Implementation of ICT in Higher Education as Interacting Activity Systems

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ABSTRACT
Implementation of ICT in higher education is not a trivial process. It is however a process leading to a number of challenges and problems. The paper develops a theoretical model of the implementation of ICT in higher education based on activity theory and on a case study in a Danish university. The model suggest that implementation in itself is an activity system. The implementation activity is composed of three processes: Selection of ICT; adaptation of ICT and change of practice with ICT. Furthermore the model suggests that the implementation activity interacts with and systems development activity and an educational activity. Based on the model and case study the paper suggests a framework of challenges that must be met for an implementation to succeed.

Keywords
Implementation of ICT, higher education, activity theory

INTRODUCTION
Implementation of networked learning in higher education is a complex task. It affects the way students learn, teachers teach and often the way administrators administrate as well as the way leaders lead the university. It does so by challenging existing organisational, pedagogical and technological practices and the aims normally are to increase quality, efficiency, flexibility and quantity. Research in Computer Supported Collaborative Learning (CSCL), networked learning and related subjects has already stated that ICT influences from a organizational as well as a pedagogical perspective, but a deeper understanding of the implementation seems to lack (Collis & Moonen, 2001; Dirckinck-Holmfeld & Fibiger, 2002).

Higher education thus needs to explore ways to organize implementation of ICT in learning environments. Bearing in mind the continuous development of ICT it also seems important to recognize that implementation of ICT isn't going to be a one time event. One of the very first steps needed in order to qualify the facilitation of the change processes is to actually understand what implementation of ICT in learning environments is and how it affects practice. Here implementation is defined as *the process leading from one practice to a new practice where the new practice is characterized by use of ICT*. In addition implementation is understood firstly as a social process and secondly a process in which competent individuals decides to start to use ICT.

In the literature inspiration on how to interpret and understand implementation of ICT and networked learning can be found in at least three disciplines: Systems development, organisational learning and theory on diffusion of innovations. Firstly theory on systems development explains to develop ICT in general and seek to ensure that the products meet user demands and needs, but a focus on implementation seem to lack (Banks *et al.*, 2004; Beyer & Holzblatt, 1997; Dahlbom & Mathiassen, 1993). It seems to be an implicit assumption that the implementation process is crucial, but also that one has to look elsewhere for information on how to design or support the process. Secondly theory on organizational learning contains relevant aspects since implementation of ICT is closely linked to organisational changes. However the focus on ICT is traditionally relatively blurred (Argyris, 1999; Von Krogh *et al.*, 2000; Wenger, 1998; Wenger *et al.*, 2002). Thirdly theory on diffusion of innovations focus on the process of adopting new technologies (Rogers, 1995). However it tends to overlook some of the complexity of an adoption. It is as if adoption is either full adoption is none at all (Bøving & Bødker, 2003; Gallivan, 2001).

With the present paper I unfold one possible way to strengthen the theoretical foundation for understanding implementation of ICT in higher education. I do so by drawing on the theoretical framework called activity theory. Activity theory seems relevant because it is already widely used to understand learning and development processes and useful when it comes to tying individual, organisation and technology together in one framework.

The rest of the paper is divided in four sections: Activity theory as perspective on implementation, Case study design and analysis based on activity theory, Analysis and Conclusion. Activity theory as perspective on implementation gives a short introduction to activity theory and argues why and how this perspective contributes to the understanding of implementation of ICT in teaching and learning. The section concludes by suggesting a theoretical model of the implementation process and it's relation to other processes. The section Case study design and analysis based on activity theory presents a case of implementation of ICT in higher education that is analyzed in the section Analysis. The analysis is structured around the theoretical model suggested and it is concluded firstly that the theoretical model is feasible and secondly that a set of specific problems that must be solved for the implementation to succeed can be identified. The section Conclusion summarises the findings.

ACTIVITY THEORY AS PERSPECTIVE ON IMPLEMENTATION

Introduction to Activity Theory

Activity theory derives from Russian psychology where psychologists as Vygotsky (Vygotsky, 1978), Luria (Luria, 1982) and Leontjev (Leont'ev, 1978) developed a cultural historical social psychology during the 20th century. Over the past 10-15 years activity theory has been subject to growing attention. Yrjö Engeström (Engeström, 1987) and others have developed activity theory to use on pedagogical development and design of software and the practice it aims at. Kari Kuuti has also taken part in the development of activity theory and defines it as:

"a philosophical and cross-disciplinary framework for studying different forms of human practices as development processes, with both individual and social levels interlinked at the same time." (Kuutti, 1996).

This however also means that activity theory cannot be regarded one complete coherent theory. I thus want to give a brief introduction to the elements of activity theory I draw on bearing in mind that other traditions or foci within activity theory is left out. My point of departure here is the works of Leontjev and Engeström. Leontjev took his point of departure in the works of Vygotsky to continue the development of a cultural historical psychology with focus on the dialectics of human development. Leontjev worked on the key concept *mediation*. He did originally focus on tool mediation to explain how a tool carries the result of a cultural historical development. A tool thus also mediates the way the user of that tool perceives the task at hand. Leontjev also introduced the distinction between three different levels of an activity. He distinguished between activity, action and operation – three levels that correspond to motive, goal and condition in human behaviour. Motive is the overarching force driving our actions, but it is normally not given conscious attention. Goal is on the other hand a concrete here-and-now in focus goal we pursue as part of a concrete action. Conditions are the out-of-focus, but necessary conditions for an action. What is motive in one activity may be goal in another and so on . Operations may fail and suddenly be brought into attention and thus converted to an action. In all cases the source of development is contradictions because contradictions force us to consider new practices – new practices that can exist until new contradictions become too strong.

Engeström draws on both Vygotsky and Leontjev, but are less psychologically focused. Instead his focus is on what he defines as developmental work. Engeström has developed the triangular model that shows the main components and mediating artefacts of an activity. In the light of the activity theory the working definition of implementation of ICT as *the process leading from one practice to a new practice where the new practice is characterized by use of ICT* can be elaborated. First of all the old practice can be expected to be part of the new practice since the history is represented either through artefacts, practices, culture, subjects or tools. Activity theory also stresses that implementation of ICT is not only about exchange of two tools. When the new tool offers new possibilities the conditions for practice changes. This may lead to contradictions and thus induce a new practice. It is finally important to notice that new ICT developed in one context and given specific meaning in that context may be given a different meaning in a the use context when it is implemented.

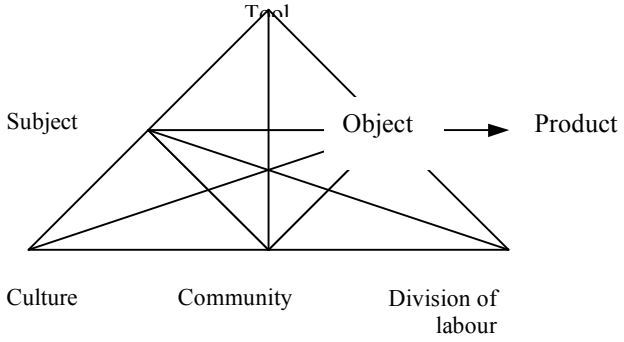

Figure 1. Triangular model of an activity.

Implementation, Education and Systems Development

It is a central argument of this paper that implementation is something in its own right even though it is closely linked to other processes. In the case of implementation of ICT in higher education at least to neighbouring processes can be identified. These are the process ICT is implemented into, higher education, and the process that produces ICT in the first place, systems development. The main theoretical hypothesis behind this paper is that implementation, education and systems development are driven by different motives and thus represent different activities or activity systems. The hypothesis however also is that these activity systems interact and thus influence each other.

If we look at the research literature on systems development there is different definitions of what software quality is (Beyer & Holzblatt, 1997; Dahlbom & Mathiassen, 1993; Vliet, 1993). Some stresses the technical quality while other stresses the needs of future users as a measure of software quality. The literature does however convey the assumption that a prominent motive of systems developers is to create systems of high quality. In the light of activity theory this also implicates that it is feasible to regard systems development an activity. This does not necessarily mean that systems development contradicts implementation of ICT in higher education. It is an important condition to have quality software, but the research on ICT in higher education also stresses that this is not enough.

The general assumption of research in teaching and learning in higher education is that an important motive (but not the only one) for teachers and students is quality education (Biggs, 2003). In the present case teachers and students give high priority to student driven activities such as problem based learning or problem oriented project pedagogy (Kolmos *et al.*, 2004). Data from the present case do however also show the teachers and students prioritize time and resource efficient practices.

Finally the assumption is that an implementation is driven by its own motives and thus can be regarded an activity too. This is based on the assumption that a need or wish for change is a prominent driving force behind implementation. The product of the implementation activity is a new educational practice with ICT. If this assumption is correct it is reasonable to conclude that implementation is an activity in itself because it is driven by a motive different from the motives of systems development and higher education. It is however also important once again to stress the three activities are closely linked. Systems development produces tools for higher education and implementation. Systems development also integrates a certain perspective of which practice tool is produced for. When producing a new educational practice the implementation activity also shapes a practice of which the new tool is a part. In short the systems development and implementation activities primarily interact on the ICT component of the implementation. On the other hand the implementation and educational activities primarily interact on the educational component of the new practice.

The analysis will show that it is feasible to understand implementation of ICT in higher education the way suggested here and add more detail based on a case study. The analysis and concluding section of the paper will also look into possible consequences by suggesting how the theoretical model may inform implementation practices in higher education.

CASE STUDY DESIGN AND ANALYSIS BASED ON ACTIVITY THEORY

The analysis of the case study presented later in this paper is based on activity theory. Frameworks that suggest how to base research and analysis on activity theory have been suggested by researchers in the past. Engeström (1987) suggested an extensive iterative approach that combined investigation and development in an action research like expansive cycle. Kaptelinin, Nardi and Macaulay (1999) developed a more light weight activity

check list that had research in human computer interaction as its primary focus. Here I have selected an approach that draw on both Engeström and Kaptelinin. The present study builds on four cycles of development and data collection in an Engeström inspired manner. The analyses however build on a Kaptelinin inspired check list. In the next two sections I present the case design and analytical strategy.

Human Centered Informatics Case Design and Data Collection

The focus of the research project is implementation of ICT in the program Human Centered Informatics, Aalborg University. Human Centered Informatics is an educational program within the humanities offering both bachelor (3 years) and master level (bachelor + 2 years) education and has approximately 500 students. It combines communication, organisation and ICT studies to provide students with the tools necessary to be critical, but constructive, participants in the evaluation and construction of ICT and new media. The project moved through four iterations involving gradually more students until the full educational program including all teachers, students and administrative staff was involved. The project also used different change and research strategies as shown in table 1.

Iteration	ICT implementation	Involved	Goal	Research method	Data
1. Fall 2001	5th semester of Human Centered Informatics. Teachers free to choose technology.	6 teachers, 21 students	Document existing implementation procedures.	Pilot study of existing practice.	Interviews, ICT used in courses
2. Fall 2002	3rd semester of Human Centered Informatics. Teachers have to use the same technology for communication.	20 teachers, 80 students.	Develop, use and document new implementation procedures.	Action research.	Interviews, ICT based infrastructures created and used, log-files.
3. Spring 2003	4th semester of Human Centered Informatics. Teachers have to use the same technology for communication.	30 teachers, 160 students.	Develop, use and document new implementation procedures.	Action research.	Interviews, ICT based infrastructures created and used, log-files.
4. Fall 2003	All semesters and specializations of of Human Centered Informatics. Teachers are adviced to use the same technology for communication.	60 teachers, 500-600 students.	Use implementation procedures.	Case study of practice.	ICT based infrastructures created and used, log-files.

Table 1. Research design.

The ICT that was the primary focus of iteration 2-4 was Lotus Quickplace. Quickplace is a web-based tool for asynchronous information sharing, communication and collaboration. In this case it was used to distribute administrative information to teachers and students, course information, and to facilitate collaboration between students.

Activity Oriented Analysis

Table one has listed several data sources, but in the analysis the primary data source has been the semi structured interviews (Kvale, 1996). The interview data has been clustered in clusters defined by the central foci of activity theory and the theoretical model of implementation of ICT in higher education suggested earlier:

- Motives, goals and conditions – with special attention to the implementation, educational and systems development activities.
- Subjects (actors) in the activities.
- Mediating artefacts in the activities (tool, culture, division of labour).

- Contradictions internally in one activity or between different activities.

Due to the limited number of pages the following pages are not a full account of the analysis, but an extract of the full analysis reported in Nyvang (2006).

ANALYSIS

Implementation activity

Data supports the basic hypothesis of the paper. Patterns in the data material show that study and educational practice with ICT is the central object of an activity whose motive is to develop teaching and learning by implementing ICT and developing a new practice around it. The patterns of the implementation activity that all actors involved return to over and over again are *identification of needs for development with ICT*, *choice of ICT* and *development of practice with ICT*. These patterns equal the goals of the activity.

The implementation activity is also characterized by different prominent mediating artefacts. First and foremost tools already present in the organisation have shaped the implementation in at least two ways. Firstly needs for development have been formulated as a reaction against existing tools. Secondly development of practice has had roots in the existing practice and has thus also had to deal with the infrastructures laid out by existing tools. Tools in focus are tools that the people driving the implementation know based on other professional or private activities they are involved in. Finally the existing pedagogical model is a sort of tool that influenced choice of tool and change of practice.

Culture is another highly influential mediator in the present case. The pedagogical model is also part of the culture of the organization. It is thus expected that new tools and a new practice supports problem oriented project pedagogy or at least doesn't contradict it. The high degree of freedom for teachers and students to choose their own tools and work methods is another highly influential aspect of culture. In the light of this freedom it is not a surprise that the implementation readiness is greater with individuals or smaller groups that implement on their own initiative. In the present case this freedom was challenged by the program wide implementation of Lotus Quickplace.

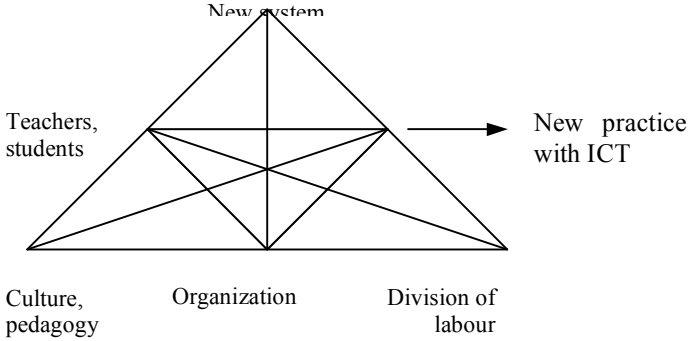

Figure 2. The implementation activity.

Division of labour mediates the division of labour between management, teachers, students and other actors involved. In the present case development of a new practice by implementation of ICT was used as an opportunity to introduce a new division of labour between teacher and students by some of the teachers. The teachers wanted to move away from traditional lecture based teaching to a learning and learner centered approach. It did on some occasions induce a contradiction between the expectations of teacher and students.

Interaction between Educational Activity and Implementation Activity

In the present case the relation between the educational activity and the implementation activity is obvious. There is full or partial overlap between subjects, culture and tools. The two activities are actually directed towards the same or part of the same object. The shared part of the object can be defined as *educational practice*.

One of the clearest examples of interaction between the two activities was observed when groups of students that were in the midst of the implementation process turned the implementation into a study object. They did so by making it the focus of a semester project. In that way the implementation process had direct impact on not only the form but also the content of their study process. The same group of students suggests that the students are given more opportunities to shape the implementation of ICT as a result of projects like theirs. They do so in recognition of the importance of personal involvement. They stress that the implementation of new ICT is more likely to be a successful part of student practice if the students feel involved, responsible and thus develop personal ownership of a new tool and practice.

It is also possible to trace a tendency to interaction between the two activities among the teachers. One of the teachers explicitly refers to the relation between teaching and implementation because implementation of ICT in his teaching is one of the ways he keeps his knowledge of the technical issues he teaches up to date. The technical challenges he experiences in programming a web interface is thus an integral part of his personal professional development. The same teacher also refers to the interaction between teaching and implementation. When the same question or problem has come up a significant number of times in his classes he changes the design of his web-based course materials. It is however a very small number of teachers that explicitly expresses links that close between the two activities. Other teachers express the link in a less direct way by asking if the engagement in the implementation project really pays of and can be justified by improvement in teaching and learning.

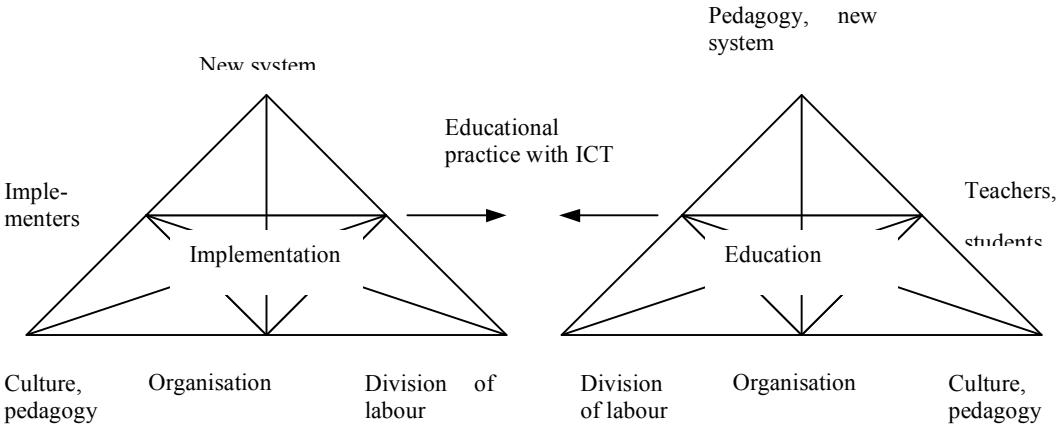

Figure 3. Implementation and educational practice - interacting activity systems.

Interaction between Systems Development Activity and Implementation Activity

In the present case the relation between the systems development and implementation activity surfaces in at least two ways. Firstly systems development activities have produced the tools already in use as well as the new tools to be implemented. Secondly the relation steps into focus when the negotiation between the affordances of what has been developed and the needs defined by the implementation activity starts. The two activities interact on a shared object that can be defined as *ICT for educational practice*.

The interaction on the shared object first appears when in-house system developers and their ideas about the specific needs of the organisation are challenged by the new system Lotus Quickplace. There is a debate on the difference between existing systems and the new one. There is also a debate on the actual needs of the organisation. The in-house developers on their part stress the importance of a light weight communication platform that is easily accessible from different clients. The implementation activity however aimed for a tool that was easier to customize into for example course portals by end users such as teachers or students. Case studies during the early iterations of the development project made it clear that both the old and the new solutions had their qualities. It turned out that many users had preferred a new tool that were as light weight and easily accessible as the old communication system and on the other hand had the support for design of new structures and content that the new tool, Lotus Quickplace, offered.

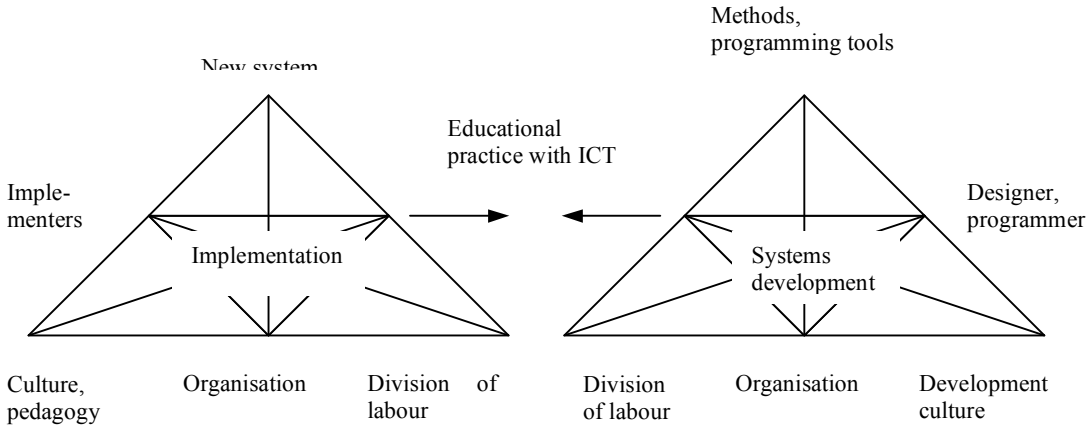

Figure 4. Systems development and implementation – interacting activity systems.

CONCLUSION AND IMPLICATIONS FOR PRACTICE

The paper has a twofold conclusion. First of all the model of implementation of ICT in higher education is a theoretical output. The model supplements earlier research (Gallivan, 2001; Rogers, 2002) with its focus on the influence of personal motives and goals. Implementation is thus not only about management driven decisions. It is also a complex negotiation between factors that are often contradicting each other. The theoretical model also contributes with its focus on the domain of higher education.

The model does however still need to be challenged by new cases in new contexts to strengthen its empirical base. It also has to be considered how the relation between the individual in focus here and the overall strategic level of the organisation can be introduced in the model.

The second aim of the paper was to use the theoretical model and case study to extract a list of the major challenges that need to be handled for implementation of ICT in higher education to succeed. In table 2 the challenges identified are listed.

	Implementation	Implementation in interaction with education	Implementation in interaction with systems development, operation and maintenance
Motive	What is the overall motive that drives the implementation? What steps are taken to secure broad ownership of the motive?	How does implementation influence education – an opportunity for radical change or smaller steps? What steps are taken to secure broad ownership of the motive?	How does the new ICT fit with ICT strategy in terms of for example platform, open/closed source and standards?
Goal	How is ICT selected, adapted and used to change practice?	How do the new practice and ICT fit existing practice with ICT? How are contradictions resolved?	How does new ICT integrate with systems in use? How are contradictions resolved?
Condition	How are the future users trained to use the new ICT?	Are old course materials and structures transferred to the new ICT? If so, how?	How are existing user databases transferred to the new ICT? How are challenges handled?

Table 2. Challenges for implementation of ICT in higher education.

Table 2 represents challenges that have been identified in the present case and organises them in a structure extracted from the theoretical model of implementation. The most prominent and most difficult challenge is probably the need for a broad ownership of the implementation and its results. Without broad ownership among the potential participants in the implementation they are likely to ignore implementation of ICT or engage in a competing implementation project. The present case has shown that this challenge is most efficiently met by involving as many actors as possible in the mid-level activities. Personal involvement of the decision and design

process has not surprisingly turned out to induce ownership. It is however also quite difficult to develop a new infrastructure for communication and collaboration this way. For such an infrastructure to succeed it obviously needs to be shared between a number of individuals, but often the needs expressed by different individuals contradict each other.

There is also still work to be done of the list of challenges. Firstly it needs test and elaboration against other data too. Secondly it should be developed to suggest strategies or heuristics that prepare implementers to meet the challenges.

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