe what's happening. But now the solution is just a few mouse clicks away!"* (p. 77). Thus, the technology will grant access to domains that might be beyond the students' present skills (see p. 26). In this case, the technology actually adds to the instruction and probably also to the students' understanding of the equations.

Compared to educational scenarios presented above (see p. 23 ff.), the distance education example is primarily an example of transmission even if it utilizes modern technology that would permit students to collaborate in a

studio scenario. The course leader even uses the words transmit (see p. 78). Using Koschmann's (1996) categorization of technologies, computer-assisted instruction (CAI) would be the closest characterization of the instruction when considering the fixed content. However, the course clearly has a collaborative focus (around a fixed content, though) more like the Logo-as-Latin paradigm (see p. 25 f.).

Summing up the study, one might ask: What are the main characteristics of the educational effort? Firstly, the course under scrutiny is a good example of dual mode education. Whereas the classes in which the lecturer is physically present very much resemble traditional lectures carried out with the help of some technical tools (hand calculators or the like), the far-off group benefits and is dependent of information technology. Thus, it is not possible to give an account of the value of this course based on the observations solely.

Secondly, in this course there is an unambiguous content of which the relevant aspects are indisputable and as a consequence it might be possible to transmit this knowledge. If, on the other hand, the content to be learnt were ambiguous (as in most cases) it would be very difficult to base the tutorial system on some logical order of subject matter. This course is a package, which the participants buy with a lot of personal effort. In return they might acquire the skills necessary for engineers.

Thirdly, the course – despite modern technology – represents a traditional approach to teaching. It is mainly based on an individualist and mentalist view of learning, a view often called in question today when collaboration is a keyword in educational research (cf. Koschmann et al., 2002). However, among the course objectives in this course there is an organized collaboration in newsgroups. The activity of submitting messages to other participants let the participants appropriate the newsgroups as a commonly used collaborative tool in a researcher practice. Viewed from the aspect of participation, the use of newsgroups can be seen as participation in a community of practice (see p. 33). Briefly, this means that participants do not just learn subject matter but also how to participate in practices where certain knowledge is used (see p. 32 f.). Through participating together with others in communities of practice one gradually appropriates what characterizes that community and finally becomes a full member.

Fourthly, the issue of individual versus social learning might also be viewed from Vygotsky's (1978) concept "*the zone of proximal development*" (abbr. ZPD), which contends that we learn together with other people who always know something that we do not yet know and in doing so we stretch beyond or individual capacity. Vygotsky used the phrase "more able peers" when the less knowledgeable learn from the more knowledgeable. However, this might also be interpreted as a case of instruction in which the tutor is the "more able" and therefore it may be wiser not to reject teaching based on lecturing as an outdated strategy (see also p. 28).

Fifthly, one might reflect upon the issue of physical presence in distance education. Is it possible for participants to benefit from working *with* the computer tools at their own pace (see p. 26)? The course observed has all the facilities that would make it possible not to attend classes. Still, the participants gather in a special room to hear lectures. However, participants cannot easily turn to a friend and ask a question without running the risk of disturbing the ongoing activity. Moreover, sighs, smiles, jokes, and body movements will be of little importance. On the other hand, the classes make the participants progress at a certain speed, something that might be difficult to accomplish on your own.

Finally, there are a number of pointers for future practice flagged up by this study. Some of the most important might be: a) The technological potential does not seem to be a problem but how should we best apply technology in relation to particpant characteristics and content requirements? In this case the technological facilities were quite advanced and expensive. Still, they severely hampered the participants' activities. On the other hand, the technology made it possible for the the participants to explore and manipulate the content in a way that had not been possible without it. b) If we believe that learning entails discursive dialogues among particpants and among participants and tutor, how do we promote such dialogues? Provided that the tutor agrees on the importance of such dialogues, it will not be a big problem when the students are few and capable. However, teaching many inexperienced students will constitute a major problem. It is evident that none of these two issues is new or even specific for this investigation. Still it is important to point out that not even a well planned course and a quite impressive technological setup could solve them. This is an important result from this study.

DISSEMINATING ICT IN EDUCATIONAL PRACTICE

INTRODUCTION TO INSTITUTIONAL DILEMMAS

Whereas higher education institutions normally have a relatively good infrastructure, the conditions of primary, secondary, and upper secondary institutions are quite varying. In many cases it is a burdensome effort for educational institutions with limited budgets to achieve an updated infrastructure, since it often requires expensive reconstructions. On the other hand, educational institutions are compared to other institutions with anticipated or proven success. Therefore to be updated is an issue of great significance for schools, which do not wish to be considered outdated or old-fashioned..

Even if the infrastructural requirements are quite concrete, the dilemmas relative to instruction and learning with technology are somewhat elusive. Here technological supply, teaching experience, public opinions, and educational research converge and the educational practitioner is confronted with a variety of demands; be it conflicting demands of self-managed individual learning or collaborative learning supported by computers just to mention some.

In sum, there are many sources of potential conflicts and dilemmas concerning the use of new tools in education. Institutions may experience dilemmas in rebuilding and competing with others. Solutions from comparable activities may be judged superior to what is familiar. Methods, be it problem-based-learning, information seeking, or whatever, may come in conflict with educational outcome, personal preferences, or the normal way of working within a community. The computer tool itself may also invoke dilemmas among individuals who feel incompetent, or completely disregarded by loud-voiced rhetoric.

Purpose and Research Focus

The ongoing and continuous activity in schools may be considered the normal activity. From such a viewpoint information- and communication technology (ICT) can be experienced as a kind of disturbance of common activities i.e. what above has been conceptualized as examples of communities of practice (see p. 33) or as activity systems (see p. 34 f.). Any disturbance will cause some kind of reaction in the activity system. Any change of the tools to be used in an activity will eventually lead to changed ways of carrying out the day-to-day activities. However, the character of these changes is difficult to anticipate. The most reasonable attitude to take when exploring potential changes is therefore to be attentive to how a practice develops instead of evaluating it with the intention of telling how it should develop if everybody had made the best decisions compared to some standards. The normative trait of this study therefore could be expressed: Do not be normative concerning educational development. Try to understand the processes of change.

The main purpose of the study is to contribute to a conceptual understanding of processes of change in educational practices, when new tools are introduced. Such an account requires theoretical models to make phenomena comprehensible. Therefore, this study will explore a theoretical framework with the capacity to conceptualize and explain processes of change in educational practices. Thus, the study may also contribute to an extension of the conceptual discourse of educational developmental processes. Particularly the study will:

Conceptualize processes of change by taking educational practices introducing ICT tools as an example.

Explore a framework for understanding encountered and potential dilemmas in changing practices by taking educational practices introducing ICT tools as an example.

METHOD

The methodology applied in this study corresponds with what has been described in the general methodology section (see p. 43 ff.). It resembles most the procedures described in the study "Making Sense in Class" above

(see p. 52 ff.). The participating schools are the same. Virtually the same data material has been used. However, the focus of the analyses in this case is the institutional activities.

Essentially, an ethnographic approach has been applied. A general characteristic of such analyses is the production of written documents most often based on observations, informal talk, interviews, audio recordings (also video), and/or document studies. Ethnography therefore is more of an interpretative endeavour in which reality is reconstructed using literary conventions than a neutral documentation (Atkinson, 1991; Beach, 1995). The ethnographical accounts of the activities of the eight schools presented below represent such interpretative reconstructions of developmental activities in the eight schools.

Any effort to give a detailed account of the cognitive work involved in a qualitative analysis is likely to fail since it is essentially inutitive. However, the steps carried out on the manual level can be described. Data, i.e. texts produced from field notes, informal talks, and documentation, were initially analyzed separately for each of the school settings. All texts belonging to a specific school setting were entered into Atlas/ti software (see p.48 ff.). There it was segmented, coded, memoed (see also p.47 ff.). The generic question: *what are these data about?* guided the process.

In subsequent analyses the material was analyzed in its entirety with a particular focus on emerging themes and concepts. Eventually a *core category* was chosen (Glaser, 1978). This is not to say that the category chosen was the only possible category. Interpreting as well as designing of artifacts entails trade-offs (see p.26). In this case the analysis trades in a variety of fuzzy details for a manageable category that summarizes the processes.

RESULTS

First, the ethnographical accounts of the different schools will be presented. Second, a meta-analysis of the accounts will be undertaken. Third, the generic concepts from the meta-analysis will be investigated within the structure of an activity system. Data for the schools are summarized in the table above (see p. 54).

Ethnographical accounts from eight schools

Each description below represents the most characteristic traits of each school. The accounts have been given a narrative style which means that the text type is essentially descriptive. Moreover the most distinguishing property of each school has been condensed into one phrase.

The endeavours of **East Gate Hill** upper secondary school have been condensed into the phrase *Focussing on breadth*. The two schools **Forest Ridge School** and **Flat Rock Elementary** are characterized by two opposing phrases: *He is IT personified in this school* and *Applying the tools of joviality and the rod of iron at the same time* respectively. *Founding ideas of change on brick and vision* characterizes **Burgher Senior High** and *Former grammar school turned into an Internet café*, characterizes **Chestnut Grove Comp**. In **Spring Creek Comp** *Optimism and empathy* is the most distinguishing traits. *Encountering IT with confidence* summarizes the processes in **Fox Dale Elementary**. Finally *Applying IT as the standard procedure* characterizes **Dockyard Elementary**.

East Gate Hill

"*Focussing on Breadth*"

The school is the starting point and further coordinator of thirteen national upper secondary programs located in the nearby surroundings. The school has 2250 students, a teaching staff of 191 persons, and 40 persons in administrative duties.

From the outside the oldest part of the school is a venerable multi-storeyed brick building. Over the wide entrance with its copper plated doors is written in gilded letters "Högre allmänt läroverk" (transl. state upper secondary grammar school). It gives a powerful unwavering impression dating back to a time when learning and knowledge was held in veneration. From another perspective a quite new annex can be seen.

The large coppper gates are divided into some smaller doors. One of these has a handle that is somewhat shiny. This door is probably used for normal entering and exiting. Just inside the gate a staircase in red and brown stone material leads to a landing with some information boards. It can be noticed that the physical education department has changing-rooms for "män och kvinnor" (transl. men and women). In Swedish this way of writing gives quite archaic connotations. From the landing runs a corridor with a grey

stone floor. The lower part of white walls are tiled in a yellowish-brown colour. The ceiling is white with with stucco works. The corridor is lit by common fluorescent tubes. On the floor there is a gob of spittle.

In the strategic plan for IT development the dissemination of competence to the whole staff is an important issue. Another goal is to give the students access to databases and other services that can be reached from the Internet. This goal should be viewed in the light of a pedagogical vision involving self-governed work, evaluation of information retrieved, and a cross disciplinary approach to school work. Likewise, giving equal opportunities for male and female students and establishing contacts with universities and comprehensive schools are viewed as important goals.

During the initial observations the IT dissemination work bears the stamp of the natural sciences. The natural sciences teachers have already quite long computer traditions. This impression is further strengthened in an interview with the upper secondary principal (also from the natural sciences). The strategic plan for the IT development describes with a remarkable frequency applications from the natural sciences. It should be noted, though, that the observer's contact is a teacher of mathematics and therfore the natural sciences staff are better represented in the initial observations.

Within the natural sciences, several IT applications are presented. In physics the computers are quite natural measuring devices. With the help of the program "Mätverkstaden" (trans. measuring laboratory) the characteristics of temperature in congealing stearin can be assessed. Information about phenomena in physics are regularly retrieved from the Internet. The spreadsheet software Excel is regularly used for students' accounts of their assignments.

In East Gate the students are given the opportunity to choose between Computer Science and Astronomy. In Astronomy a group of students participate in "Astronomy On-Line" and "Hands-On Universe" which both are international projects with particpants from all over the world.

The IT dissemination endeavour entails lots of work. The school is very big and generally the the IT development is not particularly advanced. The natural sciences staff treats the computer more or less as a common device for the day-to-day work, whereas staff groups representing other areas still

treat the computer as a strange artifact. The contact is convinced that the advantages will be apparent to anyone as soon as they have continuous Internet access and networked computers.

In the first phase of the IT-project at the school, attention is focused on the building of a physical network. Students from a vocational training program are given the opportunity to practice their future work supervised by a computer technician. Next the library will be equipped with computers for information retrieval.

The library changes during the observation period. Intially there are just two computers for CD-rom searches. Later, the library is equipped with several computers connected to the Internet. At the end of the observation period, there are four computers in the library, which can be used for information retrieval from the Internet. Besides, there are several old computers, which can be used for writing assignments. During the last observation period, Internet searches are common. The difficulties of doing intelligent searches is exemplified by a funny story in which some students doing assignments on Shakespeare's dramas entered the word "Hamlet" and happened to retrieve lots of information about a stallion namned Hamlet.

To be able to utilize the benefits of a networked environment, the staff needs to be trained. At the first observation, a survey to the staff is presented to the observer. The respondents had each been asked what kind of in-service IT training they considered most needed. During the spring of 97 a training program called "Nätverksutbildning vt 97" (transl. Network training of spring 97) is going on. The participants are grouped according to their prior knowledge. The observer has the opportunity to participate in a group consisting of teachers from the social sciences and teachers from the languages. The participants of this group were considered to be on the lowest level of knowledge at that time. As far as can be judged from the observation, some teachers have minimal computer skills.

The in-service-training takes place in a computer lab after normal work hours. The participants accomplish tasks from a self-instructing material made by the school's network technician. Competent students have been assigned the role of supervising their teachers.

During the entire project period some kind of training or repetition is going on. In the spring of 98 Internet access has been accomplished and the in-service-training is focused on Internet skills. A training session consisting of six occasions is scheduled. During the sessions, the participants will train Internet searches for texts and images, find useful links, evaluate sources, be informed of legal issues, train scanning, and take digital photos. The particpants should sign-up for those parts which they consider most valuable.

At the second visit the Social sciences teachers are observed. Initially that group was not particularly interested in computer work, but this situation is gradually changing. In the social sciences department there are five groups of computers each dedicated to History, Social sciences, Geography, and Religion. They have been placed in mobile units so that they can all be moved into one room if necessary. The teachers consider IT to be of great value to the social sciences. At the same time, they also point out that television, video, cable tv, and daily newspapers are important resources together with computers and CD-programs.

In the autumn of 97 the social siences teachers regularly use the computers. Now they can connect their mobile units to the Internet. Moreover, they can book the computers in the library. The teachers all mean that they have to take the lead and be ahead of the students. It is not a practicable strategy to forbid the use of ready made reports that students can retrieve from the Internet. Instead, these reports can be used and critcized as any other source cited in a report. The same applies to video and film. Perhaps these teachers represent an exception, still, they represent a constructive approach to what can neither be controlled nor concealed.

During subsequent periods, classes from different subject areas are visited. Within social sciences the teachers have found out how to utilize the ”Mediearkivet” (transl. the media archive). Some teachers of the English language showed how they used the Internet in a project focussing American poets. The Swedish language teachers showed how they utilized the Internet in their work with argumentative texts. A teacher of the Swedish language tells of a project labelled “Broar” (transl. bridges) which was accomplished with Internet support. At the last observation a new project aimed at establishing contacts between schools, universities, and business is presented.

The real specialists in IT production are found within the Media Program. Their products are quite different. One of the teachers tells that they are involved in a multi-disciplinary anti-drug project. The goal of the project is to change the attitudes to trying and using drugs. In the project, they have cooperated with Swedish language, History, English, Mathematics, Physical Education. Background material has been collected from the Internet, newspapers, books, radio, and television. The project has resulted in presentations of different modes: posters, newspapers, videos, radio programmes, and computer presentations. IT has kept the project together.

In sum, there is a characteristic focus on breadth at the school. This eventually leads up to IT becoming a valuable tool to more and more groups in the staff. Starting as a tool for experts of programming in computer sciences, IT has gradually become a valuable tool within many subjects at the school. The project management characterizes the whole dissemination endeavour as a systematic focus on breath without spectacular features. Many people have to be trained. Many people start from very limited skills. Transforming the school to an IT-school is a gigantic task.

Forest Ridge School

"He is IT personified in this school"

The school is located in a suburb to the north of the big city. The suburb has a comparably hight rate of immigrants. The housings in the school's catchment area consist mostly of semidetached houses and multi-storey buildings. The school was built in 1992. It consists of three parts, "houses", and in each of these houses there are four classrooms, which are the "home classrooms" of four classes. The teaching in each house is carried out by a work team, which handles most of the teaching for the classes located in the house. During the autumn of 94 a pavillion was built for pupils in grades 4-6. Approximately 50 teachers work at the school. The teaching staff is comparatively young.

"He is IT personified in this school!" is one of two utterances expressed by some teachers in the staff room at the first observation. The idea that one single person would personify the IT development in a school was expressed with a touch of humour. In his next sentence the teacher explained that individuals are associated with their interests be it

composting or something else. The second utterance, which was expressed by another person, "there is no IT strategy", had less of a humorous touch. Still, it might be highly interesting for the subsequent observations.

During the two year long observation period it gradually became apparent that the statement announcing that IT largely is the work of one man was not quite incorrect. The impression from the observations is that it might be true that school management rely too much in one person's work as to IT.

The fact that the person responsible for the computers is knowledgeable does not necessarily imply a positive IT development at the school. If one single person who is also a colleague should have the responsibility to take care of his fellow workers IT training and development, he must be extremely talented as to leadership skills and social relations.

In this school no one else but the IT contact person informs the observer. School management only occasionally show up. The contact walks the observer through different computer labs stating that the computer park needs replenishment and renewal. He articulates the fact that the school, which is a part of the entire school system of the big city, has been given reduced economic resources. Besides, computerization is not the only issue requiring resources.

In a little room, a former photographic dark room, the contact person has his own special room. It is decorated in a personal style. On the wall there is a banner showing support for one of the local football teams. Into this room he can go away and work in peace with the computers, it seems. He can also lock up expensive equipment. He informs the observer that there was not a total agreement that he should have this room at his disposal.

During the two years he repetedly returns to the issue that computerization in this school is dependent on him. He is in charge of the money, which is dedicated to computers. From his account it seems that he has a quite limited budget. The district board has to fight large deficits in the budget. On one occasion, when the school had managed to ge a certain surplus that might be used for computers, the district board had simply withdrawn the money. He summarizes his role as one of "being the spider in the web". However, it is not quite clear whether he likes to be such an important person or if he finds it burdensome.

Repetedly it is pointed out that the staff group is young. Thererfore many of the individuals are occupied with their own specialities. Many of them play in bands. The contact person describes the activities as being a bit “straggly”. He feels it is quite difficult to accomplish the task he has been given by the school management.

On most information occasions, no one from the rest of the staff is present; most often the contact talks to the oberver in a separate room. If this is because he wants to be undisturbed when he informs the observer or if there is another reason is not easily assessed. In fact, his talking strategies delimit the social contacts for the observer. It is quite difficult to get occasional chats with other persons if it is not decided in advance.

It seems that the decision to participate in the project is not supported generally among the teaching staff. One one occasion, a person says that someone from above has decided that the school participate in the project. Taking part in a project entails some publicity. This point of departure will certainly make the work of anyone responsible for IT development difficult to carry out, particularly if he/she is alone.

IT is normally not a characteristic of this school. Instead the school is well known for a well-developed teamwork involving collaborative planning and cross-disciplinary work. Many teachers participate in networks with other schools and they often host educational visits to their own school.

When the contact talks about the students (concerning IT), they are often treated as a problem generally. They often destroy the computers and therefore they cannot be left unattended. To diminish the effects of the destructive behaviour it has been judged necessary to glue together computer mice to prohibit the students to take the ball out and also to glue the keys on the keyboards not to let them change places or disappear. Recently some student had taken the memory cards out of a computer. Facing such problems, project management found it necessary to keep all computers behind locked doors. All this inevitably restricted the computer access and created a vicious circle.

At the end of the project period a couple of students are interviewed. They talk very negatively about the computers at the school. The computers are

old, often out of order, and they have only uninteresting software. At home, they have much better computers, they say. This might not be a unique conception of school computers; most students would probably say so. Computers are imbued with conceptions pertaining to time off school. Such conceptions do not necessary disqualify the school computers if they can be used to fulfill the goals of the school system. Admittedly, quite a lot of energy will be needed to make the students accept this fact, though.

The project leader who is responsible for the computerization says that he will not push the school to use the Internet. He wants everything to work smoothly until he will open up the systems (eg. letting everything be free). He says he is not willing to let his school mess things up. At the end of the observation period, after all, two computers in the library have Internet access.

A situation where the school has a restricted number of computers locked up in computer labs, moreover without Internet access and email, probably gives the students a feeling, that the computers are not worth their interest and, accordingly, they will not be careful either.

During the observation period, though, the library gets a librarian as well as a library assitent. They try to make the students get used to the fact that the library should not be treated as a pastime (which it used to be). The library staff set out to explore how they can regulate the access to the Internet. The librarian intends to list links appropriate for school tasks. However, she seems quite lonely.

Observing the school during this particular period, might not result in a true picture. At the first observation during the autumn of 96, the other computer responsible teacher starts her maternity leave. This fact has left the present contact person as the only person responsible for the IT development. Since he is the technician and she is the pedagogue, the team is left without a part of its original competence. It seems from the observations that the computer work has got a technical bias that might be unfamiliar to the common teacher, thus the seemingly slow development. However, there is no reason to blame the person who has to work alone with the IT issues.

Turning back to the two initial utterances, the male technician has probably been forced to take responsibility for the IT development. Thus, it might be a

correct observation that "he is IT personified in this school". The other utterance saying that there is no IT strategy at the school is somewhat difficult to comment upon. However, IT has left very few marks on the activities at the school.

Flat Rock Elementary

"*Applying the tools of joviality and the rod of iron at the same time*"

The school is situated in the countryside on a spot with beautiful scenery about 10 kilometres to the south of a small town in the west of Sweden. Most students get there by school bus. Grazing cows can be seen just outside the school grounds. The headmaster tells that the school location is a compromise between the local farmers; eventually it was decided that the school should be located within equal distances from most students' homes. Therefore, most children will come to school by bus. The school has 250 students ranging from preschool to the sixth grade.

In-service training is considered one of the most urgent efforts to implement IT successfully at the school. The account below will constitute an example of how the in-service training on a school is put into practice.

This school joined the project from the National Agency of Education during the spring of 96. However, the efforts to implement IT had started a long time before that. It is reasonable to say that it began during the autumn of 94. One of the teachers at the school, she is now the project leader, had the opportunity to use a computer in her classroom. After having attended a university course focussing the computer as an educational tool, she was given the mission to be in charge of the IT training at her school. During the first observation during the autumn of 96, the staff has already had several hours of in-service training.

From the very first observation it was evident that there was a combination of high spirits and purposefulness at the school. This will be illustrated by an example from the in-service training one afternoon when all students had been bussed home.

The headmaster receives the observer and offers coffee. After coffee all persons make for the classroom where the in-service training is going to take place. The room is prepared in advance, it is blacked out, and a video

projector projects a computer desktop on a white screen in the front of the classroom. A video projector is a rare commodity in schools but the project leader has borrowed it from the company where she has a part-time job. The participants take their seats positioned so that the screen can be seen.

Previously the headmaster had announced that he would be glad to keep the project leader at his school as long as possible. Unfortunately, many school practitioners with IT competence are quite interesting for the industry. It is a dilemma for schools generally that they cannot compete with the industy. Any competent person will get better paid by the industry than by the societal school system.

The training session begins with a call-over. The teachers who have chosen to participate in the afternoon training may substitute it for mandatory training during summer holidays. The female project leader is young, maybe not even thirty. Still she has authority enough to supervise colleagues with a much wider teaching experience.

She repeats what should be accomplished. She asks them if they found their tasks valuable. They give positive answers. They had been given the task to spend a fixed number of hours according to their own descisions trying to find out how to use the Internet in their work as educational practitioners. This afternoon they are all going to account for ther efforts.

Suddenly something surprising occurs; the headmaster interrupts the training session and produces two large bags with well known super market logos. He then distributes bananas and chocolate to everyone in the room. This gets everyone in high spirits.

The project leader takes the command again. Who wants to start? she asks. An elderly female teacher wants to say something. Well, she has spent lots of time trying to get famililar with the Internet but repetedly she encounters ”fatal error 500”! This is not a good situation when one wants to learn something. The session runs the risk of getting into a critical atmosphere. The headmaster comes to rescue by telling that there are negotiations with Telia (the big telephone company) and in the future it will most probably be much better. The project leader picks up the idea and succeeds in turning a potential outburst of disappointment into something positive. She declares that she is glad to find them disappointed since that will be an evidence of

that they actually care. Now she wants to get started with the individual accounts; in passing she blames them for not having sent her the emails that were agreed upon. Lack of time, or? They certainly have and they are not quite familiar with how to do it either. She will repeat how to send emails after the accounts. Now they must get started.

The first teacher has found something named KidPub. Her students have published some of their texts and they have also received answers from both the USA and Canada. It is great to see the eyes of the children getting answers, she claims. Suddenly there is a technical discussion coming up about Shockwave. Someone has found that an Internet site requires Shockwave to be installed. Someone thinks it could be stored on a floppy disk. Others pick up the thread and want to now how to download programs from the Internet. The project leader promises to show them after the training session.

In the next account a teacher tells how she happened to find a site called "Fråga vetenskapen" (transl. ask science). It is a site targeting mathematics and physics. Someone informs the audience that there is a site, "Skoldatanätet", (transl. School computer network), which provides such links under the headline "Fråga en expert" (transl. ask an expert). In this way they share their experiences and their knowledge in the group.

The woman who repetedly suffered from "fatal error" tells the others of a site targeting mathematics. It is about calculating the risks in business. Some children invested their savings in a small lemonade business. They were further supported by wheather forecasts. To succeed they needed to advertise. What must be bought? What would the weather be like? How much should be spent on advertising? The site had called up animated discussions in her class. The teacher judged the site valuable. How did she find it? Without hesitation she rattles off the entire search path. In passing she also bookmarks the site in the web browser.

The next participant demonstrates how to customize a didactic program called Lexia to one's intentions. Subsequent practitioners show how to construct a simple data base using one of Windows' accessories. Still another gives evidence of how she has got lost in the mathematics training program called Cheop's pyramid.

In this way the accounts go on in an exhilarated but still focussed manner. The project leader contributes by showing what her students have accomplished by using a program called KidPix. The presentation has moving pictures accompanied by the students' voices. The listeners are very interested.

When they are all done the project leader is going to show some tips and tricks with the email. Those who consider themselves proficient are allowed to leave. Only a few leave the room. She shows them how to cut and paste and save their emails, how to enter text into word processors, and how to create adress books and mailing lists. However, when she is going to show how to send a picture as an email attachment, the server is down.

The in-service training has been observed on two occasions. On both occasions it can be characterized by a humorous and at the same time a focussed attitude. At the very first observation, the warm atmosphere was noticed. The teaching staff consisting of women solely, was a mix of both very experienced and quite new teachers. The only male persons in this school are the headmaster, an ambulating teacher of handicraft, and some temporary workers.

The headmaster gave his consent to observing without restrictions. None of the teachers seems to have been embarrassed at having an observer taking notes and asking questions. Nobody would excuse herself for not having anything interesting to show. On the contrary, all gladly showed what they had accomplished even if it had no connection with IT.

From the first observation it was evident that all teachers should accomplish a minor project, alone or in collaboration. The procject leader had been given the task by the headmaster to plan, distribute tasks, and to put demands on the others. They should report to her when they were done and eventually they should account for their work in front of their colleagues.

A distinguishing trait of the in-service training is that it expects teachers to think for themselves. They need to be taught basic skills but it is up to each one to figure out how to use the skills in educational acitivites. When the teachers account for their work, the emphasis is on what they have accomplished in class. In the future it might be necessary to go on with the training without the present project leader. Thus, everyone is encouraged to

think for herself. On one occasion the observer asks the headmaster if the whole endeavour is dependent on one single person. No, he says, it seems that they are so interested that the risk for a reverse is minimal. Besides, the male handicraft teacher has started to take on the duty of assisting in the training of the colleagues. The headmaster gives a recent example from a session targeting photo manipulations. Smiling, he tells how fun it was to work with the scanner, the digital camera, and the photo manipulation software.

At the end of the project period the headmaster analyzes his activities. Probably, he says, the key to success is the humble attitude, the curiousity, and the lack of prestige in the staff group. It might be due to the fact that there are so many women. Nobody needs to prove she is better than anyone else. This is also in line with the project leader's comments from the first observation. When she was about to teach her colleagues she said: "Surely, I don't know everything. But we'll learn together!"

Writ large, the working factors of the development in this little countryside school seems to be a combinaton of joy, humility, curiosity, lack of prestige on the one side and on the other side there is purposefulness, structure, and demands. Taken together they yield a combination of joviality and purposefulness.

Burgher Senior High

"*Founding ideas of change on brick and visions*"
The other upper secondary school hosts a range of programs: the natural sciences, natural sciences/international, social sciences, social sciences/economics, and business and administration. Besides students can choose to study for the International Baccalaureate.

At the first observation during the autumn of 96 the school buildings consist of two main bodies in dark brick with a lower building in between. There is also a more recent annex attached to one of the main buildings.

The contact is constantly busy answering the telephone, seeing students, and signing papers. All this can be observed from a place outside his office. After some time he succeeds in getting some time to inform the observer undisturbed. He characterizes the ambitions at the school as a combination

of internationalization and IT. Several international projects (f.ex. Leonardo, Comenius) are going on. IT and international projects go hand in hand, he says.

The IT strategy is ambitious. The headmaster states that his school should be on the cutting edge as to IT in education. Moreover there is an ambition to develop education towards a problem based approach (PBL). To accomplish the goals, all teachers and students should be given opportunities to utilize networked communications. The necessary training can in most cases be carried out as in-service training while using their own resources. Presently, training for the European Computer Driving Licence (ECDL) is going on among the teaching staff. The project leader points to the fact that the school has got a full time technician which is a necessary prerequisite to manage a big network. Minor technical issues are dealt with by knowledgeable persons from the regular staff.

Initially the school has somewhat more than 200 networked computers with access to the Internet via the city network. This means that the school has not got a web server of their own. Most computers are placed in computer labs.

The Internet access is rather instable and has caused the teaching staff a lot of trouble. Thus, it has been judged too risky to rely solely on Internet access for lesson planning. When it actually works, it is rather slow. Also the email functions quite occasionally. As an example, emails tend to disappear without notice. A top priority for the future will be a faster and safer access to the Internet.

At the very first observation the blueprints for a coming reconstruction of the buildings are presented. In the new building there will be a library, classrooms, rooms for group activities, and plenty of computer terminals. The project leader announces that project- and group-work cannot easily be accomplished in traditional classrooms. He is convinced that the reconstruction will change educational work.

The idea for the new buildings is tightly coupled to a vision of changing the teaching into a cross-disciplinary PBL-based approach mediated by information technology. Originally, the notion of change can be derived from difficulties experienced in accomplishing the goals of upper secondary education using traditional educational approaches. School management

therefore has an ambition to develop education towards a problem based approach. Explicitly stated, the students should be self-governed, responsible, capable of collaboration, and have an interdisciplinary attitude. Eventually, they will be well prepared for future studies at the university or for working life.

A necessary prerequisite for a new way of working is teacher teams composed of teachers representing different subjects. These teams should plan and formulate the goals to attain in cooperation with students. The time table must be organized so that long periods of continuous work will be possible. This will also make the planning of computer access easier.

As Burgher Senior High is such a big school the access to computers will always be a problem. Anyone who occasionally needs a computer will find the computer labs occupied by someone else. Regularly it will be a problem for those who have not planned in advance, to occupy a computer lab with a whole class. The PBL approaches, therefore, can also be viewed as an effort to create a flexible use of computers. The new rooms will have computer terminals that can be used even if not booked in advance.

Actually, the management might be fortunate not to have all teachers using the computers in their daily practice. When asked if many teachers use the computers, a teacher answers that unfortunately only the interested teachers use the computers. This was also pointed out by some students in a conversation during a break. Generally, they were critical to the fact that computer use was dependent on the personal interest of each teacher. They considered the knowledge of computers absolutely necessary for their future work. This view was supported by examples from their trainee periods. The computer was used “all the time and for all tasks”, they said.

The school tries to direct the work towards the goals in the IT strategy. Some examples will follow below. Eventually a lengthy description of a PBL project will be given.

An Internet site for vocational- and study guidance, containing more than 2000 links, is managed by persons at the school. This site is nationally known and it is supported both by the National Agency for Education and the telephone company Telia.

Another example is a multi-media project within the social sciences. Some male students showed their project called the Vietnamn War. The deadline for the projects was due the same day and they were all intently focussed on completing their projects which was to be stored on an CD. Some careful students were worried that there work would not be good enough when they had to hand it in for CD-burning. Facing such conditions, they would rather not hand it in at all.

The teacher was quite satisfied with the students' work. He describes it as a kind of teamwork in which students help each other. In such a project the full potential of the Internet will be focussed, he says. The students search for facts, find images which can be further processed in computer programs, add sound, and write their own texts.

However, Internet searches might be quite difficult even for students in the upper secondary level. This was demonstrated by a student trying to find an American flag. The search took quite a long time even though he used what might be labelled intelligent search strategies.

Enthusiastically, one female language teacher shows how to use the computer for Italian language teaching. She describes herself as an elderly woman who will soon be retired. She tells about the difficulties for language teachers to get access to the computers in the computer labs. Therefore the language teachers have got a small computer lab of their own. In this computer lab there are eight computers.

The language teacher is eager to show a variety of programs which can be used to create tasks for students to take home on a floppy disc for further training. What she is most interested in, though, is the vision of creating a meeting place on the Internet for teachers who teach the less common languages. Via the National Agency project she has established a contact with another language teacher from another upper secondary school. Together they have contacted the National Agency to ask for further support of this issue.

The PBL approach in practice was demonstrated by a natural sciences class working thematically with heat. This was a collaboration project in Physics, Chemistry, the Swedish language, Computer science, and Technology. The project was initiated by a brainstorming session. The outcome was written

down on flipcharts and then taped onto the walls of the classroom. The scheduled time for the project was 5 weeks and it should result in a written report in which the contribution of each student must be evident. During Mondays the students could work without interruption from other subjects for a long continuous period. Moreover the entire Wednesday was dedicated to the project work. A necessary condition for this kind of work is that the different subjects pool their resources. When asked about their opinions, the students particularly mentioned the advantages of working for a coninuous period. Still, they felt it was a disadvantage when they had to stop in order to do something else.

Working teams were allowed to negotiate whether they would work together all the time or solve parts of the main issue individually. One of the tasks involved logging the work. Students could show their contributions on the walls so that teachers were able to monitor their progress. Eventually, individual contributions were to be compiled into a coherent report. An additional task involved planning and presenting experiments to the class. The entire project was asssessed and graded in a written examination which was presented to the students about a week before it was due.

During work shifts the students had the opportunity to use a computer lab. As an experiment they had also been given key cards so that they could enter the computer lab without asking for permission. It was remarkably calm and silent when students worked. Someone sipped a soft drink form a bottle, some sat on a table discussing something. When asked about time on task, a female student at the end of the class said that it was necessary to pull oneself together to get the work done. Quite a lot of writing has to be done at home, she said.

The students seem proud of their work. A male student even asks permission to show earlier work that he has accomplished in cooperation with a group. He browses the folders in his computer for some time and eventually he can show the winning entry of an environmental contest.

On one occasion the issue of teacher teams was discussed. The participants believe that teacher teams are rather uncommon in the upper secondary. This is due to the fact that they are all specialists in different subjects. They believe that compulsory school might have reached further as to working in teams.

After lunch the project work continues in the computer lab. A Mathematics teacher is available for answering students' questions. The students make their way up to him asking him to translate or explain texts from the Internet. They queue up to get their questions answered. He must not be afraid to be asked about almost anything and he cannot possibly answer all kinds of questions.

At the final observation during the spring of 98 there is just one week until the official opening of the new buildings. The contact demonstrates the beautiful and shining new creation. There is a library, places to work with computers without being forced to book months in advance. There are workstations, which can be booked and scheduled. There are common classrooms and group rooms. There are working places for teachers. Actually, all preconditions for a PBL approach are available. The new building is actually a concrete symbol for the development in this big upper secondary school.

Chestnut Grove Comp

"*Former grammar school turned into an internet café*"
All students in the municipality aged 13-16 years attend this school. The school has 475 students in all. The teaching staff consits of 45 persons and school management consists of 2 persons. Moreover, there is a janitor, office staff, cleaning staff, nursing staff, pupil assistants, a student hostess, and school lunch staff. The municipal school of music training is also located at the premises. The school has special classes for music and sports.

On one occasion there is great fuss; someone has succeeded in breaking into the school's network. Everyone with qualified access rights has been locked out from the network. The technician was very busy. Telephones were ringing all the time. This happened the week before a new network protection system was going to be installed.

The school is fortunate to have a skilled technician. Thus it is possible to act in a more relaxed manner towards the students, than if they had to wait for some remote technician every time someone breaks into the network. Now there will always be someone who is able to master the problem. Evidently,

it would not be possible to reach the technical level of this school with just technically interested teachers.

At this time, nothing seemed to have been damaged; it was just meant as a demonstration from someone who wanted to show off his/her skills. Actually, a certain admiration (even if reluctant) for the skillfull students could be observed.

At the time of the observation, the entirely new IT-café is demonstrated. On a previous occasion the head master of the school had described the plans which were now realized. The school building is an old multistorey building with long corridors. The oldest part is from 1939. At the end of the 60's an annex and a large sports- and swimming hall were built. During the 80's the school was restored again. Until 1972 the school was a grammar school. After that it was turned into a comprehensive school.

What the potential visitor to the IT-café first catches sight of is the school's logotype fitted into the floor and illuminated by a spotlight. Just to the right and behind a glass wall is the computer lab. Probably there is a good view of the activities in the computer lab from the IT-café. To the left, there is a cafeteria where the students and teachers can buy soft drinks, sandwiches, snacks, and coffee.

In the far end of the room is the library which is connected to the IT-café. The furniture is arranged in groups. There are desks and tables suitable for writing tasks as well as sofas and armchairs suitable for reading or just relaxing. Most groups of furniture are occupied by students talking, reading, or playing chess. There is no music playing; it is quite calm and silent.

In other places music can be heard. Since this is a school with an emphasis on music there is a lot of music in some corridors. On the second floor in one end of the building just outside of a music classroom there is a piano. At one observation, the students performed beautiful part-singing accompanied by guitar and piano.

Behind a waist-high wall, one can find approximately fifteen computers with Internet access. All computers are occupied; four of them are dedicated to female students in particular. No male students may use these computers wheras females may use all computers.

The permanent Internet connection has entailed a quite large non-recurrent expense. Besides there are monthly costs of about 6000-7000 SEK. However, some of the large costs have been cut by selling some services to others.

Other sources of income for the school are inter-municipal charges. Many students from other municipalities attend the school in order to specialize in sports or music. The normal catchment area is the surrounding farming district. The fact that most students come from rural districts also means that this school does not have many problems typical of urban areas. There are no big groups of immigrants either.

In the centre there is a large table, the teachers' table. Here the teachers have their coffee break in the same room as the students have their breaks. As seen from without, it might seem a bit uncommon to see teachers and students having their breaks together. In many schools students have their own space in which they more or less create their own (counter-)culture. In this school students and adults have breaks together. What will be the consequences of that?

The teachers are asked directly:
-Do the students like having the teachers around in their break?
- Ask them, someone says.
- How do you like the teachers having their break in the same room as you have?
A student from the seventh grade answers with a laugh:
- They do not disturb us! Maybe we are a bit more quiet!

Whether the teachers voluntarily have their breaks here or if they are expected to do so is not quite evident. In the old staff room two teachers sit alone. Do they sit here because they do not want to sit in the IT-café or do they prefer some privacy? Observing another part of the school it becomes evident that at least some teachers find it strange to walk through the entire building to the IT-café when they have already got a separate staff room for their working team.

The teachers of this school are organized into working teams. The head master of the school explains the idea behind the organization. Before the work started he visited schools in different parts of the country to study

their experiences of work teams. His idea was not to reconstruct the buildings at the cost of many millions and/or handpick his staff. His vision was to use the available resources as a point of departure.

The different working teams have become more or less self-governed. The teams are responsible for planning of education, economy, and scheduling. Only the time slots not handled by the working team are scheduled by the school management. Also the classrooms and staff working rooms are grouped together as far as possible for each working team. The team has a shared responsibility for its group of students. A mentoring system is substituted for the previous form teacher system. Thus each adult will be responsible for fewer students.

It is reasonable to imagine that the organizing of working teams will not be entirely without problems. At least it is reasonable to imgagine that there must have been some problems in the initial phases. In a report describing the working team organization the head master writes that those teachers who were formed by the old grammar school system had some difficulties in accepting the new comprehensive school. Since many teachers have recently retired most of the staff is 30-40 years of age. Due this fact, there was a chance to reorganize and to fulfil the requirements of the new National Curriculum. However, nobody shows any disappointment related to the working teams, at least not to the observer. Quite the contrary, the comments are rather positive.

The students have quite of lot of latitude at the computers, still no one seems to misbehave. However, some teachers intimate that there have been incidents. Occasionally students try to break into the network as described above but each incident will give new experiences to the staff in how to handle the situations. It seems the school has got the students on its side.

Some students in the top form were asked how they manage to handle their latitudes at the computers. Initially, everything had been locked up, they said, and they needed the teachers' permission to log on. At that time, it was a merit to make one's way through the obstacles. Now they have access to everything and accordingly they feel more responsible. As a rule, the one who downloads unsuitable material from the Internet is not in great repute with the others. However, the one who can design an impressive home page will be of great repute with the others. In order to encourage what the school

considers to be desired activities the management has announced a competition for the best home page. At present the first price is 500 SEK. They jury is composed of both teachers and students.

Students who have proven to be both knowledgeable and responsible have been given particular rights in a network administrator group. Together with such appointments come increased access rights to the network. Some of the tasks have involved the teaching of small children and senior citizens. The school also runs optional courses with technical content especially for female students and computer courses for mothers. The students involved noticed the big difference between the teaching children and senior citizens. The seniors were afraid of ruining something, whereas the children gladly practiced a trial and error approach.

The great popularity of the computer activities at the school was demonstrated the day before a particular teachers' seminar. At the teachers' table in the IT-café several students asked permission of the headmaster to be in school the next day even if it was a day off for the students. Do they really want to come to school when they have a day off? The headmaster was not surprised. During the last Easter holidays some students had been at the school gate at seven o'clock in the morning to be sure to get access to a computer.

Normally students will have the opportunity to stay in the IT-café for some time in the afternoon. Besides there is the "computer club" once a week which will give them the opportunity to stay in school to be engaged in their favourite activities.

After having made observations in the school the IT-café constitutes a natural meeting-point. Conjecturally, the students will also feel that. When being in the IT-café students are not controlled by anyone (which they are in most schools). No one is sitting on the table, no one is making noise, hardly no one is wearing a cap indoors. At the computers the concentration is total. Various activities are going on. Some play games, some surf the Internet, and some chat. It seems too intrusive to read what they write on their screens. At some computers they sit in pairs.

How do they manage to reach this state at the school? Why don't students pick the ball from the mouse, let the keys on the keyboard change places, or

download pornography from the Internet? Some students from the top form tell about a boy who had downloaded a pornographic picture. All the female students had gathered around him telling him off until he had blushed with embarrassment. On another occasion they had made a printout of the pornographic picture and sent it home to the parents. In spite of this it seems unlikely that the school has reached the cooperative spirit by repressive means. It rather seems as though the students know what is expected from them. Self-discipline is an often used word.

The school management is very explicit. The first impression of the headmaster comes from a press cutting from the local newspaper. In a picture the he is positioned in front of a locker containing tangled cables. There he declares to the reporter that from now on his school will be able to exchange information with the whole world.

At the first observation he shows the computer equipment at his school with a certain pride. Directly asked if all this equipment is thanks to him he points to inter-municipal charges and some other resources. He also claims that they have been successful in getting results by teaching each other. However, it seems unlikely that there would be such an up to date computer infrastructure in this rural district without someone leading the development in that direction. Conjecturally, the headmaster is a driving force. It is probably wise to be seen in the newspapers as well.

It might be risky to make statements about a school after having visited it just a few times. The image of the practice might be faulty. All teachers might not want to sit among their students during breaks. Notwithstanding the IT-café is real and most teachers and students actually sit there together even if it does not imply all. Not even all students are there. At least some of them make music somewhere else in the building.

Spring Creek Comp

"*Optimism and Empathy*"

The school is located in a municipality just outside of a big city. It is one of four schools in the municipality and the only one having the upper level of compulsory school (grades 7-9 in Sweden). Ever since 1994 they have focused on computer communication and Internet at this school.

At the beginning of this project the computer equipment consisted of some old stand-alone computers with one single modem connection to the Internet. At the end of the project period the school has an up to date machinery with permanent connection to the Internet. Moreover, they have one procjetor and a couple of mobile units which can be networked. Just outside of the computer lab there are four networked computers which can be used by the students when not in class.

At the very first observation the computer responsible person informed about how they had succeeded in carrying out quite inexpensive in-service training at the school. He also informed about the lively KidLink activities. He told about the enthusiasm necessary to run the Internet communication of the entire school by way of using diskettes and a single modem connection. At present, he said, the staff felt that they had been treated unfairly as to processing of project applications. However, positive descisions concerning the renewal of computer equipment was previously taken.

During the second year of the project period new machinery is installed and a network is built. The municipality has engaged a new computer coordinator who will divide his work among the schools in the municipality. Now, there is no feeling of dejection any more.

The coordinator demonstrates the server room at the school. It is just a matter of time, he says, until there will be Internet access from all computers in the network. Email, however, will come somewhat later. It is not hard to realize how important it must be to have a technically knowledgeable person to handle the equipment. In a school with a network a local "school technician" is necessary. Networked computers should probably not be managed by the ordinary teaching staff. A dedicated competence is needed. Evidently, the municipality has realized the role of technicians and at the end of the project period there is an additional technician at the school.

As to premises, changes occur during the period. Initially, a traditional computer lab is situated on the first floor. At the end of the project period the computer lab is integrated with the library into a resource center. In all of these rooms there are networked computers. In the library there is also a real librarian.

Even if most of the IT build up takes place in the computer lab/knowledge center, there are computers in other places as well. Languages, Natural sciences, and Swedish have each been supplied with mobile units. During the last period of the project also a Natural sciences lab will have computers installed. The network is ready and the computers are still in their packages ready to be installed. The teachers of natural sciences have been trained in using various programs.

Where does this equipment come from? Why all these computers? At the very first observation it was explained that this little municipality has a high rate of immigrants and a high level of unemployment. The contact informs that the municipality wants to give ample opportunities to disadvantaged students. Earlier the students from this school have often failed when reaching higher educational levels. Probably computerization might be one way of dealing with this problem.

In the resource center there are good opportunities for observing the students' work and for talking to to people working there. One of the teachers describes the computer activites at the school. It has been organized in such a way that there will always be someone from the staff in the computer lab. The students come here to accomplish various tasks. In practice this means that students come from various classes and with quite separate tasks to be accomplished. Lots of various tasks go on at the same time in the computer lab.

Despite the variety of tasks, the students are very concentrated. The staff on duty has seemingly no problems with order. However threre is quite a lot of students moving when needing help and support.

Letting the students work in the computer lab does not mean that they can just go there to get rid of work that they find boring. Anyone who enters the computer lab is expected to have a clearly defined task. Any task accomplished is entered into a binder. A quick glance in the binder shows that "Social sciences", "Home page", "Music", "Swedish", and "English" have a high frequency among the assignments carried out in the computer lab. On the other hand, "Natural sciences" and "Mathematics" are almost non-existent.

There are also rules for behaviour in the computer lab. Thus, students are expected to take off their caps and their outdoor clothes before they start working at the computers. CD-roms can be borrowed temporarily and after use they are locked up. The activites can be characterized as controlled as to routines and student behaviour.

On the other hand, the students are given the freedom to experiment and discover at the computers. One of the teachers explicitly states that students learn through freedom. Therefore it is important that the students try out their ideas in the computer lab. There is also an ambition among the teachers that computers should not solely be used for word processing but also for sound-, image-, and multimedia applications. The students should feel free to experiment, but in return an ethically acceptable behaviour is expected. There is an agreement at the school to deal with "acceptable things", says the informant.

Generally, there seems to be good relations among teachers and students. During work they talk in a relaxed and playful manner to each other. On no occasion during the observation period, disputes between teachers and students are observed. Neither has there been any arguing among students working at the computers. A distinguishing trait of this school is not treating the students as a problem.

The Internet is the trump card of the school. No home can possibly compete with a continuous access to the Internet. Computer work is therefore, like in many other schools, popular and a lot of students actually find it hard to leave school in the afternoon. At the moment, there is very little vandalism. One of the teachers explains that irrespective of the Internet it is dependent of which students they have at the school.

That students are trusted is demonstrated not only by giving them the freedom to experiment at the computers but also by putting four computers with Internet access at their disposal in the corridor outside the computer lab (providing that the rules mentioned above are followed). Every time the students in the corridor are observed they are totally absorbed by computer games via the network. At the last observation preparartions are made for a big Quake tournament in the computer lab during the weekend. The entire organization is run by the students and some teachers have promised to be

present and be responsible for the computer lab in their free time during the weekend.

The successful IT work has resulted in various external projects. One of these is a project in cooperation with the media centre of the municipality. Another project is run in cooperation with the local television channel. A cross-disciplinary project entailing the participation of teachers of Computer sciences and Media , Swedish, Social sciences, and Drama is in the planning stage.

During the last observation period the school participates in a project around the ”Öresundsbron (The Oresund Bridge, my translation). The project proved to be successful and therefore the consortium building the bridge contributed with some money to be used for purchasing IT equipment. During spring the school has been given the responsibility to create the official home page of the municipality. The students will work with this project supervised by a competent teacher.

At the very last observation the computer coordinator announces that the email server is now fully functional. During next school term the students will probably have their own email accounts. As an experiment, they have also tried to let students access the network from their home computers.

The IT development in this school is both dynamic and optimistic. It is carried out with a special focus on the disadvantaged groups in the community. The implicit image of school- and municipality management is positive. The work at this school might be characterized as a good example for other schools in municipalities with similar demography and labour market conditions.

Fox Dale Elementary

"*Encountering IT with confidence*"

The school consists of two buildings located some hundred metres apart. The students, who in some cases are grouped into mixed-age groups, are between 6 and 12 years of age. The school is located in a relatively new housing area that changed from a rural area into a suburbian residential area in the beginning of 1984. Lately, some blocks of flats have been built.

In the autumn of 97 there are 295 students at the school. They are grouped into six different classes with students in grades 1-3, six classes consisting of students in the grades 4-6, three preeschool groups, and four after-school recreations groups. The staff is divided into three working teams. Each team is composed of practitioners having different competencies. Each working team consisting of eight adult practitioners has the responsibility for approximately 100 students aged 6-12 years.

From observations and from reading of strategy documents it is evident that IT is not a priority area. From the very first observation it is evident that there is no romantic conception of IT as a means to changing everything. It seems that the staff is quite clear-sighted concerning the requirements of an educational practice. However, they are interested in how to handle information and therefore, they say, they want to learn how to use information technology and they need more and better equipment.

The teaching staff is quite experienced. They identify themselves as prior leaders of in-service training of groups in other schools. The observer is told that they used to run commerical courses focussing mixed-age approaches in education.

The information technology equipment at the school is remarkably sparse. The contact person has two computers in a room for group activities located between two classrooms. They are quite old and they do not have CD-players. At the first observation neither teachers nor students can be seen to use a computer. However, there is a pedagogical vision embracing the utilization of computers.

At a later observation, when groups from the teaching staff have had the opportunity to visit other schools, they gradually realized the advantages of these schools. They realized they were not given the technical possibilities they really needed at their own school. The municipality was not particularly interested, not even after the school had been choosen to participate in the National Agency project. At the school the staff felt they had to manage the computers themselves.

One of the few male teachers who was described as technically interested had to take care of the equipment. To be true, there was a full-time technician in another school in the area but his visits were considered too

few and far between to be of real value. One example of the difficult situation might be when the lightening had struck telephones and modems. In this case it took several months until they could use the equipment again.

The staff noticed the technical advantage of those schools they had visited. Their conclusion was: "many men and lots of technique". Still, even if the schools they had visited were technically their superiors they also noticed that they were not pedagogically ahead of their own school.

However, visits at other schools initiated new ideas. The teachers discussed among them what they had seen, what the others used the technology for, and how they could use IT in their own practice. All these discussions were held in a relaxed manner, many times with a humorous touch. On one occasion, after an in-service training session in town, they noticed with a slight touch of irony that all schools in the project except their own had a home page on the Internet.

Maybe, after all, they feel a certain pressure to get started up with computer use in their teaching since most students in the catchment area have computers at home. On many occasions students have to search for information and make printouts at home and then take them back to school. Many students complain about the miserable equipment they have in their school.

Not until the second year of the project Fox Dale succeeded in establishing a working Internet connection. Now the discussions focussed on where to put the single computer by which the Internet could be accessed. The first suggestion was in the teachers' staff room. Later the computer was placed in a room which was alternately used for eating lunch and for recreational activities. Some students demonstrated the procedures when going to this room to get their email.

There were no email accounts for the different classes not to speak of individual students. From an observer perspective the lack of email has been quite a problem since it has not been possible to be in contact with the school that way. To be true, there is an administrative network but that could not be used for regular communication with the school contact. Eventually, the contact could be reached by her private email.

During the spring some persons from the staff try to increase the number of computers at their school by turning to local businesses. As a consequence the school gets a number of older computers for free. During the autumn some persons from the staff group apply for a grant which later gives the school the opportunity to buy a digital camera, a scanner, and some educational computer programs.

In the autumn of the same year they are about to start a new IT project among the students in the middle grades. This project has been initiated by a person who is employed as a computer pedagogue. The project aims at changing the image of the town. They want to get rid of the media image of being hostile to immigrants. Media only report on negative events, they say. By using information technology and by meetings in real life they want to establish contacts between students from different parts of the town and between different ethnical groups. As soon as they have the necessary technical requirements the project will start.

In the spring of 98 the school has got email accounts. The headmaster shows the computer in the lunchroom/recreational room. The project has begun. The contact person and her students participate in a project called ”Future Kids” (my translation of ”Framtidsbarn”). She shows the home page of the project. At one observation she has just returned from an educational visit abroad. Vividly, she describes how the students in the school she had visited had very limited technical resources. Still, they seemed proud of their school. This might be considered an eye-opener as to a comparison of technical resources in Sweden and abroad, she contends.

At the end of the school year the project leader announces in an email to the observer that now they have Internet connections in all classrooms for their students in the “middle classes” and in one classroom for the “lower classes”. The email also says that parts of the staff have attended lectures, work-shops, and university courses targeting IT and pedagogy.

In sum, the school constitutes an interesting example of IT development. They started from a comparatively low level as to IT but with a wide educational experience. This made it possible to be influenced and to learn from technically more advanced schools without being neither seduced nor discouraged.

Dockyard Elementary

"*Applying IT as the standard procedure*"

The school applies a mixed-age grouping of students with emphasis on Montessori methods. At the premises there is a day-care center, a preschool, a compulsory school, and an after-school recreation centre. In all there are 350 students in the school; they are taught and are taken care or by 45 adults. The different units of the school have all names referring to shipping. The main building is a beautiful red wooden house. At first sight it does not look like a school at all. In the immediate surroundings there are nature areas, historically interesting buildings, and small industries. The sea is within walking distance.

Before this project began a lot of IT related work was going on at the school. From documents one can find out that the school is already a participant in another National Agency project and has taken part in national projects focussing History and writing skills. Therefore, they already have some experience from IT projects and a quite relaxed attitude as to IT can be noticed. The present observations will not make a great stir either. Conjecturally, this school has left the pioneering period behind and it now carries on with the expericences from earlier successful work.

Dockyard Elementary is situated in a area of the big city which without doubt, is well off part of the city. Unemployment is low, no ethnical conflicts stir the area. The school started in 1993 and at that time the computers were bought and the network installed. This brings both advantages and disadvantages.

It has certainly been an advantage to have early access to computers and therefore they are ahead of other comparable schools. They also had access to the Internet (by ISDN) from two connected computers quite early. Now they have two computers connected to the Internet in each classroom for students in the "middle grades" (10-13 years). The disadvantage is of course that the computers by now are quite old and need to be substituted. Some new programs, which they would like to use are not compatible with their old computers.

Viewed from the outside it appears that schools which are an integral part of the larger school system of a big city seem to have less freedom as to purchase and choice of equipment than the schools of smaller municipalities.

Notwithstanding, this school succeeds in getting eight computers from a company. These computers are placed in a computer lab so that it is possible to run training courses for groups of staff. At the end of the observation period a radio connection is substituted for the old ISDN connection. The school will also get a web server of its own. The hope that a planned change into a comprehensive school, teaching students from their first school year unto their ninth, will probably result in a technical improvement as well.

At the first observation, the contact mentioned that she was one in a group responsible for the computers. Besides, there is one person responsible for the computers in each working unit. She also said that most children have computers in their homes and therfore they are not particularly interested in the computers at school. Sometimes, she says with a smile, the children must be persuaded to try the Internet. But normally, she contends, they will get more interested as they grow older.

On one occasion she states that IT is not the only thing being important at this school. Other media are just as important. At the moment they are making a film with animated clay characters. A walk round the school also shows that the decoration of the school holds a high level of artistry. Students as well as professional artists have contributed to the decoration. At the end of the period, the students carry out a project about "Grease", the muscial. First of all, the muscial is performed in their own school but after they had succeeded in establishing a contact via the Internet they were given the opportunity to watch the musical being performed by professional actors in another town.

This school is normally most well known for its Montessori work with the students. A look at the time-table shows that there is quite a lot of time where the students actually have a choice of activities. This way of working fits in well with the computers, says the contact.

The main document for the IT strategy is a plan from June of 96. The goals are connected to student age. The starting point is the very handling of the computer which gradually change into programs for playing, drawing, and training. Next students should practice wordprocessing, CD-rom programs, and various multimedia programs. Eventually they will end up using spreadsheets, desktop publishing programs, and databases. In the plan there

is also the goal of enhancing computer access and computer literacy for all people involved.

The contact is responsible for the training. She repetedly assures that the training is optional for the staff. She also has the responsibility for the training of preschool teachers and other groups of staff. The training is carried out in a recently set up computer lab. The school has also given a suggestion to the teacher training institutions offering to help in the training of student teachers. The prospective teachers are amazingly ignorant of IT in education, she contends.

The impression after two years of observation in the school is that the computer activities seem established and quite natural. They are not particularly conspicuous; the equipment is rather common and not quite up to date; nobody engages in spectacular projects. Still, important and interesting work is going on. Conjecturally, when IT is integrated in a natural way it will not be particularly visible or spectacular.

Among the visions of the school, communication and exchange of experiences are viewed most important. Dockyard Elementary does not engage in large-scale visions. During the observation period some new communcation projects are initiated. One of these is accomplished with support from the European Union. The purpose is an exchange of experiences between European countries. Among other projects some classes participate in a project called "The Planet", designed for 6-10 year old students. "Koality Kids" is another project targeting the development of quality. It is run in cooperation between schools and business. Finally, there is also a pen-friend project between Nordic schools.

To sum up, the IT activity in this school is an integral part of the practice. It is not particularly conspicuous as in many schools for older students where students will be be pushing towards a more advanced use of technology. The development in this school is governed by a will to use IT as a means both adapted to and comprehensive for the student group. The school's participation in the present project can be viewed as a logical continuation of the efforts to communicate and exchange experiences with other schools.

Meta-analysis of Ethnographic School Accounts

The primary analyses, i.e. the narrative accounts, were eventually submitted to a meta-analysis with the aim of reaching a higher level of abstraction and thus obtaining a more generic result.

The meta-analysis resulted in five generic concepts representing social processes: *disseminating*, *involving* (staff), *reorganizing* (stucture), *caring and compensating*, and *confiding in competence*.

The meta-analysis was carried out in much the same way as the primary analysis. Essentially, the following procedures were employed: The narrative accounts were entered into the Atlas/ti software and the procedures of segmenting, coding, and memoing were repeted. In this case, however, the narrative accounts were not analyzed separately. Instead, generic concepts were sought across the accounts. However, this approach was only partially successful. In most cases the resulting concepts can be traced back to a specific school setting.

It should not be denied, though, that the concepts are more or less applicable across the settings. Thus, all schools are occupied with some kind of dissemination of ICT and the staffs have to be involved in one way or another. Nor should it be denied that competence often results in confidence. However, the actual rebuilding of schools are not to be found anywhere in the material; neither is the compensating of disadvantaged studens a pronounced focus in the settings generally. Thus these concepts are strongly connected to specific settings.

For reasons of clarity, even if concepts may be applicable across settings, they have been connected to the settings in which they are most evident in the table below (Table 2).

Table 2. Generic concepts connected to most typical occurrencies.

Concept	Phrase	School Setting
Disseminating	*Focussing on breadth*	East Gate Hill
Involving	*He is IT personified in this school*	Forest Ridge
Involving	*Applying the tools of joviality and the rod of iron at the same time*	Flat Rock Elementary
Reorganizing	*Founding ideas of change on brick and vision*	Burgher Senior High
Reorganizing	*Former grammar school turned into an Internet café,*	Chestnut Grove Comp
Caring and compensating	*Optimism and empathy*	Spring Creek Comp
Confiding in competence	*Encountering IT with confidence*	Fox Dale Elementary
Confiding in competence	*Applying IT as the standard procedure*	Dockyard Elementary

The concepts will be further elaborated below and illustrated by excerpts from the narrative accounts.

Disseminating

The disseminating category has four properties: training, access, reconstruction, and contexts. The aim is to make ICT a tool for all and not only for parts of the staff. The dissemination endeavour entails all groups of the staff. To accomplish the goals, programs for *training* have been set up. After ordinary classes, groups of the staff go to training sessions in the afternoon often led by competent students.

> The in-service-training is carried out in a computer lab at the end of the day. It is accomplished with the help of locally produced and self-instructive material grouped according to complexity. Proficient students supervise their teachers. Among the teachers, some have very little computer experience. (East Gate Hill).

> The training session begins with a call-over. The teachers who have chosen to participate in the afternoon training may substitute it for mandatory training in the summer holidays. (Flat Rock Elementary).

> The contact person (the observer's gate keeper) is responsible for the training. She repetedly assures that the training is optional for the staff. She also has the responsibility for the training of pre-school teachers and other groups of staff. The training is carried out in a recently set up computer lab. (Dockyard Elementary)

> Presently, training for the European Computer Driving Licence (ECDL) is going on among the staff. (Burgher Senior High).

The dissemination of ICT requires general *access* to ICT resources. Therefore infrastructural changes including both the construction of a physical network and the *reconstruction* of buildings are going on.

> In the first phase of the IT-project, attention is focussed on the building of a physical network. Students from a vocational training program are given the opportunity to practice their future work supervised by a computer technician. Next, the library will be equipped with computers for information retrieval. (East Gate Hill).

> To accomplish the goals all teachers and students should be given opportunities for networked communications. (Burgher Senior High).

> All computers in the school have Internet access. (Chestnut Grove Comp).

> At the end of the project period the school has an up to date machinery with permanent connection to the Internet. Moreover, they have one projector and a couple of mobile units which can be networked. (Spring Creek Comp).

> At the end of the school year the project leader announces in an email to the observer that now they have Internet connections in all classrooms for their students in the “middle classes” and in one classroom for the “lower classes”. (Fox Dale Elementary).

> At the very first observation, the blueprints for a coming reconstruction of the buildings are presented. In the new building there will be a library, classrooms, grouprooms, and plenty of computer terminals. The project leader announces that project- and group work cannot easily be accomplished in traditional classrooms. He is convinced that the reconstruction will change educational work. (Burgher Senior High).

> At the observation, the entirely new IT-café is demonstrated. (Chestnut Grove Comp).

> As to premises, changes occur during the period. Initially, a traditional computer lab is situated on the first floor. At the end of the project period the computer lab is integrated with the library into a resource center. (Spring Creek Comp).

The Internet access also gives opportunities to interact with new *contexts of practitioners,* other schools as well as universities.

> At the last observation, a new project focussed on establishing contacts between schools, universities, and business is presented. (East Gate Hill).

> Some of the tasks have involved the teaching of small children and senior citizens. The school also runs optional courses with technical content especially for female students and computer courses for mothers. (Chestnut Grove Comp).

> Regularly the students make documentary reports to be broadcasted via the local tv channels. (Spring Creek Comp).

> The contact person and her students participate in a project called ”Future Kids” (my translation of ”Framtidsbarn”). (Fox Dale Elementary).

> During the observation period some new communcation projects are initiated. One of these is accomplished with support from the European Union. The purpose is the exchange of experiences between European countries. (Dockyard Elementary).

Involving Staff

The involvement category has four properties: management, spirit, agreement, and trust. Schools usually appoint one person to be the *manager* of the implementation of ICT. However, this does not necessarily imply that the appointed person is the only person involved. A "one-man-show" in isolation from colleagues and with a narrow technical perspective should be contrasted to a tight collaboration and a user perspective.

> The fact that the person responsible for the computers is knowledgeable does not necessarily imply a positive IT development at the school generally. (Forest Ridge School).

> The female project leader is young, maybe not even thirty. Still she has authority enough to supervise colleagues with a much wider teaching experience. (Flat Rock Elementary).

> The school management is very explicit. The first impression of the headmaster comes from a press cutting from the local newspaper. In a picture, the headmaster is positioned in front of a locker containing tangled cables. There he declares to the reporter, that from now on his school will be able to exchange information with the whole world. (Chestnut Grove Comp).

Another property of involvement can be labelled *spirit.* The most conspicuous dimensions of spirit are joy and repugnance. The training of ICT skills in most cases requires work at late hours. The outcome of these training sessions is highly dependent upon the degree of cooperation from target groups. The combination of authority and humor seems to be the most successful option.

> It seems that the decision to participate in the project is not supported generally among the staff. One one occasion, a person says that someone from above has decided that the school participate in the project. (Forest Ridge School).

> Suddenly something surprising occurs; the headmaster interrupts the training session and produces two large bags with well known super market logos. Then, he distributes bananas and chocolate to everyone in the room. This gets everyone in high spirits. (Flat Rock Elementary).

> A distinguishing trait of this school is, not treating the students as a problem. (Spring Creek)

Involvement of staff is also dependent on *agreement*. Traditionally school practitioners are used to pursue their own interests. Therefore it is a challenge to school management to make staffs put ICT-issues as a first choice.

> Repetedly, it is pointed out that the staff group is young. Thererfore many of the individuals are occupied with their own specialities. Many of them play in bands. The contact person describes the activities to be at bit "straggly". He feels it is quite difficult to accomplish the task he has been given by school management. (Forest Ridge School).

> The impressions from two years of repeted observations of the IT development at the school, are that the use of IT in education is quite established and natural i.e. it is part of the everyday activities. (Dockyard Elementary).

Eventually *trust* is an important property of staff involvement. School management or project leaders can either monitor every step of the in-service- training or let individuals be responsible for their own training even if mandatory.

> The participants are given the opportunity to sign up for those parts of the training they need most. (East Gate Hill).

> A distinguishing trait of the in-service training is that it expects teachers to think for themselves. They need to be taught basic skills but it is up to each one to figure out how to use the skills in educational acitivites. (Flat Rock Elementary).

> Some people might feel obliged to start using computers, since most students have computers at home. (Fox Dale Elementary).

> She repetedly stresses that the in-service-training is optional. (Dockyard Elementary).

> The observer is told by the headmaster that the staff has been trained in using the Office programs. Presently, there is also training for the European Computer Driving License since the school's ambition is to be on the cutting edge of IT development. (Burgher Senior High).

Reorganizing Structure

The structural reorganization category has the following properties: physical resources, educational approaches, team building, and leadership. The most obvious property of structural reorganization is the reconstruction or renewal of *physical resources* which do not measure up to the new ideas. The

rebuilding concerns new or rebuilt houses as well as interior rebuilding. Physical rebuilding also entails changed social interaction patterns. On another level renewal of resources entails more and newer computers. The aim is to increase the ratio of computers to students. To this aim also technical support must be taken into consideration (see also *reconstruction* above).

> The library changes during the observation period. Intially, there are just two computers for CD-rom searches. Later, the library is equipped with several computers connected to the Internet. (East Gate Hill).

> In the new building there will be a library, classrooms, rooms for group activities, and plenty of computer terminals. The project leader announces that project- and group-work cannot easily be accomplished in traditional classrooms. (Burgher Senior High, see also above).

> The project leader points to the fact that the school has got a full-time technician which is a necessary prerequisite for the management of a big network. Minor technical issues are dealt with by knowledgeable persons from the regular staff. (Burgher Senior High).

> During the second year of the project period, new machinery is installed and a network is built. (Spring Creek Comp).

> During the spring, some persons from the staff try to increase the number of computers at their school by turning to local companies. As a consequence, the school gets a number of older computers for free. During the autumn, some persons from the staff group apply for a grant, which later gives the school the opportunity to buy a digital camera, a scanner, and some educational computer programs. (Fox Dale Elementary).

Educational approach is another property of restructuring. The new buildings are aimed at supporting project work that should be accomplished during long periods without traditional classes. This way of working requires that students can be trusted to use computers without being monitored by their teachers. The educational approach in favour requires a teacher role, in which traditional control cannot be upheld. Consequently, students as well as teachers must be involved and accept the new ways of working.

> School management has an ambition to develop education towards a problem based approach. Explicitly stated, the students should be self-governed, responsible, capable of collaboration, and get an interdisciplinary attitude. Eventually they will be well prepared for future studies at the university or for working life. (Burgher Senior High).

> The students are given freedom to experiment and discover at the computers. One of the teachers explicitly states that students learn through freedom. Therefore, it is important that the students try out their ideas in the computer lab. (Spring Creek Comp).

New ways of working also require *team building*. In most cases, teachers are grouped together in self-managed teams, thus taking on many tasks which were earlier accomplished by school management. The mandatory team work represents something new to many teachers.

> A necessary prerequisite for a new way of working is teacher teams composed of teachers representing different subjects. These teams should plan and formulate the goals to attain in cooperation with students. The time table must be organized so that long periods of continuous work will be possible. This will also make the planning of computer access easier. (Burgher Senior High).

> The different working teams have become self-governed as to their activities. The team is responsible for planning of education, economy, and scheduling. (Chestnut Grove Comp).

Finally, a visionary *leadership* is a recurrent property in the reorganization category. In most cases, school leaders have explicit plans, which they are prepared to force through. Accordingly, they are in control of the economical allocation issues.

> In the strategic plan for IT development, the dissemination of competence to the whole staff is an important issue. (East Gate Hill).

> At the end of the project period, the headmaster analyzes his activities. Probably, he says, the key to success is the humble spirit, the curiousity, and the lack of prestige in the staff group. (Flat Rock Elementary).

> The IT strategy is ambitious. The headmaster states that his school should be on the cutting edge as to IT in education. (Burgher Senior High).

> Since many teachers have recently retired most of the staff is 30-40 years of age. Due this fact, there was a chance to reorganize and to fulfil the requirements of the new National Curriculum. (Chestnut Grove Comp).

Caring and Compensating

The category is composed of three properties, visionary activities balanced by realistic day-to-day practice and the acknowledgement of infrastructural requirements. The *visionary* image of a school acknowledges student needs. It will give equal opportunities to all students irrespective of socio-economic status and ethnic origin,. Trust, responsibility, and an effort to give students meaningful tasks characterize the vision.

> The contact informs that the municipality wants to give ample opportunities to disadvantaged students. Earlier the students from this school have often failed when reaching higher educational levels. (Spring Creek Comp).

> That students are trusted is demonstrated not only by giving them the freedom to experiment at the computers but also by putting four computers with Internet access at their disposal in the corridor outside the computer lab. (Spring Creek Comp).

The balancing property, the *realistic* practice is realized by requiring that students accomplish goal directed work regulated by explicit rules.

> Letting the students work in the computer lab does not mean that they can just go there to get rid of work that they will find boring. Anyone who enters the computer lab is expected to have a clearly defined task. Any task accomplished is entered into a binder. (Spring Creek Comp).

> Nobody engages in spectacular projects. Still, important and interesting work is going on. Conjecturally, when IT is integrated in a natural way it will not be particularly visible or spectacular. (Dockyard Elementary).

> Recently some student had taken the memory cards out of a computer. Facing such problems, project management found it necessary to keep all computers behind locked doors. All this inevitably restricted the computer access and created a vicious circle. (Forest Ridge School).

The visionary image of education is further subject to *infrastructural* requirements. Therefore rearranging of available space into information centres or the like with adequate supply of technical resources and technical support must be made (see infrastructural examples above).

Confiding in Competence

The confidence category is supported by normality, identity, and outlook. To be confident as a consequence of existing competence requires that the very technology will not be the main thing. Shortage of computers, lack of technical support, and a gender biased (male dominated) domain will not upset the relaxed *identity* of a realistic and experienced practitioner when s/he approaches the somewhat unfamiliar field of educational technology.

> The staff noticed the technical advantage of those schools they had visited. Their conclusion was: “many men and lots of technique”. Still, even if the schools they had visited were technically their superiors they also noticed that they were not pedagogically ahead of their own school. (Fox Dale Elementary).

> Nobody would excuse herself for not having anything interesting to show. On the contrary, all have gladly shown whatever they have accomplished even if it had no connection with IT. (Flat Rock Elementary).

> The students seem proud of their work. A male student even asks permission to show earlier work that he has accomplished in cooperation with a group. He browses the folders in his computer for some time and eventually he can show the winning entry of an environmental contest. (Burgher Senior High).

The confident practitioner aims at integrated mature projects that can fit into the *normal* variety of activities instead of spectacular projects (see "realistic" above). Confidence will also constitute a platform for *outlook,* for crossing borders and learning from others.

> Several international projects (f.ex. Leonardo, Comenius) are going on. (Burgher Senior High).

> During the last observation period the school participates in a project around the "Öresundsbron. (The Oresund Bridge, my translation) (Spring Creek Comp).

> Among other projects some classes participate in a project called "The Planet", designed for 6-10 year old students. "Koality Kids" is another project targeting the development of quality. It is run in cooperation between schools and business. Finally, there is also a pen-friend project between Nordic schools. (Dockyard Elementary).

Below

(Figure 13) the ethnographic accounts, which occupy somewhat more than twenty pages, have been summarized into one graphical representation.

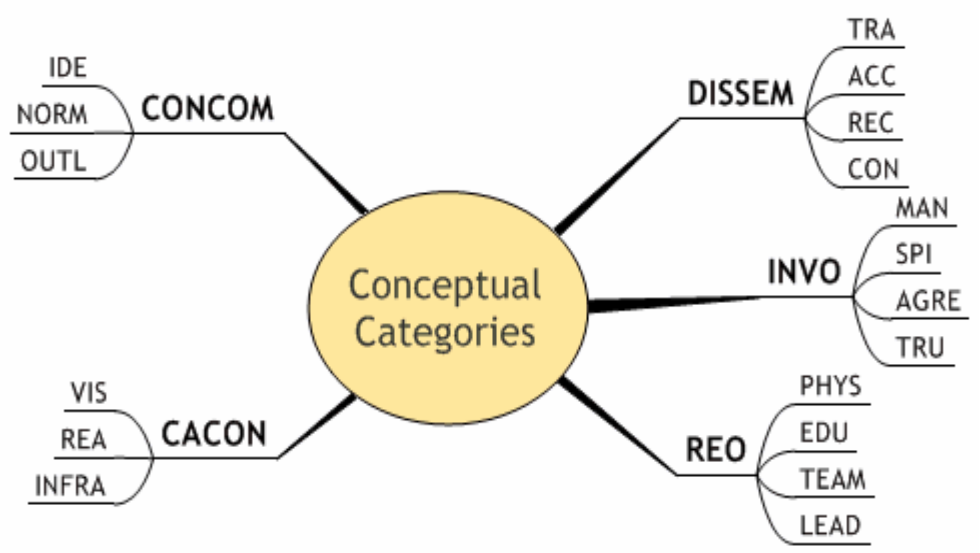

Figure 13. Conceptual categories describing the processes of ICT implementation of the eight schools in the study. DISSEM=dissemination with its properties TRA=training, ACC=access, REC=reconstruction, and CON=context; INVO=involving staff with its properties MAN=managing, SPI=spirit, AGRE=agreement, and TRU=trust; REO=reorganization with its properties PHYS=physical resources, EDU=educational approach, TEAM=team building, LEAD=visionary leadership; CACON=caring and confiding with its properties VIS=visionary pedagogy, REA=realistic practice, INFRA=infrastructural requirements; CONCOM=confidence in competence with its properties IDE=practitioner identity, NORM=normal pedagogy, OUTL=outlook and learning from others.

Disseminating as the Core Category

Whereas the conceptual categories above represent a continuing abstraction process of the ethnographical accounts from the different schools, the continued analysis below represents an effort to unify the entire conceptual material into one coherent framework.

Following the procedures of well-known approaches within interpretative analyses, the selection of a *core category* will create coherence among the concepts (cf. Glaser, 1978). For reasons of clarity, the core category can be likened to a title, which is the most general organizing unit of a coherent text. The choice of a core category is to a great extent an intuitive process. However, during intense work with the conceptual material the analyst will gradually get a sense for a reasonable core category. To give an idea of the factual process involving manipulation, conjecturing, comparing, and eventually deciding an intermediary example of the analysis process is depicted below (Figure 14). Such an analysis is to a great extent facilitated by modern computer software intended for mind mapping, which allows preliminary ideas to be entered, coloured, deleted, dragged around, and commented.

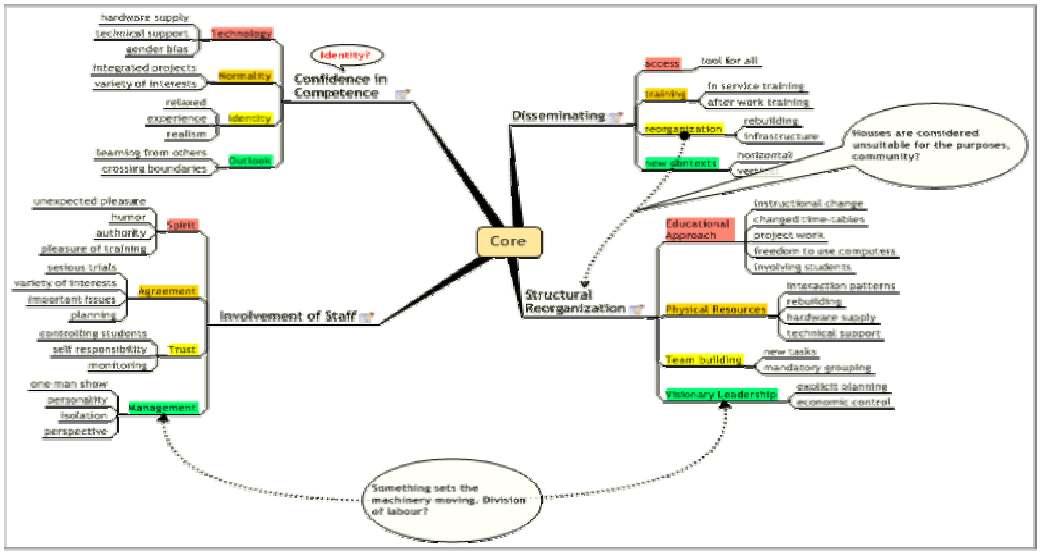

Figure 14. Mind mapping example

The core concept, *disseminating*, was found to unify the properties of *reorganizing*, *involving*, *caring*, and *confiding*, which are social processes. In this sense disseminating should be understood in its literal meaning. The word stem "*semin-*" is an integral part of *seminal*, *seminar*, and *seminary* which are all related to aspects of growing, literally as well as figuratively.

The concept of dissemination conveys the meaning of something that is growing as a consequence of action. Thus, dissemination denotes a deliberately initiated *process*. Eventually, disseminating is also in agreement with a common sense conception of the activities in the eight schools: after all they joined the project with the purpose of disseminating ICT in their respective settings (Figure 15).

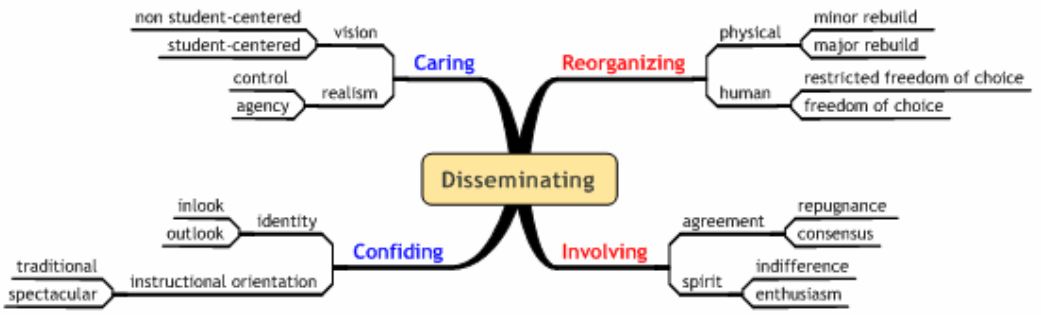

Figure 15. The core category, disseminating with its properties and dimensions.

However, reorganizing and involving can be labelled *basic social structural processes*, whereas caring and confiding are *basic social psychological processes*. In the case of basic social structural processes there is not much doubt that reorganizing and involving should be viewed as structural processes, which have beginnings and ends depending on the actions undertaken. Caring and confiding, though, might be viewed as normal psychological properties of human beings not necessarily labelled processes. However, in this context, they are treated as psychological processes dependent of the disseminating activities.

The reorganization category has the properties *physical* and *human* with their respective dimensions i.e. major rebuilding versus minor and major reorganization of staff versus minor respectively. The involving category has the properties of *agreement* and *spirit*. Agreement may vary from total consensus to repugnance. Spirit has the dimensions of enthusiasm and indifference. Caring has the properties of *vision* and *realism*. Whereas the property of realism takes on relatively obvious dimensions of responsibility versus rule governing (monitoring), the visionary property can not readily take on observable dimensions. However, the dimensions equality and student needs can be measured relative to their prominence in visionary planning. Finally, the confiding category has the properties of *identity* and

instructional orientation. Identity is predicated on dimensions of experience and scope of interests. Instructional orientation is predicated on dimensions of integration and structure i.e. what normally is labelled traditional or innovative work.

Taking the concept map above as the point of departure one might propose generic dissemination scenarios. Any one who is given the mandate of dealing with institutional processes in educational settings might consider *physical issues* (buildings, infrastructure), *social issues* (involving, participation), *pedagogical issues* (student relations, instructional orientation), and *psychological issues* (identity, engagement).

DISCUSSION

The approach undertaken managed to produce concepts describing the processes of the investigated practices. Each theoretical concept is grounded in observable phenomena. For instance, the reorganization concept above is grounded on physical and human properties which in their turn are predicated on observable dimensions of rebuilding and degrees of freedom of choice in everyday practice respectively. The latter dimensions will influence the day-to-day practice of subjects to a great extent and thus they will be potential causes of dilemmas and conflicts but also the necessary conditions for change. Writ large, the analyses so far can be viewed as sensitizing procedures i.e. they all contribute to an evolving capacity to see and conceptualize what is going on in practice. Actually, what cannot be conceptualized neither can be communicated.

However, the purpose of the study also entailed exploring a framework for understanding encountered or potential dilemmas in educational practices and contributing to an extension of the conceptual discourse of educational developmental processes. Accordingly, the categories presented above will only fulfill the purpose partially. Besides, even if the categories are well grounded in empirical findings they might invoke a "so what" attitude if presented as the result of the study. Therefore, one way of enhancing the applicability of concepts as well as of exploring a theoretical framework, thus also contributing to an extension of the discourse of educational practices, would be to relate the findings of this study to an existing theoretical framework.

By way of assigning concepts to functions within an activity system (see p. 34 ff.), they will also be charged with potential power in relation to each other. Such an activity theoretical exploration would be methodological i.e it would contribute to the overall body of knowledge of how to analyze changing educational settings.

Dissemination as Human Activity

An activity theory framework is above all suitable for analysis of workplace processes as exemplified by studies of medical staffs (cf. Cole & Engeström, 1993) and by the study of fighter pilot training in the last study of this thesis (see p. 146 ff.). As a first step in the AT analysis, the categories and their substantive dimensions will be compared to the AT framework. In a second step, we will focus on separate parts representing different functions of an activity system and then hypothetically investigate what characterizes each subsystem.

Putting Things in Place

An AT analysis would logically take the transformation of an *object* as a point of departure since no meaningful activity exists without an object. In this case, the object is multifaceted. Materially, *enhanced hardware access* and technical support are properties of the object. Socially, the object might be to *achieve consensus on common objectives*. Ideationally, the object can be described as an aim for *project- and self-determined work*. The three objects will be labelled *acess*, *objectives*, and *project work* in the figure below.

The transformation of object(s) of the activity has anticipated *outcomes* that eventually will be accomplished by the activity. However, there is never a one-to-one relationship between object and outcome in any human activity. Put differently, what will lead up to an agreed upon outcome will always be subject to negotiation. Generally, outcomes are expressed visionary in such a way that most people would not argue against them. On the most far-reaching level, students should become skilful, active, and responsible *citizens* and no one will argue against that. On a somewhat tangible level, schools should *compensate* for societal inequity; staffs should feel comfortable in *crossing borders* to get an outlook and learn from others.

To accomplish anything in the first place there needs to be a *subject*. In this case the subject may as well be plural or a collective subject. The activity of disseminating ICT in the activity system is accomplished by the *ensemble of participants*. For analytical reasons one might speak of teachers, students, technicians, project leaders, and headmasters. The caring and confiding categories above will be of crucial importance for the subject node of the activity system. Here conceptions of teaching practices as well as of student relations converge. The subjects' *identity* and educational *experience* are put to tests.

The third component of Vygotsky's original depiction of tool-mediated activity is constituted by *tools*. The realization of visions by explicit and focused *leadership* work on the most general level concerning planning and allocation of economical resources but also strategies of trust or monitoring are important tools. The *reorganization* of physical resources (buildings and infrastructure) may also be viewed as tools or strategies. On the staff level, the grouping into new working units as well as the tangible *training* sessions after work are also tools for accomplishing the object. The concepts of reorganizing and involving above can be considered as tools.

No man is an island, not even a teacher. The *community* of practitioners is composed of individuals characterized as subject above. Here a variety of *interests* and interaction *patterns* intersect. Practitioners in day-to-day activities are assigned to *typologies* concerning authority, humour and tasks – not to mention gender issues. The *rules* of a workplace can be considered to be constituted by the normal ways of handling day-to-day practice. The activity of disseminating ICT, though, entails *new tasks* and *new* – often mandatory – *grouping* of staff. In the school setting the participant needs to adapt to (and benefit from) the culturally produced rules which regulate the relationship and interactions between individuals who are oriented towards an object.

One of the most obvious properties concerning *division of labour* is the *assignment of tasks*, whether the dissemination is carried out as a one-man-show or if it is a matter of common interest. Problems pertaining to the appointment of single persons are alienation and perspectives not commonly accepted. Another property of division of labour is the *allocation of time*. Normally practitioners already work full time and therefore the

dissemination endeavours might be carried out either by trading in normal work for training or by requiring additional work.

An overview of the dissemination concepts as an acitivity system is depicted below (Figure 16). It will be followed by a brief exemplification which is not intended as substantive analysis. A serious effort to tie the activity system to the empirical material is made in the following section called "Conjectural Investigations of Sub-Systems".

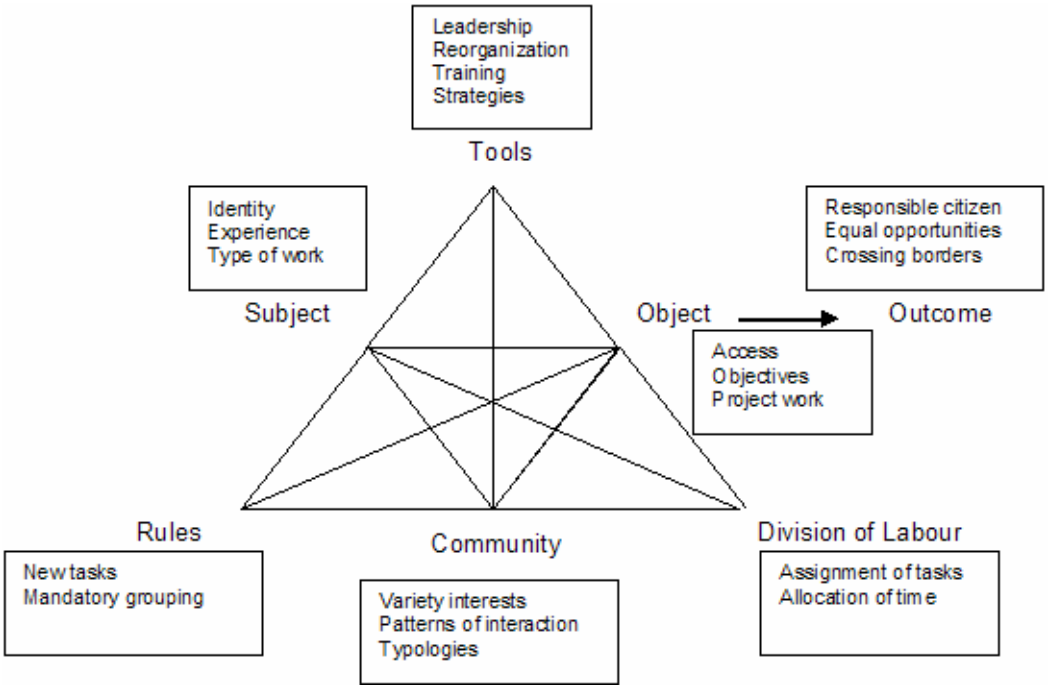

Figure 16. Concepts of disseminating shown as an activity system

A distinguishing characterstic of AT analyses is the capacity of identifying dilemmas and conflicts on different levels in the activity system (see p. 37 f.). As mentioned above, first level dilemmas occur within a single node (subject, rules, object etc). A few examples will clarify this.

In the subject node the practitioners' identity might be dilemmatic as a consequence of new demands. It is also not difficult to a anticipate dilemmas as to mandatory grouping or late afternoon work.

Second level dilemmas will arise between nodes in the activity system. Very conspicuous in the empirical material is the variety of interests within certain communities when compared to objects of education. In case project work is not of prime interest within a community of practitioners or among individual subjects, a severe dilemma might arise. Also reorganizing strategies might be considered counterproductive to educational objectives.

Third level dilemmas arise between an object which is considered superior to the one in the old activity. The concept might be applied to educational methods generally. In this case, there is a strong ambition to apply a problem-based-learning approach, which is considered the method to be introduced. This means that the practitioners should substitute this method for the ones they are familiar with.

Eventually, fourth level dilemmas arise out of comparison with other schools. Today, when schools more or less are actants in a market, comparisons with other institutions have become necessary. If a school (at least in densly populated areas) gets a reputation for having better teachers, better outcomes, better computers, and generally better visions this will be utterly important for attracting new students.

Conjectural Investigations of Sub-Systems

For analytical reasons the four subtriangles of the activity system representation could metaphorically be viewed as geographical spaces from which very different perspectives will become apparent (see p. 36 f.). Even if no activity can be accomplished in real life without taking the entire activity system into consideration, it might be a revealing endeavour to see what becomes visible when separate parts of the system are in focus.

From within the *consumption* triangle only the subject, community, and object nodes will be visible. Notably, the object will give direction to a conjectured activity. Any actor located here will be occupied with arriving at an agreement with the community on the object of the activity. It will not be sufficient if an actor alone wants to decide upon the object. Any one-man-

show is likely to evoke protests from the community. The only sustainable solution to strive towards will be an unanimous decision. In case of disagreement much of the the energy will be spent on that. Conjecturally, the consumption triangle have a slight resemblance to school settings which are mainly occupied with agreeing upon objects without really considering how to accomplish the object i.e. by what means?, when?, how?, or who will do what?

Giving empirical examples of theoretical concepts is a risky endeavour since theoretical concepts generally support cognitive activities instead of direct empirical mapping. Bearing in mind that there will never be a one-to-one correspondence between theoretical concepts and empirical events some examples from the empirical material presented in this study might be conjectured. The following might be examples from the consumption triangle:

> Repetedly it is pointed out that the staff group is young. Thererfore many of the individuals are occupied with their own specialities. Many of them play in bands. The contact person describes the activities as being a bit "straggly". He feels it is quite difficult to accomplish the task he has been given by school management (Forest Ridge School).

> A distinguishing trait of this school is not treating the students as a problem (Spring Creek)

In the first example the relation between subject and community is problematic. Neither seems there to be an agreement on the objective. In the second example there seems to be agreement among individuals as well as to object.

From within the *production* triangle the subject is the judge of object orientation. Implicitly, no negotiation between individuals is anticipated. No arguing about the object will take place and what object to direct activity towards will be what the subject alone decides. What might vary are the mediating tools suitable for the activity oriented towards the object. Experimentation in search of the most effective tool might be undertaken. However, no surrounding community concerning the choice or handling of tools are taken into account. On the other hand, no one will cause troubles depending on a different opinion. A view from this perspective also makes clear that the use of tools without object orientation will be without meaning i.e. learning a computer program for the sake of learning will be a waste of

time. Conjecturally, this is the realm of school reformers and eager project leaders. Some examples might illuminate the conjectures:

> The school management is very explicit. The first impression of the headmaster comes from a press cutting from the local newspaper. In a picture the he is positioned in front of a locker containing tangled cables. There he declares to the reporter that from now on his school will be able to exchange information with the whole world. (Chestnut Grove Comp).

> The IT strategy is ambitious. The headmaster states that his school should be on the cutting edge as to IT in education (Burgher Senior High).

Typically, these examples involves strong leaders with a vision to accomplish an object. They are also prepared to take the steps necessary to accomplish their visions. In the chosen examples, the community is quite absent. In practice, however, this does not necessarily mean that the management rides roughshod over others' opinions.

Being the inhabitants of the *exchange* triangle appears to be a dreary business. Subject and community will have to negotiate the rules, but rules for what? The exchange location will be bereft of direction since no object can be seen from there. However, negotiations of work place regulations generally can be undertaken. In the worst of cases general dissatisfaction may be given rise to. Conjecturally, trade union representatives might be interested in inhabiting the exchange triangle. Some conjectures from the empirical material is suggested below:

> The in-service-training is carried out in a computer lab at the end of the day. It is accomplished with the help of locally produced and self-instructive material grouped according to complexity. Proficient students supervise their teachers. Among the teachers some have very little computer experience (East Gate Hill).

> The different working teams have become more or less self-governed. The teams are responsible for planning of education, economy, and scheduling. (Chestnut Grove Comp).

The examples above point to the way rules of the workplace influence activities. Whereas the first example entailing work late in the afternoon more or less can be connected to the IT activities, the latter can be charaterized by a contemporary trend in educational settings; it has no direct connection to the IT activities. Conjecturally, the exchange triangle will appear in quite varied shapes depending on its inhabitators. For the military staff described in the next study (see p. 146) ordered instructions will not be

a problem since it is indigenous to the normal work whereas school staffs in most cases want to negotiate the rules of work (as well as the objectives of the activity).

The *distribution* triangle, finally, will be guided by the object. Most of the energy will be spent on issues of dividing labour. Who will do what? Who can avoid working late in the afternoon? Who will be most suitable when it comes to accomplishing the object? Who should work with whom? Also issues of resources might arise. To accomplish a task, more people may be needed. Some other tasks might be inhibited. The kind of questions put forth will depend to a great extent on the community's approval of the object. An approved of object, is likely to evoke constructive solutions. Individuals might deliberately reschedule their time-tables out of pure interest, whereas a disapproved of object is likely to evoke resistance and efforts to escape the disliked tasks.

The division of labour in the empirical material of this study is most evident as to project leadership:

> The contact person (the observer's gate keeper) is responsible for the training. She repetedly assures that the training is optional for the staff. She also has the responsibility for the training of pre-school teachers and other groups of staff. The training is carried out in a recently set up computer lab (Dockyard Elementary)

> The fact that the person responsible for the computers is knowledgeable does not necessarily imply a positive IT development at the school generally (Forest Ridge School).

But labour can also be divided "within the project" between colleagues or between students and their teachers:

> From the first observation it was evident that all teachers should accomplish a minor project, alone or in collaboration. Eventually, the project should give an account of the project before their colleagues (Flat Rock Elementary).

> Proficient students supervise their teachers. Among the teachers some have very little computer experience (East Gate Hill).

> In the first phase of the IT-project at the school attention is focussed on the building of a physical network. Students from a suitable vocational training program are given the opportunity to practice their future work supervised by a computer technician. Next the library will be equipped with computers for information retrieval (East Gate Hill).

To repeat, the exploration above should be treated as a pure analytical endeavour since no subtriangles can exist without the main triangle i.e. the activity system constituting object-oriented activity. However, the exercise of temporarily focussing the subtriangles in turn might point to issues in a more distinct way similar to what would be revealed when pointing a torch to different objects in a sparely lit room. Most important, however, would be the insight that an integration of subsystems will be necessary for the comprehension of human activity.

Concluding remarks

The study focuses on systemic dilemmas of introducing educational technology in educational practices. The choice of technology in the various school settings might be considered optional. Some of the settings focus the entire system, reconstructing buildings as well as technological infrastructure, whereas others limit their efforts to staff training and/or use of didactical software.

Whether technology is necessary or not for the schools might be subject to the same arguments as in Making Sense of ICT in Class (see p. 52); efforts of increasing the ICT competence in the educational organization generally cannot be considered optional. Accordingly, it will also be necessary.

Actually, the tension between old and new practice which was conceptualized in *Making Sense of ICT in Class* (see p. 52) can also be recognized on the systemic level. *Disseminating ICT in Educational Practice* represents tensions between different systems as well as tensions within the systems viewed as activity systems. In stretching the tension issue to the limit the two studies can be said to represent the tension between a somewhat *conservative classroom practice and more innovative institutional efforts*.

The concepts presented in this study make possible the focus on crucial aspects of changing educational practices. They also contribute to widened and new ways of viewing changing educational practices. The integration of the concepts into an established theoretical framework not only strengthens their validity but also indicate that reformation of educational practices is a systemic endeavour; it can never be accomplished by merely supplying tools, by rescheduling time-tables, by forming of selfmanaged teams, by

positing educational goals, or by appointing visionary leaders. Accordingly, a combination of all these factors will always be necessary.

CONDITIONS OF LEARNING IN FIGHTER PILOT TRAINING

INTRODUCTION

The prestigious JAS 39 Gripen system with its cutting edge military technology puts great demands on those who are going to handle it. Even if experienced pilots witness that the plane itself is extremely easy to fly and enables an exceptional situational awareness the entire system is also considered tremendously demanding as to the multi-role concept (http://www.f7.mil.se/article.php?id=869).

The Swedish Air Force has quite wide and successful experiences of pilot training. A report from the Swedish National Defense College (cited in Försvardepartementet, 2000) shows that the educational system of the Swedish Air Force is very efficient compared internationally. It is concluded that the efficiency is largely due to the educational philosophy permeating the Swedish fighter pilot training.

A fundamental aspect of military pilot training is that it is an integrated part of the training to be an air force officer. Therefore all skilled air force officers on regular duty at their home wings not only have the duty of training and maintaining their own skills as pilots but also have the role as instructors for new officers. It can be concluded that air force officers from the very beginning of their careers are trained to be pilots as well as pilot instructors.

It is evident, that the necessity for high quality pilot training is of great importance for the safety of all people involved in the project. Furthermore, the Swedish government anticipates that there will be good opportunities to exporting the JAS 39 Gripen to air forces in other countries. This will put demands on both the capacity and the skills to train pilots from the buying countries. Therefore the government emphasizes that the quality as well as the necessary capacity of pilot training training must be given high priority.

Eventually, a high quality might be valuable in the negotiations of a future joint European pilot training program.

Military Pilot Training in Sweden

After learning what might be labelled general officer content during the first 12 months the air force officer starts his flight training, which is built up of several phases targeting specific skills. In its entirety an air force officer training program takes approximately four and a half years.

The initial phase of military pilot training consists of two phases going on for 12 months each, *GFU*[4] (translated: Basic Flight Training) and *GTU* (translated: Basic Tactical Training). During these two phases the learners fly the SK 60, a jet plane particularly suited for learning. It should be noticed that military pilot training is entirely carried out using jet planes ever since the middle of the 80s.

The subsequent two phases of training are located at the wing F7 in Såtenäs where this study is carried out. First, there is a 6 months long phase called *TIS* (translated: Type Training Phase). This is the phase in which the pilots learn to handle the JAS 39 Gripen concept for the first time. However, the pilots of this study doing their TIS are already expericenced from other heavy fighter aircrafts (i.e. Draken and Viggen), thus they are far from beginners. The TIS is followed and combined with the *GFSU* phase (translated: Basic Aircraft Type Training), which lasts for approximately 18-22 months. In this phase the pilots learn to use the entire Gripen system including advanced flying, handling of information- and weapon systems, and combat exercises. After that period the pilots normally return to their original wings for the *FFSU* phase, which is equivalent to their continued activity as fighter pilots in which they gradually increase and maintain the skills necessary to be a Gripen pilot.

When the pilot has passed 40 years of age he will gradually be involved in other duties. Managerial tasks combined with less flying are common. Some Gripen pilots will go on flying Helicopters or Transport aircrafts. However,

[4] In Swedish the abbreviations mean: GFU-grundläggande flygutbildning; GTU-grundläggande taktisk utbildning; TIS-typinflygningsskede; GFSU-grundläggande flygslagsutbildning; FFSU-fortsatt flygslagsutbildning.

the change is to some degree dependent on individual characteristics (http://www.rekryc.mil.se/article.php?id=8388).

Purpose and Delimitation of the Study

The wing F7 is the first Gripen wing in the Swedish Air Force. It has been given the responsibility for the training of all Gripen pilots in the air force. Therefore, the participants of the present retraining events in this investigation must not just appropriate a new air force system; they also must learn to be instructors for other experienced pilots as well as novice pilots in the future. Eventually, all pilots who successfully have appropriated the entire JAS concept should be able to instruct others.

As mentioned above, being an air force officer entails a dual function. Therefore, among the participants in the present retraining sessions all have previous experiences of being learners as well as instructors. These experiences have laid the ground for individual conceptions of norms and values concerning the identity of an air force officer and of an air force flying instructor.

Above (in Disseminating ICT in Educational Practice, see p. 88 ff.) the potential sources of educational dilemmas as consequences of the introduction of new educational tools were discussed. Similar dilemmas may occur in this context. However, there are differences. In this case the tool must be appropriated within in a specific time frame. Neither is the appropriation optional. Instead, the appropriation of the technological artifact – observing strict safety regulations – is the very essence of the training process. Moreover, the learners must anticipate their future role as flying instructors.

Of particular interest are the dilemmas, which can be identified in the activity system (see p. 37). To repeat, a dilemma is a state that cannot be resolved by separate individual actions; the solution will always require negotiations among individuals. Engeström applies Bateson's concept *double bind* (Bateson, 2000, p. 201) to characterize a dilemma which can only be solved by an unconventional idea that will give the activity system either a new object, new ways of organizing the activity, or new tools to use.

Thus the unit of analysis will be a functional system consisting of individuals and artifacts organized in a specific way i.e. what previously has been labelled an activity system (see p. 34 ff.).

The conditions mentioned above can be viewed as the background for the present study. The focus is on the instructional context in which very experienced pilots from earlier versions of Swedish military aircrafts are trained to fly the new JAS 39 Gripen.

The purpose of this study is to investigate what characterizes the institutional setting as a pedagogical environment facing the requirements of a new technological artifact. An additional purpose is to offer suggestions for improvement of the pedagogical means and tools.

The study is delimited to a group of ten officers doing their TIS **and** their fellow officers acting as instructors. Moreover, the present study is delimited to 10 preparatory simulator sessions combined with theoretical content to be learnt. The simulator sessions are cumulatively built up of specific "training profiles" which specify the content to be trained during each simulator event. This means that the study has been carried out during the initial phase in which the participants get acquainted with the specific characteristics of the new plane, take off/landing procedures, and emergency training. Actually the very first simulator session was about the correct strapping of the pilot to the ejection seat in the cockpit. The first ten sessions end with the learner actually driving the plane on the ground. After that 16 sessions of actual flying will occur. These are not treated in this report.

The present report is based on a larger evaluation project of the training to become a JAS 39 Gripen pilot (Fransson & Jonsson, 1999; Fransson, Jonsson, Lindström, & Selander, 1999; Jonsson, 2001).

METHODS

In order to be able to describe the processes of negotiating and eventually identify the characteristics of the activity system a participant observation approach was chosen (see p. 43 ff.).

The fact that the study was carried out in a military setting entailed some restrictions. The investigation task was given to two educational researchers (the author of this report is one of them) without specific knowledge of military settings except for military service a long time ago. Both researchers were experienced practitioners from compulsory education as well as from higher education, particularly teacher training.

At the outset the researchers had to pass a security control. Since this was not carried out in advance the first days entailed a lot of waiting and loitering in settings like coffee room and corridors. However, after having been instructed by the security officer at the wing and after having signed documents entailing a promise of secrecy the researchers were granted admittance as well as key cards to all places of interest for the investigation.

Still, the military setting influenced the investigation. Writ large, recording equipment could only be used where and when it was explicitly permitted. Intitially, therefore, the observations were carried out by taking notes with pencil and paper. However, audio recordings of interviews and simulator communication were permitted after some time. Eventually also video recordings were permitted. However, they are not part of the empirical material in this study.

Data collection

The data collection for this study was carried out during 14 days spread out over 4 weeks. Initially, the observations started with a get-to-know-phase. The empirical material consists of observational accounts, audio recordings, informal talks, and formal interviews. All together, approximately 15 simulator sessions were observed. Eleven of these sessions were observed as well as audio recorded. The audio recordings amount to approximately 14 hours. At the MMT simulator observations were made during approximately 2 hours. Data also consists of 13 audio recorded interviews amounting to approximately 11 hours. Finally, a considerable number of observations have been made during theory classes, daily assemblies, coffee room chats, and other occasions.

Jordan and Henderson (1995) problemize whether data should be transcribed in its entirety with pauses, intonations, and so forth or whether it could be summarized thematically. For the purpose of this analysis,

however, it was not deemed to be particularly valuable to literally transcribe the audio tapes except for some particular events or expressions.

Finally, the data material was supplemented with documents. The majority of the documents consisted of instructional material for the retraining, the exercise profiles mentioned above, for instance, but also publicly available documents and pictures from the Internet played a minor role.

Analysis

General issues concerning the analysis of qualitative data are described above in this thesis and will not be rehearsed further (see p. 47 ff.).

For the present study data collection and analysis were carried out in parallel. The time for data collection and the analysis of data varied quite a lot. Some days the data collection periods were very short either due to an overload of impressions or to interruptions in retraining program. In these cases the day was spent writing up field notes, writing memos, making hypotheses and conjectures and so on. On these occasions it was a great advantage to be two researchers working on the same data since hypotheses and conjectures could be discussed, refined, or refuted.

The analyses were greatly facilitated by software for qualitative analysis (see p. 48 ff.). The Atlas/Ti greatly enhanced the managing of large chunks of text. However, as mentioned above, the analysis is an entirely cognitive undertaking and can not be accomplished by computer software.

MILITARY EDUCATIONAL TECHNOLOGY

The paragraphs below will give a brief overview of the educational tools used in military pilot training. The aim is to focus on those traits that are comprehensible from an educational perspective. The aim is not to give a detailed technical description.

Full Mission Simulator

The most used artifact is the full mission simulator. It has the capacity to create a simulation that is as realistic as possible. This means that the cabin

emulates the real Gripen cabin. The simulator version has principally the same functions simulated by computer software as the real aircraft, which is also heavily dependent of computers.

Being strapped to the ejection seat, wearing his flying suit with the respiration equipment the pilot accomplishes the same tasks in the simulator as in the real cabin. Moreover via his headphones and microphone built into his helmet he hears and speaks virtually in the same way as in real flight. The visual impressions from outside the plane are projected on the walls of the spherical room where the cabin is located.

From the control room nearby the instructor leads the exercise. He has the same information systems (with a slightly different design) as the pilot in the simulator cabin. From his position he can monitor as well as give instructions to the learning pilot. According to the curriculum the instructor decides what to simulate. Instructor and pilot can only communicate via voice communication (which is also the case in real flights). Recorded voice communication and observations of the instructors constitute a major part of the empirical material from the simulator sessions.

The simulator sessions varied according to content from 1.5 hours to 2 hours. During the observation period only one of the two full mission simulators could be used. This meant that the number of simulator sessions that could be accomplished each day was limited. Not only the number of functional simulators but also the status of the simulator functionality made it necessary to reschedule exercises now and then and even to carry out some exercises with reduced simulator functionality.

Multi Mission Trainer

The multi mission trainer is less sophisticated in comparison with the FMS. The MMT has the information and navigational systems of the Gripen aircraft but the pilot is seated on an ordinary office chair. Consequently, he is not strapped to the chair, neither is he wearing his flying suit. The visual animations from the surrounding world are presented on three video monitors.

Still, there are some advantages of the MMT compared to the FMS. The pilot can easily start the MMT as an ordinary computer and train specific tasks on

his own without an instructor. Furthermore, in the presence of instructors or colleagues face-to-face communication and actual pointing and showing how to carry out various actions are made easy.

During the observation period the participants in the retraining sessions had very restricted access to the MMT. Either it did not function quite well or it was occupied by a previous retraining group.

Aircraft System Trainer

The AST looks like a common computer with a screen where instruments and information systems can be pointed to and manipulated with mouse or joystick. Primarily the AST is meant to be a tool for technicians but it might be used for the training of particular moments in pilot training as well. For this study the AST was not observed.

Evaluation and Tactical Analysis (in Swedish: UTA)

The UTA[5] equipment is used for the evaluation of accomplished flying tasks. During flight, data about the flight are being recorded. After having completed his actual task, the pilot can playback the entire flight in the UTA equipment. Actually, what has been going on will be represented on instruments of the same kind as in the Gripen cabin. Moreover the movements of the plane will be graphically depicted and the voice communication during flight will be played back as well. At any time the recording may be paused, rewound, or played fast forward. Accordingly, it is possible to follow and thus to evaluate the actions of the pilot during his flight.

RESULTS

The training at the Gripen centre is still in a *phase of construction* during which a working *system must find its shape*. Several factors influence the activities. Some are delimiting whereas others are beneficial for the development of the activity. A range of factors might be labelled cultural. The interplay of these factors is of vital importance for the activities during

[5] UTA in Swedish means "**u**tvärdering och **t**aktisk **a**nalys"

this construction phase. A strong negative factor is the *shortage of time*. This has probably a restraining influence on the construction phase. The shortage of time results in instructors being heavily exploited and therefore they feel unable to maintain their own skills. This, however, is partly counterbalanced by the *positive attiude* to be found in the pilot group generally. The group is characterized by a strong ambition to manage their task successfully. In practice this is demonstrated by a will to cooperate and a willingness to work late hours. The conceptions of *educational theory* and *instructional practice* can be viewed as cultural or rather institutional. The ability to *reflect* on and *evaluate* the training will probably be of importance for the construction of a valid training program. Eventually, the construction of a *well functioning training organization* as well as the *development of a reflected pedagogical practice* are two sides of the activities at the Gripen centre. This will probably entail a partially *new role* for the community of fighter pilots. Below these aspects of the training practice are elaborated under the headings "Assuming Shape"; "Press, Stress, and Motivation"; and "Flying versus Instructing Others".

Assuming Shape

The training at the Gripen centre has still not assumed its definite shape. Everyone is aware that they are in the initial phase of constructing something new and that it is impossible to anticipate what it will be like when it is ready. Repeatedly the participants return to what is labelled Phase 0. This phase was carried out in Halmstad and it was considered to be an extremely good example of training.

It will be necessary to start building a foundational structure. *"If there is no structure a lot will fall between two stools."* One part of such a structure might be to clarify how the two squadrons must cooperate when taking over the responsibility for the training. They explain to the observers that the original idea was to have a shared coffee room in a part of the main building named "Navet" (transl. the Hub). However, before long coffee machines appeared in each squadron's coffee room and lots of opportunities for informal talks were lost. In spite of this, they say, they might have gained some advantages for their own squadron.

Tools and Time set the Limits

Some of the tools for the training constitute limiting conditions for the new training program. The Gripen centre was planned to have two Full-Mission simulators. During the observation period, however, only one of them is installed. The informants also witness to the problems they have experienced with the only working simulator. For a layman it is not quite clear what constituted the problems, but generally they depended on inadequate software, which could not satisfactorily simulate what was considered necessary for the training.

Quite different in character are the problems depending on the simulator not working at all. "*It so infuriating when this damned junk doesn't work*", exclaims an instructor annoyed. It is not hard to understand that problems will arise as a consequence of not being able to carry out the scheduled training events just because the simulator has got stuck. What is positive, though, is that the simulator, during the present training sessions, seems to work quite good.

The other tools, the MMT and the AST, do not seem to fully qualify in the present training. The AST is still in an embryonic stage and therefore it is not considered appropriate for pilot training. The risk that they learn something wrong is too big. Several of the informants say that there are many tools that really would enhance the training but at the moment there is neither time nor support for the production of additional tools.

The instructors do not seem to have total control of the advanced system they are going to instruct their fellow workmates about. This might be due to the fact that they have to act as instructors after only 60-70 hours of flying the new aircraft. This sometimes results in situations where the instructor will instruct his student about something that he recently did for the first time himself. This situation results in the instructors not having a common approach to instruction, even if they certainly would like to apply a common approach. "*You have to learn the best you can*". Most of the energy so far has been spent on getting instructors for the trainees. Quite few have finished their own training and therefore all of them must be prepared to instruct. Every possible instructor is made use of. "*Actually it is quite a frustrating situation*", says one instructor. However, at the next moment he turns it into something positive when he says that this training program will find its shape in a couple of years. It seems to be a general agreement on the fact that

the first real test of their instructor skills will come during autumn of 99 when they receive the first external squadron.

Positive Attitudes Benefit the Training

At present all forces at the Gripen centre are joined to accomplish the task. The staff really wants to be able to show that they are able to carry out their task with a high quality when they will receive pilots from external squadrons. Moreover, it is very important to show to the public that the "*JAS can fly*" since the media image of the JAS system is quite ambiguous. According to one of the instructors, this plane is in no way worse than previous new aeroplanes. A previous model of a Swedish aeroplane was said to have lost its wings on one occasion when it was in its development phase. This, however, was not noticed by media, at least not in the same way as the initial problems of the Gripen project. "*There have always been problems during the development phases*", he contends.

What are the driving forces for the instructors? How can they be motivated to go on with this heavy workload? "Today we get the satisfaction from seeing that we succeed. We can see that our students pass and we are assured that they do it in a safe and satisfactory way. And that is a satisfaction in itself", says an instructor. Economical issues are not emphasized. Sure they work overtime and should be compensated for that. On the other hand, they do not generally count planning during evenings and Sundays as working hours. Instead of more money, they would rather that "someone higher up" would see the situation. If people "higher up" really wanted to contribute to a better training situation then they must not add more tasks but try to extend the time for the present training program instead.

The task of training that the two squadrons have in common seems to have influenced the social relations. In the Gripen centre there are two squadrons, each with routines of their own. During the training session, it has been necessary to work across the squadron borders. In practice this means that instructors from one squadron will instruct the trainees from the other squadron. Moreover, the group of pilots in training is made up of participants from both squadrons. Probably, this situation has enhanced the contacts between the two squadrons. Presumably, this will also be benficial for the future.

Tradition and Experience are the Foundations of Training

The present training endeavours are characterized by a large portion of good will and of a great ambition to accomplish the mission. However, the foundations of the training are not conceptualized. Therefore the training has a touch of intuitive, uncomplicated acting which is accomplished by using common sense (anyone knows how to teach something to someone). Since all have mainly the same experiences and all are extremely motivated to learn, the need for pedagogical reflection and individual adaption has not come out strongly.

Moreover, a strong motivation is what separates this training from many other educational events. Compared to the compulsory school with its great variety of students, not always motivated to learn general and sometimes confusing content, the pilot instructors might not have had the same reason to reflect on pedagogical methods as the their fellow teachers in compulsory schooling. Training the colleagues how to fly (something that they already know) can probably be done without referring to learning theories.

The instructional approaches vary a lot among the instructors. They are individual dependent. Evidently, there is no commonly agreed upon approach. The most urgent problem for this training program is to join all educational forces possible. In such a situation there are few opportunities for common agreements. Only a few of the present instructors have attended a flying instructors course, FIK (transl. Flying Instructor Course). Several among the informants have good as well as bad experiences from their own training. Conjecturally, the outcome of the training is very much dependent on the experience and capacity of the individual instructor's. The more knowledgeable the instructor, the more he will give room for questions and digressions. Conversely, the instructor whose knowledge is limited to the particular training event, will not allow, or is even unable, to let the trainee discuss other topics.

Observing the simulator instruction, it appears to be characterized by good will and an ambition to support the colleague in the cabin. Instructors and trainees often share their experiences and together they are generally impressed by the capacity of the new plane. Still, there is *no apparent systematic knowledge building* about instruction. In the present situation it still works since they know the person who sits in the cabin to learn. The main difference between the instructor and his trainee is that the instructor has

already accomplished the exercises in real flight. Apart from that, their knowledge and their experiences are quite similar (apart from their different functions as fighter- , attack-, or reconaissance pilots).

The instructors commonly believe that they use a kind of home-made instruction, and that it might be possible to do it in other ways if they just had the time and knew how to: "*We do it in our old-fashioned way. In Halmstad they are a bit more up-to-date*". Evidently, there is an idea that there actually is "*a better way*" and thus they feel "*inferior*" for not knowing that.

They believe there are things to learn from those who are specialized in training. However, at present they have not got the time and thus their teaching will be "*old-fashioned*". Both squadrons being very busy at present there will not be time enough to teach with "*finesse*". Instead they feel they must go on in their traditional way and that will be quite okey this time since the trainees are already experienced pilots. "*If we are going to learn something new it is probably important to feel a real need for that*", they mean. When it works well there is no need to change the methods, they seem to mean.

However, there is a will among most of them to become better instructors. Those who have attended instructors' courses are generally in favour of these. Still, they have no faith in what they call "*academicized training*", which they consider less action-centered than their own practice. No pedagogical approach will work, if the instructor feels uncomfortable using it, be it problem-based learning[6] or whatever. Sometimes they have been forced to learn what they really do not want to use. In those cases, it has been "*torn to pieces*" be it whole-based learning or whatever because is has been so "*completely fucking lousy*". This, of course, might be due to bad presentations or to an individual inability to relate it to one's own context.

Inexperienced Pilots Require Explicit Methods

Till now previous experiences have laid the ground for pedagogy. At present there is little thinking about how to teach. Actually, there have been few reasons for the instructors to reflect on the teaching practice. Usually the

[6] Within the air force the concept of "whole-based learning" was substituted for what normally is labelled problem-based learning. The military acronym, accordingly, is not PBL but HBI (in Swedish: **H**elhets**b**aserad **I**nlärning)

students have been their fellow workmates, who in their turn have anticipated a traditional approach. "*Our problem is that we haven't entered deeply into educational issues*", someone says. It is a very special situaion to be in a squadron knowing everyone and getting immediate feedback about any behaviour.

It will be quite another situation when new trainees will arrive, pilots who will not have the experiences shared among the squadron pilots. Everyone, present trainees as well as their instructors, fear this new situation. A reasonable interpretation is that the instructors (and the future instructors) feel uncomfortable when faced with a situation in which they cannot expect either shared knowlede or predictable reactions from their students. In the future it will not be possible to relate to experiences from flying the "Draken" and the "Viggen" (previous versions of Swedish military aircrafts). This, eventually, will point to focussing the training methods instead of the JAS system itself.

Till now there has been no need to reflect upon training of inexperienced pilots. Particularly, there has not been a need to imagine what it will be like to sit in the backseat of a two-seated plane together with someone who has no prior experience of such a plane. To handle this situation, the instructors will need explicit training routines; the individual experience and skill will not be sufficient. It is repeatedly stated that young and inexperienced students will need explicit instruction since they will not be able to ask the relevant questions when compared to experienced pilots. It is reasonable to suggest that there are collective myths as to what the future will be like when "*the new ones*" will arrive, those who have not yet been flying "*the sharp-pointed*" (in Swedish: spetsigt), only the the SK 60. Since the entire wing is brought up to a far-reaching educational task, it will be necessary to focus on educational issues and not only on the flying skills.

Advancing the Pedagogy

Most of the pilots have probably, at least on some occasions, been exposed to educational psychology. They often talk about "*flat learning curves*", the advantages of "*motivation*" etc. Someone contends that "*whole-based learning*" will suit him fine. This type of learning, he says, enhances his self-activity; he asks the questions and he will find the answers. He contends there has been too little time at the wing to reflect on pedagogical methods.

The ideas that pedagogical courses will be benficial for instruction are quite frequent. Such courses would enable the instructor to understand the reactions of trainees in various situations better; what reactions can be anticipated during stressful situations for example. On other occasions, pedagogical courses are heavily criticized for being too general, thus they will be of little value for specific tasks.

One instructor who actually has experiences from an instructors' course is quite positive. One of the great advantages is to have fellow participants with whom it is possible to discuss appearing problems. "*It might be an idea to develop such a pedagogical flying instructors' course at the F7*", he says. " *Quite a lot of titbits can be found in such a course*", he continues.

An issue of relevance for future courses is how specialized they should be. At least some of the instructors, are not in favour of courses with a generic content. They wish that the courses be targeted to problems related to the present training issues.

Several among the instructors state that instructors as well as their students sooner or later will reach a stage where the learning seems to decline and how to handle that situation. Very few will pass the different training phases without problems. Any instructor should be able to observe and analyze the problems in order to recommend remedial strategies. When faced with the problem of teaching students not sharing experiences with the instructors, this will require a pedagogical discourse so that a *systematic knowledge building* can take place. How should one go about having all instructors giving the same instructions? Or rather: *how can the shared experiences be made explicit in order to construct an integrated educational methodology?*

It is reasonable to admit that the training of pilots is successful at the Gripen centre. Still, it can be questioned if the training of instructors is just as good. *Where do they learn how to teach someone to fly the plane?* It is reasonable to require an answer to that question from a wing, which is charaterized as a centre for training since it might be more difficult to train someone else to fly than to fly.

Reflection and evaluation

The entire training at the Gripen centre has a dual purpose: to train more Gripen pilots (so that they can become instructors) and to establish the structure of the future training. Now is the time to try out the foundations and develop the procedures to be used in the future when "*new*" pilots are to be trained. This requires some kind of systematic evaluation of the activity.

Having finished off a simulator training event one of the pilots says to his instructor: "*You think a lot. As a matter of fact, you think of much more than you will talk about"*. In some cases the pilot will bring up topics without being asked. A somewhat more systematic reflection might be more beneficial for the learning than just saying: "*Damn, we also must chatter some about the simulator exercise!*" On the other hand, there is quite a lot of non-scheduled time slots during the day for those in retraining. However, during these they must study lots of theoretical stuff. They must also prepare themselves before going to a simulator exercise.

Formal evaluations of the training often result in revisions. One evaluation resulted in moving an initial technical course to Halmstad where they have more resources and experience. A problem as to evaluation in this case is that the training is still so recent and therefore no one can view it from a distance. Simply put, no one knows what to ask for. It is an agreed upon opinion, that the instructors will not be able to overview the problems until afterwards. Neither will trainees call in question the training they are taking part in even though threre are examples of criticism from previous groups in training. One example of such criticism dealt with, what was considered to be, too hard weather restrictions, which inhibited all flying for long periods.

There does not seem to be any unambiguous criteria up to which the training can be measured. However, it is necessary to evaluate it in relation to the directions for training (in Swedish: UTB-anvisningarna). This is considered time consuming. "*Normally, you reflect for twenty minutes and then you are done*". Some of them can be seen to take notes to use in a subsequent evalutation. Still, there are no formal procedures for how to evalutate. There are many "*local bigwigs running a race of their own*". They call attention to the fact that there is a real need to gather all the instructors in a place where they will not be disturbed and then talk through all their shared experiences. On such an occasion, they might discuss the exercises and the problems they

have experienced. It is considered important to focus on the issues they experience as problematic.

It is judged extremely difficult to measure to what extent a training program has been successful. To be sure it would be necessary to undertake a detailed study of each trainee. The present evaluation will probably differ from the future evalutations with inexperienced pilots. Since the present training is a retraining, the participants have all been through the check points previously. It is a commonly held view that the experienced pilots, even if not yet trained for the Gripen, already from the start should, be viewed as qualified for the JAS system. This qualification seems to arise automatically as a consequence of a previous qualification for the Viggen- and Draken systems. Measureable variables like heigh, weight, age, and G-tolerance might still disqualify pilots for the JAS system.

A characteristic type of evaluation is the direct feedback in the daily practice. Any mistake can be explicitly told since the trainees are the ordinary fellow workers. The instructor role, however, is seldom criticized.

New Demands

A distinguishing quality of every training occasion within the air force is individuals increasing their own skills as well as training others to increase their skills. "*The entire work is an eternal learning, either we train others or we learn ourselves. What is new, though, is that never before have we been forced to teach when we have such restricted knowledge ourselves*". Moreover, it is a problem to make everyone comprehend the new situation. An example of that is the pilot who asked the training manager if it was really true that he was going to lead a simulator exercise the week after. "*We have to make people understand that it is necessary to be at least a wee bit ahead when you are an instructor*", says one of the instructors. Previously "*a guy who was born with the stick in his hand*" soon would surpass his instructor in flying, but now he will not. In six months the students will not be superior to the instructors because now it is a matter of comprehending the entire system.

It might be at bit unfair, though, to question those who learn to fly at present for not being conscious of there future instructor task. After all, they have been instructed to clear their minds and fully concentrate on their student role. Still, there are some who reflect on their future role. They think it

would be wise to revise some exercises or just change the order of some of them next time. However, this does not seem related to their own roles as instructors; that role still is not particularly focused.

Press, Stress, and Motivation

The group of pilots probably got a new mission when it was decided that the F7 would be the future training centre for all new Gripen pilots. This will surely attract attention to one's professional role. Should they look upon themselves as instructors, fighter pilots, or both? Moreover, at the other end of the airfield the transportation pilots are located and some fighter pilots reflect upon the fact that the large carrier planes are of help for others bringing supply and necessaries to starving people in war or else. In comparison, the Gripen pilots just use up a lot of expensive fuel. In spite of that, they are proud of their jobs and at least some of them fear a situation in which they would substitute paper work for flying.

Changing the Work while being Pressed for Time

Conditions will probably change because of the plane. Repeatedly, they say that the JAS system is still "*immature*". On the other hand, it is vigorously defended when they say that all new models of aeroplanes will have a similar trajectory. What is different this time is the (negative) media attention during the test period. The JAS system is described by the pilots as a very complex and quite impressive system. Therefore it is reasonable to say that it will give less room for individual idiosyncrasies and will turn the pilot into a cog in a system. Generally, flying comes second to system management.

Almost all pilots point to the fact that the plane is very easy to fly. It would be possible to teach a novice "*in a couple of weeks*". On the other hand, quite a few have chosen the air force out of interest for flying. From some of the experienced pilots it is sometimes heard that the Gripen is not a "*plane*" but a "*machine*". It might be conjectured that some of the skills needed to fly previous models of military aircrafts i.e. "*to be a skilful stickhandler*" are no longer what is most valued. Instead, the new pilots are required to be "*system engineers*".

However, those who are done with their training and now regularly fly the Gripen, are without exception impressed by the plane's performance. Even after only having driven the plane on the ground for the first time, the future pilots were quite excited by the plane's performance. They commented their experiences in turn in an enthusiastic manner.

Speeded up Training

The instructors of the present training program seem to have little control over time. Several of the intructors intimate that some persons from the higher levels of the military hierarchy do not realize what a taxing and delicate task it is to train new pilots in such a short time. Neither seems the wide experience among the staff to be made use of in the best way. On many occasions the staff experiences that the requirements of the "*SAAB-people*" have higher priority than the pilots' experiences.

The training of more instructors is an urgent issue in order to get rid of the present hectic situation. It is a serious problem with the present compressed training program that no one has time enough to repeat and consolidate their knowledge of the JAS system. What has previously been learnt is easily forgotten. Since it is quite a demanding task to learn to handle the plane, the operations must be trained to come automatically and naturally to the pilot. However, there is too little time for this. Quite a few among the instructors are worried about the future when young pilots without experience from "*heavy systems*" will fly the Gripen. Unanimously they say that the training of that category must be accomplished with another type of instruction and other types of exercises.

Also the social life of the instructors must be fitted into the schedule. During the observation period paternity leaves as well as winter holidays with the family could be observed. During this period the simulator is booked until ten o'clock in the evening four days a week. This means that instructors as well as their trainees must be prepared to work late in the evenings. One of the instructors says that he has been on duty for 30 hours during the last 48 hours period.

Apart from the social problems, the pilots do not have time to reflect on their doings. On some occasions the instructors return to the idea that they have not had the time to learn pedagogics. Instead they have to rely on personal

experiences of training (which will not necessarily be a bad thing). However, implicit in their reflection about pedagogy is an idea of a better way to teach if they only had the time to learn it.

During the observation period the staff showed many examples of flexibility as to planning and and actual instruction. The few instructors available are extremely busy when they rush between their regular flying, preparations, theory classes, and simulator instruction. Surely they have to improvise to get done. On one occasion, even it is an exception, one of the trainees has to take the role of instructor just after he had accomplished his own training in the simulator.

One reason to cope with the present situation is that it is considered temporary. At the moment all forces are joined to get new instructors so that they will be able to receive the trainees from the other wings. The idea is that the more instructors there are, the more time they will have to increase their own skills and to improve the exercises, provided that they will not suffer from people leaving the air force.

Fellowship

The shared experiences are the unifying links in the community. All are experienced pilots and they often refer to shared experiences from flying. The most central space for a relaxed conversation is the coffee room. They are often humorously ordered to go there by someone giving the order: "*Let's go there and get charged with coffee!*" (This is quite a difficult idiomatic expression. In Swedish: "Nu går vi ut och fikar upp oss!"). In this room most often a TV set is on. Quite often the programmes will trigger off comments leading to fits of laughter. Humour is a distinguishing trait in the observed group. They seem to be able to laugh at almost anything when they are together. This was also demonstrated when the theoretical tests were returned to the trainees. Some tension as well as laughters to relieve those tensions were observed. The humor resulted in playful pesterings of those who had been particularly successful in the test.

The informal spririt also dominates during simulator exercises and theroretical classes. It can be noticed that there is little distance between the instructor's own training and his instructor role. Still, even if those who are trained feel they are allowed to ask questions about anything it might feel

inappropriate when the next trainee is already waiting to be instructed. The training manager therefore quite often asks his group: "*Just say, if we push you too hard, and we'll leave it off temporarily!*"

A recurrent observation is that all speak quite openly and they do not feel ashamed if they happen to make a mistake. On the contrary, they say, it is necessary to tell about the mistakes since it can save the life of someone else on another occasion. Generally, there is no overt competition between the pilots, at least not when they are observed by non-pilots. Admittedly, though, the training requires a lot from the pilots.

Still, it is stressed how important it is to self-image to succeed. It is considered quite ill-timed to make a mistake at the end of the week. Then this mistake may ruin the entire weekend. *"No, you should do something easy at the end of the week so that you feel satisfied with what you have accomplished! Then you can go home and feel like Biggles all the weekend!"* The most constructive way to handle mistakes is to take the recording from the flight and analyze it promptly in the UTA equipment (above) to see what went wrong.

Motivation and Responsibility

In the group of pilots the motivation to learn is a salient trait. One of the pilots says in disappointment that there was no place for him in the present training program and therefore he has to wait till the autumn. Hearing him say this, it seems that learning to fly the Gripen is the most prominent desire among the pilots. The air force might take a risk letting competent pilots wait too long to fly. At least one of the pilots has chosen to leave the air force to be an airline pilot instead of waiting for his turn to be trained to fly the Gripen.

Further salient traits are responibility and loyalty to their duties. "*We suffer from stress but we never say no!*" says someone. "*Instead we'll work ourselves right into the wall and feel miserable when we are at home!*" "*We kind of, want this to be all right*!" The work is certainly carried out with a positive attitude towards it.

A vivid metaphor describing the pilots reads: "*They are like a fucking dried up sponge and they want to suck up everything!*" "*They want to learn and they will be*

fucking interested if they can get their hand on something that comes later in the training!". When the times for driving on the airfield comes i.e. only on the ground, the excitement was perfect. Observing from without, it appears to be so interesting driving around in the airfield with the plane that they can hardly stop.

The social life of the pilots makes itself evident during assemblies in the mornings. Also their social life influences the training program be it paternal leaves, sick children, or vacations. Social life and vocational life also converge as to working hours. During an assembly it is intimated that there are too many late evenings. Could it possibly be organized in another way?

Family life might influence the motivation. At least one of the pilots had decided to leave the air force for security reasons. He felt it would be safer to be an airline pilot. Security reasons come to the forefront when fellow pilots crash. As a consequence, he does not participate in the current training program.

Flying versus Instructing Others

The instructors seem to experience a conflict between their own flying and the training of others. They repetedly say that there is no time to uphold their own skills. Eventually they will lose some of their skills. Preferably, they would like to fly instead of doing paper work and preparing classes. Several instructors iteratively tell about the hardships of planning for classes while being pressed for time. Still, the instructor role is inspiring and beneficial for their own skills.

There are no signs of a similar stress as to flying even though they say that the plane is still in a continual development phase. It is reasonable to say that they have a focus on the plane and the flying. The pressure they experience might be due to their viewing the training program as a disturbance in the regular activities i.e. flying and increasing their flying skills. They have applied for admission in the air force because of a love of flying. No one has applied for admission to be a simulator instructor from morning till night.

However, it is decided that F7 should be the training centre for the JAS system and therefore the mission has to be accomplished in a qualified way.

They have got into a situation in which they will end up as instructors whether they want to or not. On the other hand, this will give them a chance to go on with a profession, which is permanently threatened by the closing down of units all over the country.

Traditions of Training

The training methods are described as not having changed during the years. They are inherited as a teaching tradition. After having been trained, one is expected to be ready to train others. This will have a preserving influence on teaching methods since no one actually has the time or is encouraged to increase his skills. Some of the instructors really feel that their training skills are inadequate for the JAS system. "*It feels as if you are losing both competence and creativity*". Metaphorically, they liken it to being in a treadmill.

The implicit idea of instruction seems to be that the instructor transmits what is in the "*training profiles*" and that he contributes with his own experiences. In the actual process the instructor structures and sorts out the content he judges necessary for the trainee to know. They are not particularly in favour of study groups composed out of trainees for two reasons: a) the students require quidance from someone who knows and b) it would take longer to discuss than to be taught. The trainees rely on their instructors to tell them what they need to learn.

Another reason for the instructor to instruct is that it is not possible to learn everything from books. The trainee generally has lots of questions not necessarily relevant for flying. The instructors try to pick the most relevant questions while still being open to dialogue.

The oral classes are mainly based on traditional transmission of content. This might be a characteristic of the military teaching tradition but it might also be viewed as a way for instructors to keep the content relevant while using time in the most effective way. Normally the instructor lectures whereas students listen. The instructor's task can be summarized: a) he should sort out an prioritize and b) he should contribute with his own experiences.

Apart from the technical tools mentioned above, the overhead projector is a commonly used tool. The instructors often show acetat copies from manuals, sometimes with information quite badly arranged. Spectacular Powerpoint

presentations are judged too time consuming to produce in relation to their benefits. Still, a few (very few) instructors have made computer presentations.

The training must result in the trainee being able to think strategically. As an example, one instructor illustrates what is needed to be known by heart. "*If the plane loses traction power at takeoff, there is no time to search the help manuals. Almost before the problem appears, the pilot must know what to to. On the other hand, if problems appear at high altitude and the pilot has all the time in the world, then he should take out his checklist not to burden his little brain by trying to know all the problems by heart 'cause this will almost certainly result in his mixing things up and he will do the wrong things by heart too!"*

To learn what is necessary, and somewhat more, there is a traditional written exam. The exam will force the trainee to study what otherwise might not be given the same priority. Above all, the test result is a receipt for the individual trainee and for the instructor, so that they both know that the training might continue safely. Those who take the test seem to trust the persons constructing it. If they pass the test they are convinced that they have learnt enough to go on. Still one might ask: If what is tested is considered necessary, how is it possible to get through without knowing everything? It seems that the pass level is based on general educational traditons rather than safety requirements.

The relation between instructor and trainee is quite informal. After all they are colleagues. Several instructors emphasize that they would never make comments about their trainees. Confidence is crucial. The attitude is one of helping one's fellow pilots to be more competent.

The instructors are convinced that they have the ability to decide what is needed for various students. "*Sometimes I am in the command; at other times I'll wait to see if they will identify the problem and are able to correct it.*" In such cases the instructors rely on their experience. Often they teach explicitly in the beginning of the training to be more of a supervisor and a monitor at the end. Someone says: "*The instructor doesn't control; he supports.*"

Simulator Instruction

During the first simulator exercise the instructor accompanies his trainee to the cabin. There he literally helps him through the processes. Later, all communication between instructor and trainee goes via the audio communication system. The communication is one between equals even if one is the instructor and the other is the student.

The audio communication has a slight resemblance to telephone support. The implicit idea is that the trainee does what he is told. The instructor structures his information into steps, which he judges suitable to the trainee. He also decides what to talk about.

Initially, it is a problem for the trainee to find everything in the cabin. A lot of time is spent on locating various buttons. The most important tool is the checklist. Initially, the trainee has to spend some time on how to read and find what he is looking for in the checklist. Being overwhelmed by information, the trainee often resorts to his common language. "*Where the devil is it?*", "*There is a hell of a lot of lamps!*" Besides there is quite a lot of common expressions but still from an aviator discourse. "*Point the nib upwards!*", "*Do the Charlie Steeprise!*", "*Position the stick right in your shirt!*", "*Fold up the gear!*"[7]

From the outside it seems that the trainees have quite little time to get familiar with the buttons. It should be possible to train these skills in other settings and not occupy the expensive simulator for such low level tasks. The way the tuition is arranged, the trainees must try to find the controls and fly (simulated flight, though) at the same time. At least on one occasion, the trainee excused himself for looking more at the controls than at the environment.

There are many examples showing how hard it is to transmit simple operations from the control room to the cabin by just talking. It seems that talking is not sufficient. It might be easier, as in the very beginning, to be in physical contact with the trainee. How about having the instructor by their

[7] The English examples represent an effort to convey at least some of the meaning of the following Swedish expressions: *Ställ näbben uppåt! Gör en Kalle Branting! Spaken mitt i skjortan (kläderna). Klappa in stället!*

side in some parts of the training? Observation does not seem to be used as a formal method of learning.

Some of the instruction is based on questions of this type: What will happen if …?, Do you know …?, Why …? A reasonable question to ask is why they do not visualize more. Why not a video, which could be discussed among fellow trainees? The old sequence of *show-instruct- practice* is not used.

The situations can be characterized by the instuctor explaining or assigning tasks, asking checkup questions, and in some cases asking the trainee to think for himself. The processes are summarized in the list:

Instructor tells the student what to do
Instructor asks checkup questions
Instructor initiates an explanation
Instructor explains a student question
The student asks
They refer to shared experiences
They talk generally about the plane
The student is encouraged to think
The student is encouraged to try
The student tries out his own idea
The instructor recommends

No instructor has any objection to being observed. It is quite okey to audio record the communication during simulator training. This might be due to several reasons; they might be confident with their role; they might be unaware; or they might be used to acting and being observed. Otherwise, the instructors are quite unlike each other. Some of them are formal whereas others are more familiar. One instructs half lying down in his chair. Are the instructors bored of being forced to be here? They have a quite heavy work load and there are quite few instructors, who often have to work late in the evening.

In most cases, the task of instructing seems to take time away from flying. But balancing this, it is stated by some that the instructor role might be a way to increase one's competence. "*It is beneficial to be forced to return back and try to understand 'cause then it will be necessary to analyze a situation that otherwise would seem self evident*."

Conclusion

The above description of the retraining can be summarized under the general title *training under construction*. It can further be condensed into a small number of recurrent issues. These will be graphically depicted below (Figure 17).

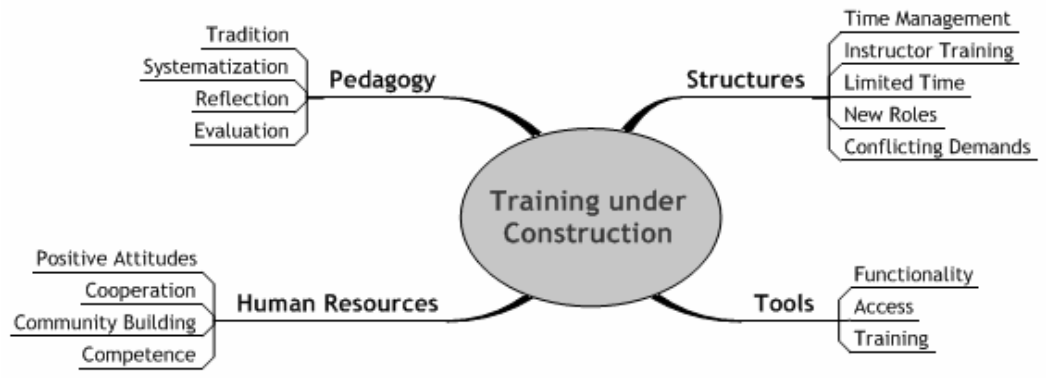

Figure 17. Main properties of Training under Construction.

Beginning with *structures*, the participants, particularly the instructors, have limited time for their tasks. Moreover, the pilots who have the skills necessary for instruction are relatively few. Therefore the aim is to increase the number of instructors as fast as possible. The instructors are also faced with a new role. To instruct about the new aircraft is a demanding task which seems to arise from the fact that it is not enough to be a skilled aviator. The new aircraft demands what many instructors label engineering skills. The latter will also in some cases conflict with the experience of what it is like to fly an aeroplane. The JAS 39 Gripen is sometimes depreciatory called a machine instead of a plane.

It is obvious that the construction of the training procedures for the Gripen pilots will also entail a focus on educational *tools*. The observed training program could not use existing tools efficiently. There was only one full mission simulator that could be used even if there were two simulators at the location. This meant that simulator training had to be scheduled even late in the evening. Also the functionality of the working simulator was unreliable. Furthermore, even if the instructors were very familiar with real

flying and the simulated version of flying they were not particularly well experienced in handling the tool itself. The other tools mentioned above were just rudimentary used and in the case of the AST it was not used at all. The only exception might be the evaluation equipment (UTA), which was frequently used.

The *pedagogical* approach is ambiguous to an observer. On the surface it appears to be very efficient. After all the learners go to their simulator exercises and the training proceeds as planned even though there are many obstacles. The approach is described as traditional and also individually dependent on the instructors. In the present situation there is not much time for reflection, though. Still, the instructors have visions of instructor training where they could learn how to teach. Actually, there is an almost mythical belief that there is a professional way to teach and compared to that their own teaching is just home-made. What can be inferred from an outside observation is that the instructors are right when they refer to traditions and personal teaching skills. Generally, there is little systematization of teaching as a domain to study.

Finally, the *human resources* might be considered the most valuable assets in the retraining endeavour. The participants are all very competent and motivated in what they do. Compared to other educational practitioners described in this thesis the instructors and their learners can be characterized by the extremely positive attitude they take towards their task even when training proceeds late in the evening. Furthermore, they benefit from being an obvious community of practice (see p.33) in which not just the formal training but also the informal features of the day-to-day practice play a substantial role in building up their identity as air force officers.

DISCUSSION

In accordance with the purpose of this study, the analysis above resulted in elaborate characterizations of the educational practice. The categories *structures*, *tools*, *pedagogy*, and *human resources*, together with the narrative accounts, may well serve as useful points of focus for further development of the educational practice. However, to test and integrate the categories and their properties, relating them to an activity theoretical framework as in the previous study (see p. 88) could be a useful endeavour.

The structure category focuses factors such as time scheduling, the role of the individual, necessary skills, and the number of available instructors. The tools category focuses on procedures and functionality of educational tools. The pedagogy category focuses on training methods and time for reflection. Finally, the human resources category focuses on the individuals' attitudes and their belonging to a community of practitioners. Subjected to an activity theoretical analysis primary as well as secondary conflicts may be indentified.

Primary conflicts

Primary conflicts can occur *within* any part of the activity system. It may be a tension experienced by the subject relating to a new role, a tension relating to methods, an uneasiness about not having succeeded with a task, an irritating divison of labour, social problems within the work community, or a disagreement of how to regulate the work.

An instructor's role is to lead the simulator training, be responsible for classes, and to uphold his own skills of the complex Gripen system. Now and then they return to the issue of losing competence as a consequence of the stressful training situation. It might be a general observation that large-scale instructor tasks often result in less time for one's own development. A reasonable conclusion, therefore, is that the instructor task is considered to take time from flying. Sometimes it feels like the instructors are bored by having to spend their time in a simulator control room constantly walking the trainees through the same exercises. It is reasonable to ask if the future pilots at the F7 will view themselves primarily as *competent fighter pilots* or as *competent flying instructors*.

The multiple roles as aviator, instructor, administrator, and developer of weapon systems are quite demanding. Having high levels of ambition, the staff suffers from not having time enough to develop their methods. Although there are instructors' courses that serve as models, it is difficult to apply the "*finesse*" in class when what is experienced is a constant lack of time. Therefore they consider themselves "*old-fashioned*" instructors.

During the training period they periodically have to *spend a lot of time on their work*. In many cases this period coincides with a phase of social life when

young men have small or newborn children at home. It is not unreasonable that they periodically think about security as well as working hours, not to mention how *one's own duties* are related to the duties of the utilitarian carrier planes across the airfield.

The role is also changed by the plane. Iteratively, it is stated that the Gripen is easy to fly but also that it has very complex weapons- and information systems. A new kind of pilot is required; the "*system engineer*" is substituted for the skilled "*stick handler*". Some of the traditional characteristics of being a pilot might not be present any more. Eventually, some pilots might be knocked off their feet. The potential conflicts are graphically depicted below (Figure 18).

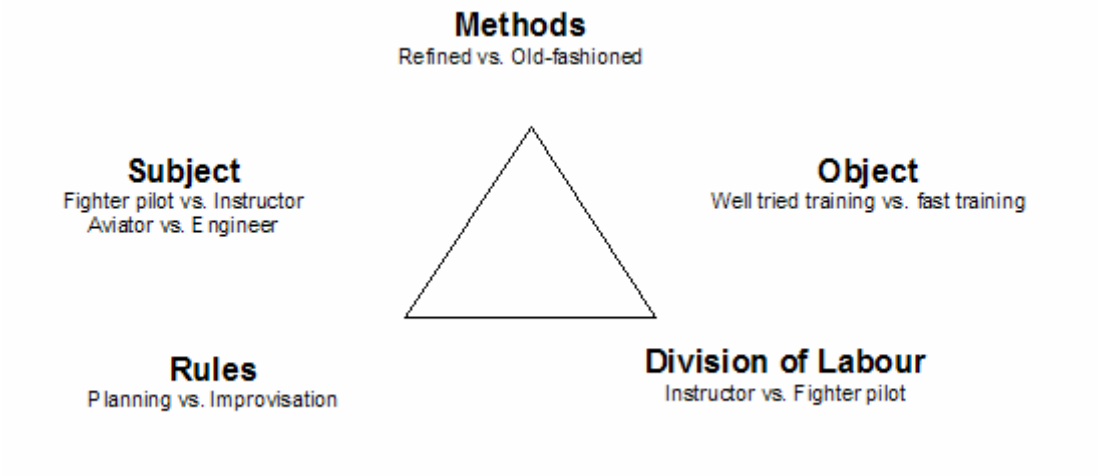

Figure 18. Primary conflicts in the retraining activity system.

Secondary conflicts

Secondary conflicts in the activity system relate to contradictions between different parts in the activity system. Those conflicts may need a resolution but all actions seem to end up in new dilemmas leading to new contradictions. For example the *subject* may experience difficulties in applying the *tools* at hand. The *tools* or methods might be considered unsuitable for the targeted *object*. On other occasions, the *methods* can be incompatible with the present *division of labour*. In some cases problems with the *division of labour* might be unresolvable within an existing *community* of

workers and so on. Below secondary conflict within the retraining acitivty system will be analyzed (Figure 19).

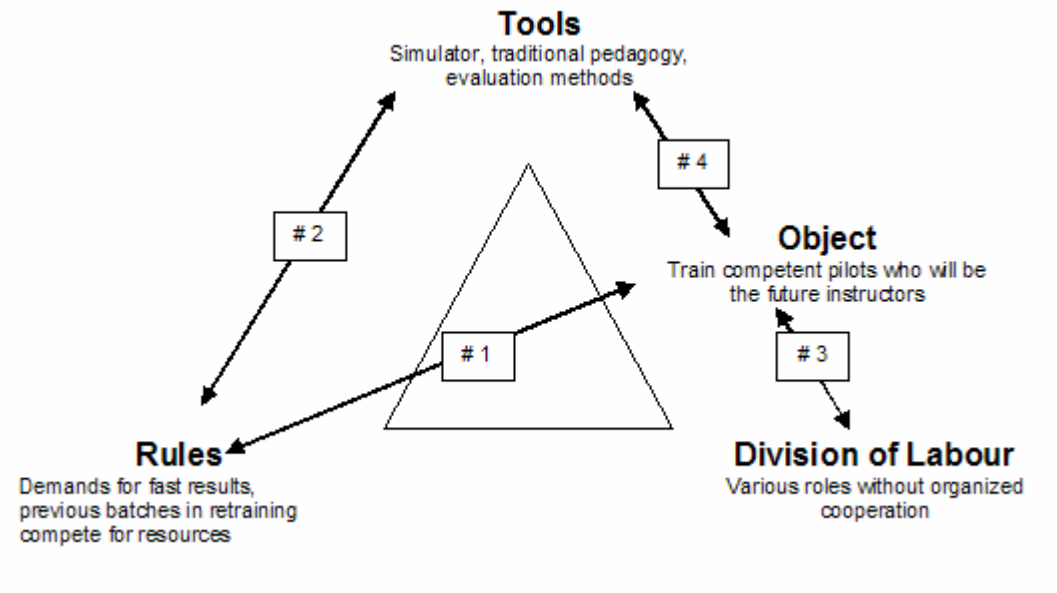

Figure 19. Secondary dilemmas in the retraining activity system. # 1: rules incompatible with object, # 2: rules incompatible with development of methods (tools), # 3: division of labour incompatible with object, # 4: methods incompatible with object.

Rules incompatible with object, (# 1)

The demand for *fast results* will probably lower the requirements as to the knowledge level of those who are trained. It is evident that the present schedule, which is a consequence of earlier delays, goes against the goal of the training. Letting time be the ruler over requirements seems inappropriate. The speeded up training will be negative for training as well as for learning

Rules incompatible with development of methods, (# 2)

There is a limited time to reflect on what is done and therefore the conceptions of educational theory and instructional practice are generally *traditional* and characterized by their origins in the setting. There is also a competition for the available tools since *other groups in retraining* simultaneously need to use the same tools.

Division of labour incompatible with object, (# 3)

The *variety of roles* as pilot, instructor, administrator, and developer are difficult to combine with the goal of the training. A single person cannot simply be just as good in all the roles. Neither will there be time to develop a commonly shared instructional approach.

Methods incompatible with object, (# 4)

The tools of the training create dilemmas for the participants. The simulator and the other *technical tools do not always work satisfactory*. Another dilemma originates from the lack of reliable methods for assessing the result of the training. There are *no tools* to accomplish this. The *evaluations* therefore concentrate on the technical aspects of the training. Very seldom they are intended for evaluation of the instructor role or for individual learning. This is partly a consequence of the fact that, there previously has not been a need for reflecting on the methods, since all the trainees were well known and had basically similar experiences. Whether the methods were relevant for the goal of the training or not, was not an issue in question. The four conflictual states are graphically depicted in the figure (Figure 19).

As a final step, the empirical and theoretical findings of this study will be used for suggestions of improvements of the pedagogical means and tools according to the additional purpose (see p. 148 f.).

Suggested improvements

The *developmental work research* (DWR) approach (Engeström, 1996), will constitute an opportunity to integrate suggestions for improvement with the results of this study. The DWR approach will first be briefly introduced to the reader and after that the suggestion will be presented.

Using the terminology of DWR the researcher should *mirror* aspects from the day-to-day practice to the participants by using representations of the practice (video, ethnographical accounts etc.) that will show dilemmas from the practice. In this case the narrative accounts will serve the function of the mirror. The DWR approach also includes a conceptual *model* of the activity. In this case the activity system model will fulfill the function of a mediating

artifact for reflecting over the practice. The analyses of primary and secondary conflicts will fulfill that role. The third step in a DWR approach is constituted of *ideas*, which represent solutions to encountered problems in practice (Figure 20).

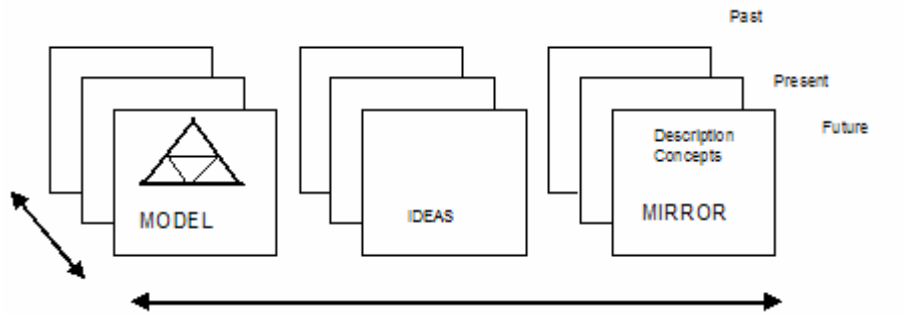

Figure 20. Depiction of Developmental Work Research model. Arrows representing horizontal and vertical movements between description/conceptualization of practice and model

The dynamic processes of DWR can be characterized as both "horizontal" and "vertical". In negotiations over the practice, there will be a continuous and horizontal movement back and forth between mirror and model. Since negotiations in a workplace normally will entail references to how participants used to do in the past as well as to how they would like things to be in the future, there will also be a vertical movement between the past, the present, and the future. Ideally, the negotiating will result in participants and researchers finding new ideas and tools to solve dilemmas in practice. In this case, however, the conclusions and ideas are entirely created by the researcher.

Suggestions for Training under Construction

The construction of a successful training context will require *united efforts* from the practitioners themselves. It seems unrealistic that external forces be responsible for the development of the training programs for the Gripen pilots. As mentioned above the prerequisites for development of the entire training programs for instructors are favourable.

As a suggestion the process of developing a training program for instructors would start while the pilot was in retraining for the JAS-system. The experiences as a student would be systematized with a focus on future instruction, if necessary with support from external resource persons. Doing so instructors and their students would join forces in constructing a *flying instructor training course*. This procedure would probably also diminish the gap between being a learner and an instructor. Put simply, the pilots not only learn to manage the JAS-system but also to instruct others in managing the JAS-system.

Eventually, these procedures might result in a specific training method conjecturally named after the training location. Even if the name of such a model might be somewhat arbitrary, it would constitute a concept into which the experiences could converge. A model would theoretically constitute an artifact with specific properties that could be negotiated and modified. The symbolic value of a specific method should not be overlooked.

Suggestions for Division of Labour

There is an obvious conflict between *flying and instructing* i.e. between being a fighter pilot and a flying instructor. It is an attractive idea that persons are both instructors and pilots but this division of labour has both gains and losses. The person who combines pilot and instructor roles in one person will certainly gain a certain credibility since he talks out of his own experiences. On the other hand, he will loose theoretically as well as practically. Quite a few instructors point to this fact. An issue to explore further is whether the training would benefit from instructors specializing in particular parts of the training program or if it is more efficient if instructors cover the totality of educational issues.

Suggestions for Pedagogical Awareness

Facing the fact that the wing will be responsible for the training of all Gripen pilots in the Swedish Air Force it will be necessary to build up a *pedagogical awareness*. Such an awareness will entail a focus not only on the content to be learnt i.e. the JAS-system but also on the training procedures. In fact, it might be necessary to *shift focus* from flying to instruction about flying. This study might constitute one part of that focus shift.

It will be necessary to focus on the *pedagogical procedures* of instruction as well as on *evaluation procedures* in order to start a systematic knowledge building process. The above mentioned openness concerning flying might well be stretched to include issues of instruction as well. In the community of practitioners various narratives concerning instructional problems might fulfill that role. Thus, the discourse concerning instruction would serve the dual roles of being both a problem solving forum and a repository for common knowledge.

The community discourse about day-to-day problems should also be supplemented by an *armoury of conceptual tools* (like those presented in this study). Theoretical discussions would also give the participants a more realistic conception of the role of educational theories. Without a conceptual awareness the practitioners tend to view educational theories as recipes from a cookery book. In other words, the practitioners have to substitute theories as *guides* of what to pay attention to for ideas that instruction is a matter of applying theoretical methods to practical situations.

Conclusions

The participants of the military setting constitute a homogeneous group. They are dressed alike and they gather in a very special place. Like the distance education students (see p. 70) the pilots are there to learn a very specialized content. However, there is a great difference comparing contents: the distance education students learn an entirely conceptual tool, whereas the pilots not only learn conceptual tools but above all they train a particular skill i.e. to fly the JAS 39 Gripen. Still, general content is quite pronounced in this study. Actually, the purpose of the original project (Fransson & Jonsson, 1999; Fransson et al., 1999; Jonsson, 2001) was to evalute the training procedures and propose suggestions for change.

The result of the study shows that the instructors experience feelings of concern as to instruction. It seems they think they instruct in their own home-made way, but it might be possible to learn other ways if they only had the time: "*We do it in our old fashion. In Halmstad they are a bit more up-to-date*". Evidently, there is an idea that there is "a better way" and thus they feel "inferior" in a way. As to a reflective attitude towards instruction, the pilot study is different from the distance education study. *Pilot instructors*

actually focus on the instructional design when comparing their own setting to the other one in the quotation above.

Finally, this evaluation has a pronounced theoretical emphasis and it has primarily targeted the system level. This has sometimes been a dilemma for researchers as well as instructors. The instructors had great expectations that the evaluation would come up with immediately applicable results i.e. they expected advice on how to do. A common desire among the instructors goes: "*We want to know if we do it right*!" However, even if the evaluation did not focus the individual or practical level there is still an abundance of information in the result of this study that may enhance individual instructors' conception of the day-to-day practice.

CONCLUSIONS

STUDYING APPROPRIATIONS OF TECHNOLOGY IN EDUCATIONAL PRACTICES

The investigations in this thesis are based on the assumption that processes of technology appropriation will differ between practices. Thus, the different practices will get a kind of independent variable status upon which many of the characteristics to be described are dependent even if not caused in strict sense. Repeating some of the commitments stated in the introductory section this thesis aimed at:

investigating how technologies are brought into and are realized in educational processes in different contexts

investigating and theoretically sustaining how practitioners introduce and make use of technology in their respective practices

Below these two commitments will be reflected upon. Firstly, the *characteristics* of the different *contexts* investigated are surveyed. Secondly, the *analytical approaches* are reflected upon. Thirdly, the *appropriations in practices* are viewed through a theoretical model. Finally, in a *concluding* section six themes of which at least some may deserve further research in the future are reflected upon. The thesis ends with a short reflection on the whole project.

CHARACTERISTICS OF CONTEXTS

The thesis presents four different studies. General characteristics of the settings are summarized in the table below (Table 3). The table can be read with different foci. Viewing the different settings, the studies presented have either an *instructional focus* or a *systemic focus*. This division is indicated in the table with a vertical line. The two columns can be further divided into instructional focus in different settings and systemic focus in different settings. This is indicated by the dotted lines. The horizontal lines group the table into properties of actors, content, and technologies made use of .

Table 3. Table showing characteristics of settings. The x denotes evident occurrencies whereas (x) denotes less evident occurrencies.

	Instructional focus		Systemic focus	
	Making Sense	*Pract Dist*	*Dissem ICT*	*Cond Pilot*
Actors				
Young	x			
Adult	x	x	x	x
Content				
General	x		x	
Specific		x		X
Technology				
Optional	x	x	x	(x)
Necessary	(x)	(x)	(x)	x

In constructing the table, *actors* were substituted for students. Initially students' properties were considered a distinguishing variable among settings. However, all individuals investigated in the studies are not students; hence actors might better fit the empirical realities.

Considering *content*, the initial dichotomy was based on a view that schools deal with a general content, whereas engineering and pilot training deal with specific content. General content cannot easily be planned, sequenced, and instructed according to standardized patterns. Specific content, on the other hand, it was argued, has an inherent structure that will guide planning and eventually the instruction. According to this view, content will influence instruction as well as curriculum issues.

As to *technology* the dichotomy optional-indigenous was initially considered to capture the fact that educational practices could, on the one hand, choose to use a particular technology and, on the other, technology was something that really belonged to the practice. This could be exemplified by the factual difference between didactic software for mathematics comprehension in primary school for example and the role of the flight simulator in pilot training. However, the optional-indigenous dichotomy might be better represented by the dimension optional-necessary. The latter alternative is better, because the indigenous alternative, strictly speaking, would only be applicable to pilot training. No other practice in this study has such an indigenous technological artifact as the flight simulator.

The table might also be viewed line by line, the x:s indicating the ocurrance of something. It should be noticed, however, that even if indicated by x:s across the columns, this does not denote general similarity between x:s in

different practices. Adults in the *Making Sense* column might differ in a lot of aspects from adults in the *Cond Pilot* column. Still, they are adults.

"Actors" in all cases involve adults making use of technology. The *Dissem ICT* alternative also has young students as their target group but the results of the representing study have adult actors in focus. Only in the *Making Sense* alternative there is a direct focus on young students.

"Content" in the studies of he primary, secondary, and upper secondary education is a general content i.e. it does not aim at vocational training. Also, the entire disseminating endeavour in the *Dissem ICT* alternative can be considered general in the sense that schools may choose what to implement and how to do it. Higher education and pilot training represented by *Pract Dist* and *Cond Pilot*, on the other hand, are considered dealing with the training of specific contents, meaning that they have delimited goals and specified ways of attaining the goals.

"Technology" in some respects might be subject to different interpretations. The table shows that all settings make use of optional technology. This means that they can choose among technological resources according to a professional decision. When practitioners of primary schools choose to use didactic software for practicing of spelling or of basic mathematical skills it is quite optional. Likewise, when university professors choose to apply video-conferencing techniques in a course for doctoral students, this is also quite optional. Even within pilot training there are some optional technological artifacts (see p. 152 ff.). The only undisputedly necessary aspect of technology is represented by simulator training in the pilot training study. In all other cases, though, the degree of necessity is not so clear-cut. This does not imply, however, that schools could choose not to use technology. Still, it might be negotiated in each case. What technology is necessary in compulsory education? Do the engineers need the technology as an aid to comprehension? This is indicated by (x) in the table.

ANALYTICAL APPROACHES

The observer of an educational practice, metaphorically cutting slices of time, will perceive the realization of a practice. Depending on the purpose of

the observation it will either suffice to describe the realization or it will be necessary to penetrate the surface and make a theoretical account.

Theoretical accounts of practices do not imply that the practices be forced into theoretical frameworks. Theory is more like an illuminator (see p. 30). Goodwin (1994) describes how the expert vision has a capacity to discover and conceptualize phenomena that otherwise would not be discovered. This is also the role of the analyses of this study (cf. reification p. 32). They focus on aspects of day-to-day activities and relate these to theoretical contexts, thus the professional vision also implies an attitude towards the observed phenomena i.e. it constitutes a perspective that can be questioned by other perspectives or modified by new data. Below the approaches will be reflected upon.

The studies taken together can be described as a corollary of analyses representing different abstractional levels. In *Practising Distance Education* the analysis is above all descriptive. It is a grouping of content into different qualitative categories and in the end the result is submitted to further reflection subsumed under the categories technology, design, and participation (see p. 82 ff.). Above all, the study is guided by a desire to account for events on a descriptive level. What is shown in the study might be viewed as an example of *innovation-focused discourse* (see p. 21).

In *Making Sense of ICT in Class* the analysis begins to leave the descriptive level. From short descriptions serving as illustrations the analysis soon advances to the conceptual level. In the first step, categories are what might be labelled *substantive*. However, the study ends with a preliminary *formal theory* of sensemaking in educational practices. The preliminary theory is represented by a conceptual model of the appropriation processes (see p. 65).

Disseminating ICT in Educational Practice unifies the approaches from the preceding studies mentioned above. On the one hand, it utilizes detailed descriptions of educational practices and, on the other, it conceptualizes the described practices. So far the approach is similar to the one used in *Making Sense of ICT in Class*. However, there are at least two important differences: the focus is on the systemic level and the conceptual analysis is further related to an activity theoretical framework (see p. 34 ff.). A necessary first step for an AT analysis is the identification of an activity system, not just

generally but applied to the targeted setting. In *Disseminating ICT in Educational Practice* descriptions and concepts from the analyses are conjecturally discussed from an activity theoretical perspective. However, the activity theoretical analysis is only tentative because of the character of the research conditions i.e. the studies of school settings were not originally designed to be activity theoretical studies. Therefore, the analysis should be viewed as a suggestion for studies of practices that would benefit from activity theoretical analyses when practitioners encounter dilemmas and contradictions.

By comparison with the school studies above, *Conditions of Learning in Pilot Training* was designed to be an activity theoretical study. A necessary prerequisite for such a study is that the researcher focuses on a single workplace for some time. In the pilot training study, the activity theoretical analysis is applied and demonstrated in a real context (see p. 173 ff.). In this study all the foregoing approaches converge. It contains extensive descriptions of day-to-day practice, (substantive) categorization, theoretical conceptualization, and an activity theoretical analysis of primary and secondary conflicts in the retraining setting. The activity theoretical analysis makes possible suggestions for future development of the educational setting based on theoretical analyses instead of mere assertions (cf. p. 3).

Conceptualizing Appropriation in Practices

One of the first conclusions of this final chapter can be expressed: *appropriation(s) will be dependent on the perceived affordances of the technology* and not on some inherent quality of the technology. Thus, technologies are perceived in accordance with the cultural values of a practice i.e. they are perceived as being useful for something recognizable. Expressed in another way, the meaningfulness is not intrinsic to technologies. Instead, *meaning arises in a process of interpretation and interaction between participants and between participants and technologies*.

Due to the perceived affordances and the interpretation of technologies, the participants of communities (or practices) will realize technology in certain ways. Conceptually, the realization comes into being when subjects *externalize* their models (see p. 39) within existing practices. These relationships can be viewed as the conceptual foundation for the result of this thesis.

However, processes are never frozen. The slices of time mentioned above are necessary components of a dynamic account of appropriation. The metaphor of film showing multiple frames of still pictures each second could support the comprehension of a dynamic model of appropriation. Still, the metaphor of film would be misleading because of its linearity.

A dynamic appropriation model, making use of the concepts presented in this thesis, would consist of a community of practice represented by an elliptic enclosure. The appropriation context, the community of practice, is visible as realizations of a technology mediated practice. Different realizations will be constituted out of events that may be described and observed. Activities, though, are theoretical entities not directly observable. What can be observed are the different actions constituting an activity (see p. 34). For the model to work, making it possible to account for the appropriation and the resulting externalizing of tool mediated activities, also the time perspective needs to be taken into account. Thus, the model will explain the changed realizations and eventually changed practices, which will be the outcome of the appropriation process (Figure 21).

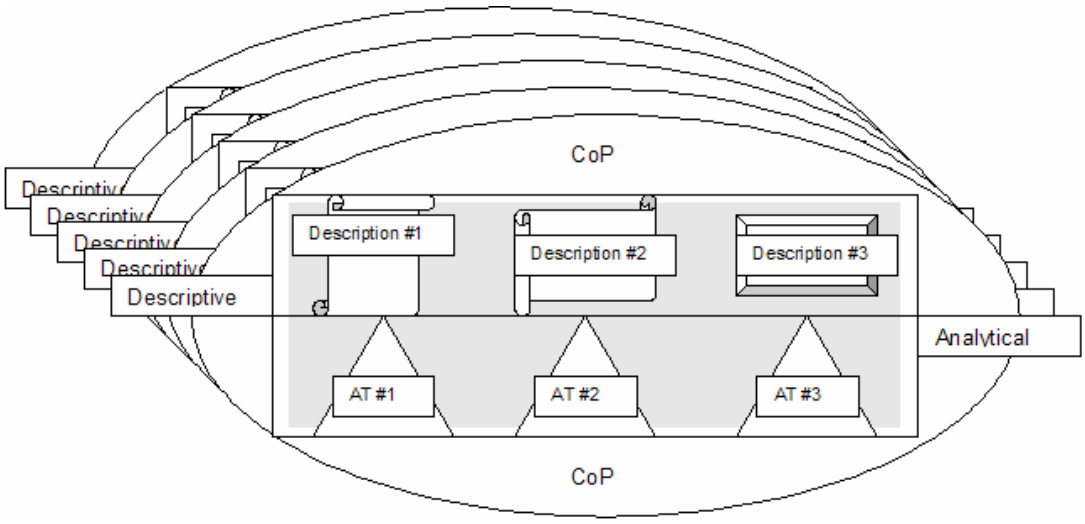

Figure 21. Integrated model of the appropriation process. Oval shape represents a community of practice. Shaded rectangle represents realization of technology in a community of practice. Horizontal line divides descriptive level from analytical level. A realization can be characterized on descriptive as well as on analytical level. Triangles symbolize theoretical models of descriptions # 1, 2, and 3. The layers of recurrent shapes symbolize changes as the outcome of the appropriation process at different times.

In sum, the studies of this thesis represent varying degrees of closeness to empirical findings. They constitute a continuum from pure descriptions to treating data as indices of phenomena (Haig, 1995; Kinach, 1995). Descriptions are needed for attaining recognition, sometimes a smile of recognition as evidenced by some of the fighter pilots who really enjoyed reading the descriptions of themselves in day-to-day practice. Conceptualizations are needed for penetrating into practices and understanding phenomena not directly observable.

CONCLUSIONS

A commonly applied conception of development is the *vertical* movement from an inferior state to a superior one. This is what is normally inferred by faster, better and more effective. This one-dimensional, upwards, conception of development is not supported by the results of this study. However, the vertical direction is applicable as a way of representing past, present, and future, yet without actually considering present superior to past. Also a *horizontal* direction is paid attention to when the participants of an activity incessantly move between conceptions of present practice, the theoretical model of a practice, and new ideas for change (see p. 178). Engeström's concept of expansive learning is *circular* or rather spiral shaped (see p. 34 ff.). Wenger's processes of change (see p. 32) do not have a particular direction. Instead it is a matter of mutual appropriation. The creek *meandering* in the soft ground is a quite good metaphor since it entails a mutual influence of ground and water. Wenger's metaphor focuses also on the time perspective and the mutuality of development; practices will change in due time but so will the tools as they are appropriated. In sum, *appropriation is neither entirely predictable nor uni- directional* (see p. 30).

Quite interestingly, in this study the schools from primary to upper secondary represent the settings, where the actors most eagerly say that educational context must be changed. The arguments for this attitude are not always easy to follow but most often they are wrapped up in a *rhetoric* of being "up-to-date", "jumping on to the train", "preparing students for the future", and so on. In higher education, though, the arguments are quite distinct. Education needs to be reformed to attract more students, to increase flexibility, and to cut the costs for instruction. In other words, the *economic* realities play a major role. Efforts to make use of information technology will

not entail a consideration of instructional modes, at least not initially. Conjecturally, this might be related to the properties of educational content. The distance education study and the pilot training study both have quite delimited learning goals. Here the *goals are focused rather than methods* to attain them. General schooling though has very general goals which are difficult to assess. This frustrating condition seems to end up in a situation where *methods of instruction are focused rather than goals*.

The results from the studies presented indicate that technologically skilled persons are not necessarily didactically skilled. This may be turned into a generic conclusion saying that *technological skill does not necessarily entail a didactic skill*. Conjecturally, the reverse may also be a valid statement i.e. *experienced educational staff might lack the skills necessary to make optimal use of technology in education*.

Moreover, the settings which are best supplied with technology seem to be the ones with the most traditional instructional methods (see p. 23 ff.). Even if the distance education described above (see p. 70), could be described using constructivist concepts, meaning that students work together and have hands-on experiences, it will certainly not include a negotiation of content to be learnt as in a negotiation scenario (see p. 23). Neither will pilot training be carried out using individually constructed strategies (Find out the best way to fly a JAS 39 Gripen!). Actually, the focus is on transmitting educational goals taking instructional methods more or less for granted. Thus, *any seemingly innovative trait of using state-of-the-art technology might actually serve quite traditional transmission scenarios*.

However, the concept of "traditional" still deserves some reflection. In common talk the word traditional" often comes bundled with negative connotations like old-fashioned, deficient, or inappropriate. Yet, it might be wise to ask why an instructional setting applies a certain methodology. In pilot training for example, the instructors are responsible for the security of their learners meaning that certain procedures have to be carried out. Thus, any instructional whim is out of question. It is evident that the choice of educational approach should be adapted to educational content as well as to the group of students to be taught. Specialized content with well-established structures may require a different approach compared to general content characterized by evaluation and interpretation. Likewise, inexperienced students might not benefit from the same teaching strategies as more

experienced students. Therefore, any educational setting should be judged taking its particular conditions into account; not ruling out educational approaches automatically, may be wise. In fact, the relation between teaching methods and content might deserve increased future attention, particularly when ICT becomes even more frequent on all levels of the eduational system. The current emphasis on both individualistic and collaborative approaches puts the educational practitioner in an ambivalent situation. Some research cited in this thesis indicates that it might not be a successful strategy letting the teacher be just "the guide at your side".

Also educational change in a general sense deserves some reflection in. Pilot training is continuously dependent on the development of new technological artifacts and a kind of adaption is built into the practice. On the other hand, its participants constitute a selected and homogenous group. School practices, on the contrary, are not generally heavily dependent on changing artifacts, but they must continually adapt to heterogenous groups of students making use of modern technolgies such as mobile phones, mp3-players and databases with ready-made exam papers. Thus, a kind of adaption is built into school practices as well. Accordingly, the concept of change and adaptive practice must not be reserved for just particularly conspicuous activites in educational practices.

In the light of the results presented in this thesis, it can be argued that the processes of bringing information technology into educational practices is a multi-faceted endeavour which will be accomplished neither by rhetoric nor by procedures taken for granted (see p. 3). This thesis wanted to convey a critical approach to contemporary views of ICT in education. Initially, it was pointed out that mere assertions of future outcomes are unsatisfactory for the comprehension of everyday processes in educational practices. A range of researchers cited in the introductory section point out the need for understanding: 1) the interaction between tools and humans in their respective practices, 2) the various realizations in practices, and 3) the seeming inertia of educational practices.

Normally, it is not difficult to find support for critical (or uncritical for that matter) accounts. To contribute to something new and not just to add more of the same kind, in a research field that already seems flooded with ready-made concepts, frequently used by professionals as well as laypersons, a methodological approach targeting processes was adopted. Events from

educational practices were conceptualized and subjected to theoretical analyses with the aim of contributing to an extended discourse.

A major part of the results of this thesis concerns theoretical analyses of processes of educational change. To be somewhat self-critical, methodological efforts might evoke an interest primarily among researchers. Even many researchers will probably be sceptical towards research that does not result in recommendations or directly applicable results. The layperson might find the methodological endeavours without particular use and ask for more tangible results. However, anyone who finds it worthwhile to muddle about among processes will eventually view the issues of technology appropriation in education from another perspective. An example might clarify this: when judged from a map or from the top of a mountain, the distance between two locations in the mountains might not appear to be an overwhelming effort for the backpacker to walk. Once he starts off, he will soon run across a lot of obstacles not previously perceived; he has to cross streams, make his way through shrubbery, and fight the mosquitos, not to mention that the distance is now much longer than expected. Hopefully, the studies of this thesis will give an additional perspective on the processes of technology appropriation in educational practices thereby contributing to a widened comprehension.

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