Reproducing Traditional Discourses of Teaching and Learning: Studies of Mathematics and ICT in Teaching and Teacher education

Studies in Applied Information Technology, Report 12, May 2012

REPRODUCING TRADITIONAL DISCOURSES OF TEACHING AND LEARNING: STUDIES OF MATHEMATICS AND ICT IN TEACHING AND TEACHER EDUCATION

CATARINA PLAYER-KORO

Doctoral Dissertation

UNIVERSITY OF GOTHENBURG

Department of Applied Information Technology
University of Gothenburg
SE-412 96 Gothenburg
Sweden

ISBN: 978-91-628-8466-6
ISSN: 1652-490X;12

Doctoral Thesis in Applied Information Technology towards
Science of Education,
at the Department of Applied IT, University of Gothenburg.

Centre of Educational Science and Teacher Research, CUL
Graduate school in educational science
Doctoral thesis number: 17.

In 2004 the University of Gothenburg established the Centre for Educational Science and Teacher Research (CUL). CUL aims to promote and support research and third-cycle studies linked to the teaching profession and the teacher training programme. The graduate school is an interfaculty initiative carried out jointly by the Faculties involved in the teacher training programme at the University of Gothenburg and in cooperation with municipalities, school governing bodies and university colleges.

To my mother

ABSTRACT

Title:	Reproducing Traditional Discourses of Teaching and Learning Mathematics: Studies of Mathematics and ICT in Teaching and Teacher Education.
Author:	Catarina Player-Koro
Language:	English
Keywords:	teacher education, educational technology, ethnography, mathematics teaching and learning, policy, discourse
ISBN:	978-91-628-8466-6

This thesis is primarily concerned with the effects of education for future teachers in the context of the Swedish teacher training (Government Bill 1999/2000:135 2000). It belongs to a theoretical tradition in which the education system is viewed as a key factor in cultural production and reproduction in educational practices through symbolic control (Apple 2009; Ball 2006; Bernstein 2000, 2003). Symbolic control defines how forms of social interaction affect what is possible to think, say and do in different situations.

The thesis is focused specifically on student mathematics teachers learning to become teachers of mathematics. It has a particular focus on the materials used in this, the meanings given to these materials and the identities produced through the possible embodiment of these meanings. The use of different educational technologies, including in particular ICT, has been of special interest. It aims therefore to understand both how mathematical discourses are produced and reproduced in teacher education and how this colours student teachers' views on mathematics and their professional identity (Bernstein 2000, 2003; Valero 2007).

The main outcomes of my thesis are that through the way that mathematics is taught and learned, mathematics teacher education in practice reproduces traditional ways of teaching and learning. This in that mathematics instruction is built around a ritualized practice based on the ability to solve exercises related to an examined-textbook-based content.

ICT use in this context is not transformative. Rather it seems as if teaching and learning with digital technology operate as a relay in the reproduction of traditional forms of education practice. This is contrary to the intentions to renew and revitalise mathematics education and the thesis thus suggests that there is a need to scrutinize the way new technology is formulated in official discourses and appropriated in educational work.

Two other things are also noteworthy in the thesis findings. The first is an increased emphasis on formal subject content through recent policy developments. This re-emphasis reaffirms the value of authoritative subject studies content as the central and most important component in the professional knowledge base. On the basis of the finding from the thesis the logic of the reform may be questioned. Also important is the ICT discourse that is constituted in wider society by selected agents. In this discourse digital technology often in many ways defines (post)modern society and the position it and education have as a driving force toward economic competitiveness. An alternative, more reflexive and critical approach where questions about technology uses in education are emphasized is suggested as necessary.

ACKNOWLEDGEMENT

My years of postgraduate training have definitely been the best thing that happened so far in my career. There are many who I would like to thank; both those who in various ways have made this journey of discovery and insight possible, but also those who have supported and helped me in various ways along the way. Writing a dissertation is a transformative process where obviously an important part is embracing the academic art of writing. This is of course only made possible by reading countless articles, books and theses. Only then can one start ones own investigation, interpretations and analysis. This process has a profound affect on the self as well as influencing those who are close in a most tangible way. These people have travelled with me on my roller coaster ride through the various phases of joy, struggle, hope and despair. Therefore, I must start by thanking them.

My main supervisor Dennis Beach has been a rock throughout the research process. Thanks Dennis! I do not think you have been aware of how much your wise comments and your keen intellect, which you have generously shared, has meant to me. With respect, you have listened to me, read my texts and with me brought the work forward. I'd also like to thank my co-supervisor Berner Lindström, whose sharp critical questions have highlighted doubts in my writing and that led me to sharpen my arguments and further substantiate my claims.

All of the colleagues and friends who have been close to me have been especially important. Among these, let me mention three people who in different ways and at close quarters have shared both the joys and the hardships. These are Lena Tyrén, Annelie Schwartz and Solveig Sotevik, a big and heartfelt thanks to you. Thanks also to everyone else who supported me in different ways, you know who you are.

Without my family I would never have had the power and motivation that was needed. My mother has been influential here. Her strong awareness of the importance of education for less privileged groups of people has influenced many of my choices in life, including this. My husband Istvan has been invaluable in many ways. First, by being my life partner, and supporting me in every way possible. He has devoted hours to listening to and discussing to the greatest and smallest details, and thus helped me to

find ways to take another step towards completion of this thesis. He has also together with my beloved children Stefan and Catalin put up with the papers scattered all over the floor and with a distracted and sometimes frustrated mother and wife at their side. My children have been a great joy and inspiration. Catalin has patiently listened and wisely commented and reflected on divergent philosophies and ideas. Stefan with his sense of humour and his perceptive comments has often reminded me that life goes on around us. I also want to especially thank my sister Kicki. Without her transcription help I probably would not have been ready in time.

In addition to the people mentioned I would like to thank the various organizations that have made this thesis possible. First and foremost, the University of Borås whose financing has made my graduate studies possible. Also the research seminars at the School of Education and Behavioral Science, which in different ways enriched the development of my knowledge. I am also grateful for all the people involved in the Graduate Center for Educational Science and Teacher Research (CUL) and its team grouping New Media, Education and Learning in the subject Applied Information Technologies who in various ways contributed to my education and scientific production.

Kinna March 2012

Catarina Player-Koro

CONTENTS

PART TWO:SUMMARY

PART THREE: THE ARTICLES

ARTICLE 1

Player-Koro, C. (2012a). Factors Influencing Teachers' use of ICT in Education. *Education Inquiry, 3*(1)

ARTICLE 2

Player-Koro, C. (2012b). Hype, hope and ICT in teacher education: a Bernsteinian perspective. *Learning, Media and Technology*, 1-15.

ARTICLE 3

Player-Koro, C. (2011). Marginalising students' understanding of mathematics through performative priorities: a Bernsteinian perspective. *Ethnography and Education, 6*(3), 325-340.

ARTICLE 4

Beach, D., & Player-Koro, C. (2012). Authoritative Knowledge in Initial Teacher Education: Studying the Role of Subject Textbooks through Two Ethnographic Studies of Mathematics Teacher Education. *Journal of Education for Teaching, 38*(2).

Part One

PRESENTATION OF THE RESEARCH

CHAPTER 1
INTRODUCTION

Over the past decade the educational system and Sweden's schoolteachers have been in the foreground of the public media where they have been chastised and critiqued. Schools, it has been written and reported, have a lack of focus, a lack of discipline and are characterised by poor-quality learning. Much of this educational debate however has gone on with little empirical substance, with the main argument being that students/pupils in school have too much freedom and that we must return to teaching in more 'traditional' ways. We need to restore discipline it is said and there is 'bad' knowledge that has pushed aside 'good' knowledge (Apple, 2009; Ball, 1990).

This debate has functioned alongside the introduction of a new policy paradigm for teacher education and has worked almost as a raft for launching 'new ideas' for teacher education activities in the country through new policies (Government Bill 2009/10:89, 2010; SOU 2008:109, 2008). In this recent round of reform there has been a break against the previously established reform trajectory that had going on since 1948 where one of the main ambitions was to create a unified teaching profession with a common knowledge base for teachers in compulsory school (Beach, 2011a; Sjöberg, 2011). This was part of an effort to break the previously bifurcated holding that derived from a differentiated school system with its roots partly in a seminar tradition focusing on practical aspects of teaching directed to teaching of younger children, and partly in the academic tradition focusing on subject studies, directed to older children and adolescents. These two types of schools gave rise to different educational traditions and ways of perceiving what characterizes the teachers' mission and professional expertise (Jedemark, 2006; Åstrand, 2006).

The 'new' ambition written in the latest round of policy involves a return to a dualist knowledge base for teachers. It redefines the primary mission of teacher education as one of providing a subject matter to student teachers, together with the skills of effective teaching tailored to pupil age and maturity (Sjöberg, 2011) and was motivated by the right-centre coalition government for what they term to be a highly needed return to basics for reasons of social democratic policy failure. Teacher education needed to return to a structure that reflects the dualist characteristics (i.e. primary – secondary school) and related knowledge needs of the school system as a whole it was argued (Government Bill 2009/10:89, 2010; SOU 2008:109, 2008).

The present research was conducted at the same time as the education debate and policy reform took place. One of its functions has therefore been an empirical one, to make visible, describe, analyze and understand the impact of educational reforms and policies on the process of education and to understand education policies, institutions, and outcomes from the standpoint of those who are involved in the social and cultural process of education.

I have tried to attain these ambitions by describing; analyzing and reflecting over the political, social and cultural foundations that structure educational practice and, from a critical perspective, by problematizing what happens in social relations close to on-going and often quite complex educational practices. I have done this in order to be able to better understand and write about the development of education and student subjectivity.

Six empirical studies have been conducted to the above ends. Four of these are presented as articles in the thesis (in part three) and two are integrated into the cover paper or 'wrapping'. They each have a slightly different focus but they are all but the first study in one way or another concerned with the modalities of teacher education and the social construction of its pedagogic discourse. The first study however functioned as the foreshadowed problem that framed the developing foci for the ethnographic case study in teacher education. Two main foci have been (a) how the use of educational materials by teachers (such as text-book, task formulations, examinations and technology) structure the learning environment and the content of classroom interaction, and (b) the effects

these things seem to have had on student learning, understanding and identity formation. The educational setting that is in focus for the investigation is mathematics teacher education. This means that the focus for the study is student teachers' learning to teach mathematics and of the role of lectures, information and communication technology (ICT), mathlabs, demonstrations, examinations, textbooks and other artefacts in this process.

The work with this thesis can, in other words, largely be described and characterized with the key elements that Troman et. al 2006 defined as the main features for ethnographic study of educational contexts. This involves the researchers engagement in a dynamic process of data production, hypotheses building and theory testing, with a focus on a specific case, through long-term engagement and involvement in the social processes of education (Troman, 2006).

In the following I will try to clarify and illustrate the way the process of engagement and the studies it gave rise to evolved, and how this has contributed to the development of knowledge presented. I will start with a brief background where I describe the societal context for this research and the aims, purpose and main research questions. This will be followed by a presentation of the theoretical perspective that has informed the data production. A more detailed description about the research design and methodology will be presented in the method section under the side heading *The empirical study*. Literature that has been read and analysed in relation to my work will be described next. After that a presentation of the four articles will follow. This is done in order to provide insight into the purpose of the studies, and to illustrate how they evolved through the research process described.

CHAPTER 2
BACKGROUND

As suggested already above, at the time of writing this text the Swedish school and teacher education have both undergone major political and policy-related changes. These changes have been orchestrated alongside a particular rhetoric, which describes the major problem with the national education system and teacher education in terms of the absence of conservative values. This rhetoric has set up a particular mission statement, which is that in order to save schools and society, these cherished conservative values must be reintroduced.

For teacher education, the new mission has resulted in the introduction of a new policy cycle, which puts knowledge of facts (information) in subjects into a key position, together with a legitimising technical knowledge of how to make these 'facts' relevant to and possible to learn and reproduce by pupils in school (Beach, Eriksson, & Player-Koro, 2011; Sjöberg, 2011). However, these changes in the educational system are not unique for the Swedish context. They are more to be viewed upon as parts of a global political project that has led to a call for a return to what is defined as pre progressive forms and methods (Beach & Bagley, 2012). This political project uses old and also looks for new ways of exerting discipline in and over education (Ball, 1990; Brown, Halsey, Lauder, & Wells, 1997; Erixon Arreman & Weiner, 2007).

Another feature of the global project is that there is a political consensus that defines education as the key to future economic prosperity. This is the so-called Human Capital Theory (HCT) of education, which assumes that investment in education has positive correlation with economic growth and development. As a consequence the quality of national education and training systems becomes part of the definition of the

competitive advantage of nations (Brown, et al., 1997; Olaniyan & Okemakinde, 2008). Moreover, the widespread consensus of HCT is in its turn often part of another discourse, one about the profound societal changes in a transition to the information society, which is a society that is in many ways re-defined in terms of digital technology and the processing of information.

This discourse about information society, globalization and the risk for nations to be left behind in terms of economic competition is one that on the one hand places high demands on the education system and that on the other blames the educational system for not living up to these expectations (Brown, et al., 1997; Nivala, 2009). The educational system is in line with this often portrayed by politicians and in the media as in a chaotic, serious crisis and in dire need of both political and pedagogical changes. This is the case in Sweden today.

The educational system, school curriculum and teacher education have become a political battleground geared to the ideological transformation of society (Apple, 2001, 2009; Ball, 1990; Sjöberg, 2011; Skolverket, 2011). In response, and with the aim to repair and transform education, new educational policies and reforms have evolved and been presented as solutions of 'problems' and challenges for education (Apple, 2009). Yet although the widely accepted picture about the surrounding society and its changes place knowledge at the centre of the economy as the new capital and as the most important factor in production (Nivala, 2009), the picture is also in many ways confused and contradictory, not at least because of the fact that intentions in reforms and policies are often contradicted by how they function in practice (Apple, 2009; Ball, 1998). There is an urgent need for further research. A key question is what happens to education, teachers and pupils? This thesis and its empirical studies, that together constitute a major part of an educational ethnographic research project and are in different ways part of the centre of the set of historical trends described above, tries to make a contribution.

PURPOSE OF THE THESIS

Linked to the above the purpose of the thesis is to critically examine the relationship between discourses on mathematics teacher education and the practical experience of the education through a combination of critical discourse analysis and ethnographic studies. This is done in three steps:

1. Critical analysis of two discourses that heavily shape mathematics education: a) the 'general ICT impact' -discourse (cover paper and article 2) and b) 'the general subject study' –discourse (cover paper and article 4)
2. Analysis of attempts to implement the general ICT discourse among teachers in compulsory school form a quantitative perspective (article 1), and among mathematics student teachers (article 2). They shows that it fails and why.
3. Provide deeper understanding of mathematics teacher education as such (article 3). Also provide better understanding of why teaching mathematics with ICT not live up to what is expected in the 'general ICT impact' discourse (article 2).

Two questions have been given specific attention in relation to these aims:

1. What is really going on in pedagogical practices in mathematics teacher education?
2. What do the answers to this question say about teacher education and the knowledge needs of teachers at the present time?

The initial study (article 1) together with recent policy development toward increased emphasis on formal subject contentment generated the first question. This question could be seen as forming the initial foci for the ethnographic case study that motivated and gave direction for the exploration of the on-going process of education, in this case for a future profession as a mathematics teacher, from the perspective of those who are involved. This initial foci has then been refined and transformed in the other three articles (article 2, 3 and 4) and the knowledge production undertaken there is aimed to shed light on the second question.

The use of ethnographic methodology has been important for these studies. Ethnography is fundamentally the study of culture and shared meanings that is based on the idea that human acts like social interactions, identity formation, and learning etc. are on the one hand formed by the individual consciousness and self-understanding but are also structured by cultural and institutional constraints. This means the study of the lived experience of participants in an educational context (in this case in mathematics teacher education) not only allows observation, description and analyse of educational processes in the specific context under study it also allows for describing, analysing and understanding of constraints and influences from wider societal factors (from the political, economical and ideological level) on what people do (Beach, 2010; Troman, Jeffrey, & Beach, 2006).

The ethnographic research process is often described as a spiralling form of data collection, hypothesis building and theory testing that takes its point of departure from theories and foreshadowed problems. From this follows that an important part in ethnographic research is the use of theory. Theorising is important not at least because of its role in bridging what people do and say in the local research setting to include wider structures in which the setting is located, in this case between the on-going process of education and the totality of culture, including for example policies and reforms, and other societal factors as described above (Beach, 2010; Trondman, 2008).

Bernstein's theory of symbolic control and cultural production, reproduction and change has played a particularly important role in formulating questions for my research, in deciding where to look for data and how to conduct data production, and also in the analysis of the data produced. The next section aims to describe this theoretical framework in more detail.

CHAPTER 3
THEORETICAL APPROACHES

There are many factors that enter into the production and reproduction of a culture or society. Education is one of these and analysing how education institutions work in these respects presents a challenge to many researchers (Beach, et al., 2011). The present thesis belongs to this kind of tradition and concerns how social relations, identity, knowledge and power are constructed in the on-going process of education, in a formal educational setting in teacher education for prospective mathematics teachers. It involves the selection and appropriation of theories that pertain to the complex relationship between social events, social practices and social structures (Fairclough, 2003) in establishing an education curriculum (Beach, 1995; Bernstein, 2003). This involves power relations, struggles, and compromises and has the consequence that neither what counts as legitimate knowledge and legitimate ways of teaching and learning in educational institutions, nor policy documents can be considered as neutral or value free (Apple, 1992).

Bernstein's theoretical framework has been important in the research process both for finding, interpreting and understanding the patterns that emerge in the specific educational practice under study and to describe the most important organizing principle or the results of teacher education in today's society. The most important reason why I found this theory suitable for these studies was because of the way the concepts developed there created a bridge between theory and the data that was useful for interpretations in this research and that also connected macro level class and power relations to micro level, educational process of the school (Best, 2007). Moreover, there are understandings about power, knowledge and social experience in Bernstein's work that have been proven to be use-

ful for many researchers in recent time for analysing the intellectual field of education, not at least for describing and investigating mathematics and teacher education (Adler, 2006; Adler, Ball, Krainer, Lin, & Novotna, 2005; Ensor, 2004b; Hoadley, 2007; Loo, 2006, 2007).

Bernstein's theories have developed since the late 50th until the present day and they address in particular those forms of symbolic control that are institutionalised formally or informally as pedagogical practices (Bernstein, 2000 p. 123). His own theoretical starting point was in the work of Emile Durkheim, but he also drew from other theoretical orientations in sociology such as for example Weber, Marx, Vygotsky, Bourdieu and Foucault, amongst others (Diaz, 2001).

The research conducted by Bernstein and his associates that have first formed and then challenged and developed his theoretical oeuvre, is based on the assumption that the field of education is a field of symbolic control, and that like the economic field, it can be seen in terms of a division of labour. Moreover, also important is that the materialization of symbolic control in pedagogical practices operates basically as a function of class relations (Bernstein, 2000, 2001; Best, 2007).

This class structuring of the educational field is, according to Bernstein, maintained by human agents as a series of contested fluid linguistic formations or modalities (Bernstein, 2001; Best, 2007). Thus, the theory has two elements; one driven by specialised communication amongst agencies and agents in different practices (at the micro level), and one that shows how those principles for communication are themselves directly or indirectly media for the production and reproduction of class relations, at the macro level (Bernstein 2000 p 123). This provides a particular notion of power. Power is held by Bernstein as relational and as operating between agents with different and unequal power positions that regulate boundaries between discourses, knowledge production and reproduction and forms of consciousness (Bernstein, 2001; Diaz, 2001).

The two elements of the theory of the constitution of the educational field(s) are condensed in the concept of the pedagogic device. This device provides a language of description in relation to pedagogical communications for both the relay (specialised communication practices) and what is relayed (principles for selection). The pedagogic device thus describes the underlying principles for a process in which symbolic control is material-

ised through internal communicative practices inside educational institutions (Beach, 1997). This transformation of knowledge into pedagogic communication places the on-going process of education in a wider context of symbolic control, which is defined as follows by Bernstein:

> Symbolic control translates power relations into discourse and discourse into power relations. (Bernstein 2003, p. 134)

This process of translation, how it is constituted and how it in its turn constitutes education subjects and subjectivity is in line with the main theoretical interest of the thesis. In the next section I will explain in more detail the theoretical concepts inherent in the pedagogic device and their function in the regulation of consciousness through communication in classrooms as an extension of power relations that exist externally to the educational practice (Au, 2008; Bernstein, 2000; Singh, 1997). Moreover, this model of pedagogic communication has been proven by researchers to be specifically useful for analysing of emerging issues and changing politics in education (Au, 2008; Singh, 1997, 2002; Wheelahan, 2007).

THE PEDAGOGIC DEVICE

A way to describe the *pedagogic device* is in terms of a system of rules aimed at explaining how symbolic control is materialised and realised in pedagogic practice through a process via which knowledge (intellectual or practical) is converted into pedagogic communication (Bernstein, 2000, 2003; Singh, 2002). The structuring of the pedagogic communication, defined by Bernstein as *Pedagogic discourse* that is taking place in the teaching learning situation in the classroom, is in other words the final outcome of a process where curricular knowledge has been produced, selected and put together in a way that also produces different identities and relations in pedagogic contexts (Singh, 1997). This is an interest that has been 'targeted' in several of the studies reported in this thesis.

The production of the pedagogic discourse arises out of the struggle between specialised agents and agencies of symbolic control operating in specialised fields with different and often competing interests and power

positions (Bernstein, 2001)[1]. It consists of three steps that are related to each other hierarchically. Each step consists of a set of rules that, in turn, forms a platform containing agents with different positions and practices, each seeking some level of domination over some part of the education field.

Basically a distinction is made between two fundamental contexts (platforms), one that structures a field of production, and one that structures a field of reproduction. The distributive rules give rise to and regulate the field of production, which is also defined as the primary context; i.e. it is the context where the discourse is produced and distributed in a process that mainly takes place through research conducted at universities. These rules distribute access to different forms of knowledge to different social groups. Through them regulation takes place between forms of power, social groups, forms of consciousness and forms of practice (Beach, 1997). Access is strictly regulated and controlled and there is because of this no broad democratic access to new specialised and complex forms of knowledge in teacher education (Beach 1995, 1997) or elsewhere in the education system (Bernstein 2000, 2003). These pedagogic practices are located in the field of reproduction, defined as the secondary context, and they are regulated and structured by the evaluative rules. A third field is located between the field of production and the field of reproduction, called the recontextualising field, where an appropriation of discourse from the field of production to the field of reproduction is taking place regulated by recontextualising rules.

Recontextualising of knowledge is undertaken in state departments of education and training, curriculum authorities, specialized media and by textbook writers etc. This means that the process of recontextualising leads to an ideological transformation of the original discourse. Pedagogic discourse is in this way constructed and formed by a recontextualising principle that operates in a selective way in education institutions. It appropriates, relocates and relates other discourses and constitutes its own

1 In this sense Bernstein's concept of fields shows similarities with Bourdieu's conceptualizing of the field as a social space of conflict and competition in which positions are created by interaction of the prevailing norms within the field, and where different fields interact with each other and are organized hierarchically Bourdieu, P., Nyman, L. E., & Rosengren, M. (1996). Homo academicus. Eslöv: B. Östlings bokförlag. Symposion..

order (Bernstein, 2000; Singh, 2002). In this way the rules that make up the pedagogic device, give rise to and work as a grammar that regulates the relations within and between three respective arenas through the appropriation of three sets of rules. This will be elaborated in more detail in the following section.

RECONTEXTUALISING: FIELDS AND RULES.

Through recontextualising a discourse is moved from the site of production to another site, where it is transformed and related to other discourses (Singh, 2002). The process of recontextualising means that the original discourse is converted into a pedagogic discourse that no longer looks like the original discourse. For mathematics teacher education, this means that agents from academic fields of mathematics and from the educational field together with professionals, bureaucrats, and politicians, in various ways constitute the pedagogical discourse that is materialized in the teaching practice through a struggle over control of pedagogic texts and practices. This has implications for 'what' knowledge becomes available, and 'how' this knowledge is transformed. In relation to my study it is about how teacher students develop legitimate meanings about mathematics and the teaching and learning of mathematics. I will describe this further in the following pages.

Recontextualising comprises two sub-fields; namely the official recontextualising field, *ORF*, and the pedagogic recontextualising field, *PRF*. The ORF is created and dominated by government, government departments, and other 'official' agencies forming the official educational discourse or policy (Ball, 1994). However, it is important to note that, in line with for instance Foucault or Fairclough's notion of discourse, the official discourse is not a single voice. Rather there is a struggle within an official discourse (an interdiscoursivity) between different agencies: such as for example government agencies, professionals who are active in the field of education and the private sector. The PRF includes educators in schools, colleges, universities and departments of education together with their research, writers of textbooks and specialised media (Bernstein, 2000, 2003; Fairclough, 2003; Singh, 2002).

Recontextualising rules are derived from the distributive rules and regulate the process where knowledge and skills are selected from the field in which they are produced and converted for use in different institutional settings. These rules construct the pedagogic discourse and structure what is actually going on in the process of education. They refer to the embedding of two other discourses. This is specifically the embedding of the *instructional discourse* (pertaining to knowledge or skills of particular kind), within the *regulative* (social order) *discourse* (Bernstein, 2000).

The rules that regulate and shape pedagogic practice on the classroom level most are the evaluation rules according to Bernstein. They define the standards that must be reached by learners and in doing this they act selectively on both the content and form of transmission (classification and framing) as well as on the subjectivity and agency of learners who belong to different social classes (Bernstein, 2000, 2003). In other words it could be said that the outcomes for learners have their roots in the modality of the social relations of practice, such as in the selection of subject content, and in the establishment of rules for the transmission and acquisition of the knowledge and skills embedded in that content selection.

To summarize this, Bernstein's theoretical contribution to the study of education takes the form of a number of models ranging from macro level to micro level of the ORF and PRF (Bernstein 2000 p 211). For this study, this means that what takes place in the teaching practice in mathematics teacher education is, viewed through the lenses of this theoretical framework, seen as a result of an on-going struggle between governments, government departments and other official agencies such as universities or schools. In teacher education at present this is most clearly evidenced through the most recent Green Paper for teacher education (SOU 2008:109, 2008) and the subsequent Government Bill, which form an official pedagogic discourse on the one hand, and teacher education departments, teacher educators, text book writers and researchers on the other, who contribute to form a pedagogic discourse that is enacted during teaching and learning (see Ball's concept of the policy cycle, Ball 1993, which can also be read in this way). The pedagogic discourse that is realised has formed the object for the present research. Data have been produced, analysed and understood with the use concepts that will be

described in the following part of the thesis. It is the constitution of this discourse and its effects that the present thesis addresses.

THE PEDAGOGIC DISCOURSE

The description of the pedagogic device shows how pedagogic discourse is defined by Bernstein as an ensemble of rules for the production and circulation of knowledge within pedagogic interactions. In fact Bernstein (2000) even says that the pedagogic discourse is more to be viewed as a principle of recontextualising that embeds two discourses, a discourse of skills of different kinds (instructional discourse) and their relations to each other, and a discourse of social order (regulative discourse) (p. 31-32). The character of the specialized form of communication that pedagogical discourse defines can thus be described in terms of *rules of social order* that encapsulate relations between students and teachers, *rules of discursive order* that refer to the selection of subject content and *rules for transmission and acquisition* that regulate pedagogic communication. The concepts that Bernstein provides to describe these characteristics of pedagogic discourse are the concepts of *codes* (classification and framing) and *modalities* (Bernstein, 2000, 2003).

Classification and *framing* are the two key mechanisms that organize experience and meaning making in pedagogical relations and they refer respectively to power and control. Classification is about relations between different categories that are related at a macro level to social class stemming from social division of labour (above), and at a micro level are about the organisational and structural aspects of pedagogic practice and boundaries between different kind of categories, which includes relations between agents, spaces and discourses. For the school context with respect to how teachers' and learners' pedagogic identities are demarcated it could be useful to think about classification as relations between different school subjects. Strong classification indicates explicit boundaries between categories whilst weak indicates boundaries that are more blurred (Bernstein, 2000, 2003; Hoadley, 2006).

The hierarchical relations between categories are maintained by a mechanism referred to by Bernstein as framing. Framing refers to social *relations within* social classes at a macro level and thus defines relations

within boundaries. Framing or 'relations within' is related to interactions that maintain (control) boundaries between discourses, spaces and subjects. At the classroom level, framing refers to the location of control. That is, to the degree of control teacher and students possess over the selection, sequencing, pacing and evaluation of the knowledge transmitted and received in the on-going process of education (Bernstein, 2000). In this sense one could think about framing as the way in which relations between teachers and students are set up, where strong framing refers to a limited degree of options for students and weak framing implies more control by students (Hoadley, 2006). To summarize this, the relationship between classification (power) and framing (control) is that framing contains the making and unmaking of classification. Classification and Framing are embedded in each other and together they structure, appropriate and legitimise the pedagogic practice (Bernstein, 2003).

Varying strengths of classification and framing generate different modalities of pedagogical discourse and can be viewed as variations of educational power in the processes through which legitimate meanings are generated, distributed and reproduced. Analysing modality makes it possible to understand different principles of pedagogic transmission/acquisition, their generating contexts and even changes in these principles and processes (Bernstein, 2003). Adler et al. (2006) used the code theory for an investigation of what legitimate meanings of teaching mathematics are distributed in mathematics teacher education in South Africa. Adler et al thus investigated questions in the same area as in my research.

VERTICAL AND HORIZONTAL DISCOURSE

The concepts of code and modality describe interactional practices in terms of how different discourses are realised. However, in order to understand what forms of discourse are realised/transmitted and what knowledge forms and knowledge structures they represent, other conceptual distinctions are needed. Bernstein (2000, p. 157-159) developed a set of concepts for this. They distinguish between two fundamental forms of discourse that arise out of different forms of knowledge and knowledge needs. They are usually typified as common sense knowledge and academic knowledge respectively and are namely the concepts of vertical

and horizontal discourse. The distinction between vertical and horizontal discourse is closely related to Bernstein's distinction between esoteric and mundane and Durkheim's sacred and profane knowledge (also Bernstein 2000, 29-30).

The *horizontal discourse* is related to concrete thinking. It is defined as directly and inextricably linked to a material base and is therefore powerful in dealing with immediate concrete situations in specific contexts but limited by being unable to transcend different contexts (Beach & Bagley, 2012). The discourse, in education relations, is embedded in everyday language and common sense understandings of the on-going everyday practices of teachers and learners and is directed towards immediate goals (Beach & Bagley, 2012; Bourne, 2004). The knowledge structure of horizontal discourses is defined by Bernstein as local, context dependent and specific, tacit, multi-layered, and contradictory across but not within contexts because of this. Another essential feature is that the knowledge contained in a horizontal discourse is segmentally organized. This entails that knowledge is transmitted tacitly within the context of performance by means of modelling and showing and that the acquisition is also context specific (Bernstein, 1999b, 2000).

In contrast, curriculum knowledge can be viewed as *Vertical discourses* that arise from academic disciplinary knowledge. Vertical discourses (or scientific discourses) are however differentiated in two underlying forms: *hierarchical knowledge structures* and *horizontal knowledge structures*. The natural sciences, with physics as the archetypal example, is a vertical discourse with a hierarchical knowledge structure, which means that it takes the form of a coherent, explicit, and systematically principled and hierarchically organized system of knowledge with a grammar and robust conceptual system (syntax) that is used to describe and model empirical situations, often at a high levels of abstraction.

The humanities and social sciences, on the other hand, are vertical discourses with horizontal knowledge structures. This knowledge structure consists of a series of segments 'of specialized languages with specialized modes of interrogation and specialized criteria for the production and circulation of texts' (Beach & Bagley, 2012; Bourne, 2004; Ivinson, 2007). Mathematics is with the use of these concepts also a vertical discourse with a horizontal knowledge structure that consists of a series of seg-

ments, such as algebra, arithmetic and calculus. Acquiring mathematics should in other words on the basis of these theoretical concepts involve understanding the structure and learning the principles that make up each segment.

The vertical discourse, through having an indirect relationship with a material base that is mediated by theoretical concepts and general principles, provides access to powerful systems of meaning that make it easier to select relevant knowledge in unfamiliar contexts or to engage in critical enquiry (Bernstein, 2000). In relation to my research this means that if student teachers should meet the intention with subject theory knowledge in teacher education stipulated in national policy i.e. that prospective teachers need access to relevant and deep understanding in subject knowledge in order to be prepared for teaching in school: (Government Bill 1999/2000:135, 2000; SOU 2008:109, 2008), this involves access to the vertical discourse of mathematics through a teaching learning situation that enables students to acquire these knowledge structures. In other words, what is valued knowledge for student teachers is access to a vertical knowledge base that is mediated by theoretical concepts and general principles.

An important strength with access to these forms of knowledge structures is according to Bernstein that it creates a space in discourse where room for manoeuvre occurs, where new concepts and principles emerge and where greater generality can be achieved. According to Bernstein (1999), the discursive distance between abstract theoretical knowledge and everyday knowledge is the crucial site of the yet to be thought.

TRIVIUM AND QUADRIVIUM

Bernstein's theories have provided the present research with concepts that have been used to describe and understand the organization of the two different discourses of knowledge in teacher education: one stemming from the seminar tradition focusing on practical aspects of teaching, and a more recent academic tradition, focusing on academic subject studies (Åstrand, 2006). These concepts were also useful for making differences between the intentions of the official pedagogic discourse - stemming from ORF - and the pedagogic discourse produced by agents in the PRF

visible. Bernstein (2003) used the two terms teacher education Trivium and Quadrivium to show a historical shift between these two different knowledge discourses. These two concepts were therefore suitable for me in the teacher education policy analysis that is described under the heading *Literature review on teacher education* change in Sweden.

The teacher education *Trivium* is a general component that is related to internal control and the development of thinking skills and attitudes toward teaching and learning processes and their outcomes. It derives from a problematization of internal learning and reflection. Bernstein on the other hand relates the *Quadrivium* to the 'external' independent subjects or disciplines that students will be expected to teach in schools as teachers (Beach, 2011a; Beach & Bagley, 2012). The organisation and communication of content, forms of communication, the relative distributions, and relations between them have varied over time in relation to teacher education development according to Bernstein (2000, p 161), who also identified six steps to this development. These are steps where:

1. The same lecturer covered both the Trivium and the Quadrivium
2. Lecturers were specialised to one or the other side of this dislocation
3. Education studies (Trivium) became specialised in e.g. the philosophy, sociology, psychology and history of education
4. A new body of recontextualised knowledge emerges between the discourses of education studies (Trivium) and school subjects (Quadrivium) that was, Bernstein (2003) suggested, in part 'technical in focus and probably in aspiration' (p. 161). This subject (called curriculum theory or didactics) became increasingly technical in terms of its relationship to school subjects
5. The specialised disciplines of educational studies (Trivium) become weakened as 'political, cultural and academic sites' (p. 161) in a manner that leaves psychology as the only remaining education specialisation. This specialisation is taught in combination with subject knowledge, curriculum studies or didactics and a professional training dimension through apprenticeship-like-learning in schools

6. Teacher education professional components become fully conditioned to apprenticeship-like-learning in schools and are often taught consecutively to the academic subject component

Step four is the one that best characterises the balance between Trivium and Quadrivium elements in the reform that is recontextualised in the present research in mathematics teacher education (Government Bill 1999/2000:135, 2000) . The most recent reform involves a reconfiguration of the balance between Trivium and Quadrivium according to Beach and Bagley (2012) in line with what is described in the next step in the model, step 5 (Government Bill 2009/10:89, 2010). The concepts of Trivium and Quadrivium are elaborated further under the heading *Literature review on Teacher education change in Sweden*.

CRITICISM OF BERNSTEIN'S THEORETICAL WORK

Bernstein's work has been discussed, tested and challenged for over four decades. Best (2007) even claims (amongst others) that Bernstein was one of the most misunderstood sociologists of the twentieth century. Bernstein was very much aware of this criticism; in fact in the introduction to of what came to be his last book, he wrote '…the main purpose is to illustrate the research possibilities of the thesis, and to engage both directly and indirectly with criticism' (Bernstein, 2000, p.xv).

One persistent criticism was against his 'Class, codes and Control project' where he was accused of presenting a deficit model of working class language. Inherent in this criticism was an assumption that Bernstein's terminology was aimed primarily at simply describing differences between working and middle class people rather than a description of learned forms of language use that explain class-regulated differential school success (Singh, 1997).

The criticism of his code concept was connected to a more general criticism of his work as a structuralist contribution that did not give space for human agency (James, 2000). One answer to this criticism by Bernstein was his concept of pedagogic discourse, that by its definition is a process of modelling between human agents where the languages that

create structures do not exist independently of the people who use them (Bernstein, 2000 p. 125).

Bernstein was also criticised for his understanding of class formations as focused on the ability of human agents to maintain classes through a series of linguistic formations (Best, 2007). Singh (1997) means that this critique may be that commentators in US were unwilling to accept the consequences of what Bernstein had to say, namely that social class gave access to different forms of educational knowledge. Despite the criticism of Bernstein's theory, the development, dissemination and elaboration of the theory through research has been going on for forty years (Davies, Muller, & Morais, 2004; Morais, 2001) in processes that involve reflection at fundamental, methodological, theoretical and interpersonal levels (Beach, 1995). For my research, this has meant that the theoretical concepts used have been reflected on in relation to other theories, as well as in relation to data production and analysis. The next section is devoted to this data production and analysis. It is about ethnography and how ethnography was used in this research.

CHAPTER 4

RESEARCH METHODS

Ethnography is the research method that I have chosen to use in relation to the main part of the research and it has been employed in relation to studies 2 to 4 in part three of the thesis. I have also employed this method in line with a particular tradition or school of application. This is the tradition known broadly as education ethnography. It is distinct in terms of several specific markers. These include origins, theories and empirical characteristics. For research in Scandinavian education research and in Sweden the tradition has been described by both Larsson and Beach (Beach, 2008; Larsson, 2006). In this section I will address; ethnography in general, the tradition of educational ethnography and of how this methodology was used in relation to my research.

UNDERSTANDING ETHNOGRAPHY

Ethnography has become a common approach to educational research in recent decades and has been featured in many journal articles, journal special issues, books, book series and conferences (Beach, 2010). According to these sources ethnography is important to educational research as it takes us inside everyday educational contexts and brings us close to everyday practices and the people involved in these, in a manner that helps correct the oversimplifications of more distal approaches and that provides insider perspectives on everyday action and institutional arrangements (Troman, et al., 2006). It is in this sense about developing close-up detailed descriptions of people's lives, identities and activities through situated investigations that produce knowledge about basic conditions and practices and the perspectives of the participants involved in them. It does

this in order to identify and develop previously unexplored dimensions of life without over-steering from purely personal ideas or pet theories. It provides valuable and detailed inside knowledge of what are often otherwise seen as closed social processes. It opens up the black box of institutional activities and practices (Beach, 2010; Hammersley, 2006).

In ethnography in general and in the Scandinavian tradition of educational ethnography employed in this research, participant observation field-notes and interview-transcripts are the main data sources for analysis, which is also often closely linked to particular theories and related methodologies (Larsson, 2006). Common amongst these at present are forms of discourse analysis, analytical induction, constant comparative method or processes of immanent criticism. Central to all approaches is an emphasis on an active and creative citizen and a dialectical relationship between human social practices, human consciousness and social structures (Beach, 2010).

However, ethnography is not a seamless, neutral observational practice (Walford, 2008), in fact, as related by Beach (2010), there are similarities as well as differences within the practices of application of ethnographic method by researches engaged in education ethnography in Scandinavia. These broadly relate to the research focus and substantive interest, but they also concern relationships between theory and observation and observation and analysis, as well as the appropriation of different (and different types of) theories in research for guiding the identification of which questions to ask and how to produce and interpret data in relation to these questions (Larsson, 2006). Often stressed is the importance of a living dialectic in this relationship that helps theory to enliven data and data to 'talk back' to determinant theories (Beach, 2008; Hammersley, 2006).

When developing my understanding of education ethnography I have engaged in a fairly broad reading of ethnographic production in relation to education research in Scandinavian countries in particular, but also more broadly than this. Certain key elements of ethnographic research applied to the study of education contexts are well recognized in the research I have read. They have been described many times and include in particular an interest in education processes and identity formations that are studied through multiple methods based on direct researcher involvement and long-term engagement in the field, in a manner that gives high

status to the accounts, perspectives and understandings of research participants and that generates rich and diverse forms of data (Jeffrey & Troman, 2004). Also commonly described is a spiral of data collection to guide data production related to hypothesis building and theory testing, with a focus on one particular case (or a very limited number of strictly bounded and related cases) in a manner that is said to be meant to lead to further questions and new rounds of field-work rather than final definitive answers about education culture (Beach, 2010). These notions are combined together with the recognition that the researcher is the main research instrument (Gordon, Lahelma, & Beach, 2003; Larsson, 2006).

The recognition of the key position of the researcher as the main instrument of research production introduces some key challenges to ethnographic practice in respect of the idea of research providing an objective picture of reality (Rajander, 2009). One of these is that it is now broadly recognised that the method, or really methodology, is unable to accomplish objectivity in the conventionally understood sense, as the observations and recordings involved in the research are always inevitably filtered through the prism of a researcher's theoretical orientation, research strategy and even background and personality (Hammersley & Atkinson, 2007; Lofland & Lofland, 1995).

As expressed by Beach (2010) this form of theoretical impregnation affects both the ontological and epistemological status of the research questions that are initially developed, the interpretation of data that have been produced with an eye to in some way providing answers to these questions (Larsson, 2006) and even perhaps informant selection and choices of where to be and what to do in fieldwork (Beach, 1997, 2010). Moreover, as ethnographers usually do their research from within a single community, which is most often only a small component of the total social matrix under consideration, and work with small numbers of informants there, they cannot guarantee that the information obtained is fully representative of all possible experiences or even the predominant cultural perspective (Arnstberg, 1997; Hammersley, 2006; Lave & Kvale, 1995). Ethnographic descriptions are in line with this sometimes described as uniquely the product of one particular observer viewing the world through his or her personal and theoretical proclivities (Rajander,

2009). How these issues have impinged on my own research will now be described in more detail.

THE EMPIRICAL STUDY

The aim with this section is to describe how the research process of ethnography has been applied and developed for and through the research, and how this process influenced and framed the design of the thesis project. For me personally, this dissertation work has been a journey, which has largely, coincided with one of the key elements, defined by the editors of *Ethnography and Education* (2006), for describing ethnographic research applied to the study of education contexts, namely:

> The engagement in a spiral of data collection, hypothesis building and theory testing – leading to further data collection…(Troman, 2006)

From this starting point the thesis has been influenced by a tradition that in present decade has come to characterize Scandinavian educational ethnography. This tradition is described by Beach (2010) as a linked tradition that shares many of the qualities that usually defines what is considered as conventional ethnography. It is highly empirical and has a concern to document and understand learning and teaching processes through detailed situated investigations, with the use of multiple methods that produce rich and diverse forms of data (Walford, 2008).

The characteristics that are specific to the Scandinavian ethnographic research, and that also influenced my thesis, is the role of theory (Bernstein), use of time, concepts of culture, and long-time fieldwork. In this work, as in all forms of ethnography, multiple methods have been used; including both those traditionally classified as quantitative and qualitative methods.

Even if ethnography is often seen as a specific form of qualitative inquiry this isn't always the case. In fact (as Hammersley, 2006 describes) early ethnographic research on schools (in the UK for example) often combined 'case study' with quantitative data and analysis (Hammersley, 2006) and the present thesis provides an example of a combination where a quantitative data collection and analysis generated questions, which in

turn formed the basis for a more conventional ethnographic 'case study' work.

As in traditional ethnographic work, the research I have conducted has been grounded in a foreshadowed problem of the educational field; in this case about educational use and use value of digital technology as explored in the first study (article 1). This investigation raised questions as to how teachers develop digital skills relevant to their profession, as well as matters of a more general nature relating to the teachers' views of teaching and learning in general. The initial study thus, together with the increased emphasis on formal subject content, especially in mathematics, through recent policy development, framed the developing foci for the ethnographic case study concerned with the effects of education for future mathematics teachers in the context of the Swedish teacher training. The subsequent production and analysis of materials, during the period of ethnographic research, was then developed and gave rise to the other three articles in the present thesis (Beach, 2010).

Taken together it could be said that through the way this ethnographic case study was designed and conducted through participant observation, interviewing and immersion in the field, it turned out to be an investigation that analyses the processes of active meaning making in teacher education in relation to one policy cycle in teacher education in Sweden (Government Bill 1999/2000:135, 2000). The concept that thus encapsulates the research approach best is policy ethnography (Troman, et al., 2006). In the following I will describe these aspects in more detail.

FIRST STUDY

This study is based on a survey conducted as part of my Master's project[2]. The research instrument was a questionnaire that was distributed to a stratified sample of Swedish compulsory schoolteachers from the province of Västra Götalands län. The aim was to, by processing and analysing the material in a new way, provide a broad and more general picture of the nature and scope of teachers' use of ICT in educational settings by sim-

2 Player-Koro Catarina (2003) Renskriva text - vägen till ett förändrat arbetssätt med stöd av IKT [Just typing text – toward a new way of working with support of ICT?].

plifying data in such a way that those aspects of the data that were relevant for the object under study were brought into sharp focus. In this case the main objective was to focus on those teachers that used ICT tool in their pedagogical work with students. The idea was to make visible the factors that were common for teachers in this group and that could be considered as related to the use of computers in teaching.

Structural Equation modelling (SEM) was used for the analysis. The modelling process began by defining relevant theoretical concepts on the basis of previous research investigations in the field of teachers' use of ICT, in this case on the basis of the two theoretical aspects from social psychology: self-efficacy and attitude behaviour relations. Based on known or underlying mechanisms given in the theoretical definitions a theoretical model was constructed that represented the general statistical expectations that follow from these theoretical ideas. The theoretical model served in turn as a bridge between the abstractions from theory and the development of the structural model. In the process of determining the relationship between the variables in the structural model stepwise multiple regression and factor analyses were used. The structural model was than modified for best fit against the empirical data (Grace & Bollen, 2008; Howitt & Cramer, 2005).

By highlighting the distinction between general and specific attitudes toward ICT use in education the model that emerged during the analysis suggests that association with pedagogical work in classroom practice is important. What is shown is that specific positive attitudes toward ICT in pedagogical work with students and colleagues are the kind of attitudes that seem to contribute to make teachers use ICT in education, whilst general positive attitudes toward ICT in education don't seem to have much of an impact. One can say that by the way the results pointed to factors that were closely related to the on-going work in educational practice, the focus for my research interest was transferred to the further study of educational practices (in this case of mathematics teacher education) from the standpoint of teachers and students who are involved in the social and cultural process of mathematics teacher education.

SECOND, THIRD AND FOURTH STUDY

SELECTION OF SITE

The research that gave rise to the remaining articles (2, 3 and 4) in present thesis is a study of practices within a teacher education context. This research has stretched over four years and started in 2007. The focus for the data production is in the university-based part of teacher education and in particular studies that are directed towards subject studies in mathematics. These studies include mathematics as a subject for secondary school (school-years 6-9) and subject curriculum theory (didactic). The teacher education program under study took place in a Swedish university.

The problem that formed the initial focus for this ethnography was the main reason behind the selection of this site. In this subject courses in mathematics according to the course plans had a specific ambition to develop prospective teachers' abilities to use information technology as a tool in teaching and learning of mathematics. Another criterion for selection of the site was the increased emphasis on formal subject content, especially in mathematics, through recent policy developments.

DATA PRODUCTION, FIELDWORK AND PARTICIPANT OBSERVATION

Altogether, the ethnographic study covered over four years of investigations at a teacher education institution. It has had a particular interest in the learning of mathematics and math teaching and the role of various media (like formal lectures, like ICT, like math-labs and demonstrations, like the subject text book) in this process.

Although in total spanning over four years fieldwork the level of intensity of the data production process has varied. A considerable amount of the empirical fieldwork for instance took place during one semester in 2007. Two male teacher-educators and seven teacher students took part. The students were between 23 to 45 years old from different ethnic backgrounds. However, in order to gain depth in the investigation and to enable progressive focusing on specific events or relevant aspects of the

site, even other student groups were visited for short periods (for more details see heading *Use of time*). Data produced by analysis of national and local policy documents have also been made before, during and after the period of field studies.

Even if this research contained the use of multiple research methods, participant observation in on-going events was still the most important part of the ethnographic fieldwork and data production. In this way the main data production was, as in most education ethnographic research in the region (Beach, 2010), grounded in participation and exploration of the particular social and cultural setting where the majority of direct social interactions took place. Access to the site was created through negotiations with the field actors that continued throughout the period in the setting. Admission includes both a license to conduct research and for creating confidential relationships with the research participants. Establishing good and trustful relations with the actors and getting immersed in the daily life and meaning systems of those studied is important and strongly related to the type of data that becomes available (Hammersley & Atkinson, 1989, 2007). For this study this meant that the course coordinator was contacted prior to my field studies and that I participated in planning meetings with the teacher team, where I presented my study and my role as a researcher, made it clear that I was not part of the teacher team, and stressed that the focus for the study was more on the students than on the teachers.

Creating trusting relationships with students and teacher educators was a process that continued throughout the field study period. Confidence must be constantly negotiated, consolidated and recaptured, in a process that also changed its key characteristics over time (Hammersley & Atkinson, 1989, 2007). I started this process at the first meetings with the respective groups where I informed them about the study and explained my role and that I had no part in the assessment of students' academic performances and that I would not discuss what students had talked to me about with their course tutors. We also discussed my prior experiences as a mathematics teacher and of being a teacher educator.

My former experiences as a student, mathematics teacher and teacher educator were important because they meant that the field was in a sense known to me and that I was unable to act as a novice at the site (Dove-

mark, 2004). This at times had the consequence that the actors took it for granted that I possessed knowledge that I did not, which is not unusual in cases where the researcher is familiar with the field, but it also had the advantage that I quickly came into the business of conducting field research and could create a closer relationship with the students and teachers. As they became accustomed with my presence I could act more freely, and they accepted that I sometimes acted more like a teacher or tutor. I felt that the relationship with the students and some of the teacher educators during the study was open and casual and I was also invited to participate in several of the various social practices of these groups.

The researcher's different social roles in ethnographic fieldwork can be categorized by the degree of involvement with the participants and the studied practice. The roles can be defined as the complete observer, which means the lowest degree of participation, observing participant, where the researcher is mainly observing without participating, participating observer, which means that the degree of participation is superior to an observer role and full participant in which the researcher is studying the business from the inside as a full participant and the researcher role is also not known others (Hammersley and Atkinson 1989, 2007). My role has varied. From time to time I have adopted the role of complete observer to that at other times assume the role of observing participant or participating observer (Atkinson, 2007).

Data production in everyday settings differs from data collection in experimental environments that has been specifically created for research purposes, in among other things that ethnographic research requires participation and presence in on-going practice. Presence is very much about time. The time in the field is crucial to perceive and understand the complexity of social structures and relationships that take place there (Jeffrey & Troman, 2004). This will be considered next.

USE OF TIME

Educational ethnography is grounded in a commitment to develop firsthand experience and exploration of a particular social and cultural setting with the intention to develop theoretical and practical descriptions of education lives, identities and activities (Atkinson, 2007; Beach, 2010). In this

process time in the field is a crucial factor to discern and understand the complexities in the social situations and the latent meaning of the education context and these intentions are well recognised in the three main design principles for ethnography identified by Bob Jeffrey and Geoffrey Troman (Jeffrey & Troman, 2004).

In the design of the present ethnography my ambition was to meet these requirements. This is common in the Scandinavian tradition (Beach, 2010). These are principles about what constitutes a respectable and acceptable amount of time for fieldwork in order to allow a fuller range of empirical situations to be observed and analysed and to allow for the emergence of contradictory behaviours and perspectives. However, time is according to Jeffrey and Troman (2004) about both lengths and frequency and since time at the field has to be weighed in relation to the total time available to the research process or project as a whole the authors suggested three different forms of time use: the compressed, selective intermittent and recurrent time modes.

These different ways of using time have been employed in the present research in different parts of the ethnographic project. The beginning of the study was characterized by a *compressed time mode*. This was a period with intense fieldwork and an aim to become as fully involved with teachers and students in their daily routines during teacher training as possible. *Selective intermittent and recurrent modes* were used alongside each other later on, when the intention was more directed toward saturating particular data categories and providing details about identified situations, features, interactions or specific classroom events (Jeffrey & Troman, 2004). This involved selection of particular events and contexts for deeper observations and interpretation and comparing different parts of the study and changes in classroom events over time.

ROLE OF THEORY

The use of time in ethnography connects to a particular ethnographic aim. This aim is for considering relations between the appropriate cultural, political and social levels of the research site and the individual's and group's/community's agency there and for including theoretical perspectives in order to (a) sensitize field research and analysis, (b) provide an

opportunity to use empirical ethnographic research as an interrogator of theory or (c) to develop new theory (Jeffrey & Troman, 2004; Trondman, 2008) in an interactive process between the researcher, the data and theory. This was an important part of the present research process and it involved a continual shift between induction, deduction and abduction practices, where described experiences were illuminated by theory and where theory in other cases was used to discover new patterns in the registered experience (Trondman, 2008).

REFLEXIVITY

Reflexivity is about being aware of what happens in data formation, development and analysis because of what you as a researcher bring to the research, and because of the fact that you are part of the social word under study. These things relate to and help form what you see there (Beach, 1995).

Hammersley and Atkinson speak of reflexivity, as a concern to understand the processes which effect the formation of ethnographic understanding (Hammersley & Atkinson, 2007). For me as a researcher reflexivity was about reflection at fundamental, methodological and interpersonal levels. These influenced all choices that I made during research and thus also affected the results. Reflexivity aims to provide a basis of rigor in ethnography, an essential aspect of its validity. It is in this sense that I had negotiated my multiple identities as researcher, PhD student, lecturer and former classroom teacher.

When described in this way it becomes obvious that the object of study in ethnography is rarely fully given a-priori (Gordon, et al., 2003; Larsson, 2006), but is instead said to emerge from within the inquiry as it progresses through processes of analysis, data production, reflection and writing (Beach, 2011b). However, as other researchers have noted the ethnographic field generally is in fact quite highly polarized in respect of the question of whether the research should or should not be clearly bounded and the object of study theoretically framed and empirically limited a priori or not (Hammersley, 2006). In my own research, and in Scandinavian education ethnography generally according to Beach (2011) there is

a strong migration toward one of these poles; i.e. the one where research unfolds over time as part of reflexive process of research development.

ETHICAL CONSIDERATIONS

The primary ethical dilemma in humanities and social science research is the balance between research requirements, which are defined as society's need for knowledge development on the one hand, and protection of the individual on the other, which includes the individual's protection against undue transparency (Cohen, Manion, & Morrison, 2000). Four ethical principles are based on the individual protection requirements. As well as existing with an intention to protect the integrity and well being of the research subjects, these are formulated to provide guidelines for ethics committees when they review research and to guide the researcher in planning a project. They are called the information requirement, the consent requirement, confidentiality obligations and use requirement (*Forskningsetiska principer inom humanistisk-samhällsvetenskaplig forskning*, 2002)

My ambition has obviously been to take these guidelines into account in the different situations I have become involved with in the research, where I have constantly sought to act in an ethical manner as a first priority. This is of course important not only for research but for all human activity. To meet the individual protection requirements, all participants, both teachers and students, gave their consent to participate in the survey and for sound and/or video recordings to be made at selected observation times. Moreover, another part of this agreement has also meant that the participant has had the right to independently decide whether, how long and under what conditions they will participate. To facilitate this, during the course of the study, I have repeatedly come back to why I'm there, and I have also discussed and answered questions about my research with participants when asked to do so. These occasions have been an important reminder to participants that the research is on-going. As the participants get to know the researcher as a person it is otherwise not unusual for them to forget that they are participating in an ethnographic study and that what they say or do can be used as data (Hammersley & Atkinson, 2007).

The confidentiality requirement means that individuals or groups of individuals should not be possible to identify from the research (*Forskn-*

ingsetiska principer inom humanistisk-samhällsvetenskaplig forskning, 2002). As the investigation has been conducted at a university with relatively few students, personal data has not been stored or used and my ambition has been to avoid disclosing private comments that might reveal an individual's identity. The boundary between the private and public domain is not razor sharp. In our everyday lives, it is often about whom acts or what manifests itself. For me, it has been important to the extent possible to exclude any statements or attributes that can be linked to an individual or particular student group by people outside of the group in question (Hammersley & Atkinson, 2007).

CHAPTER 5

PATTERNS IN LITERATURE AND POLICY RELATED TO THE THESIS PROJECT

This thesis project has, as described above, an ambition to describe, analyse and reflect over the political, social and cultural foundations that structure educational practice. This is done in relation to a theoretical framework that emphasizes the macro, micro processes where knowledge is converted into curricula and classroom talk (Bernstein, 2000, 2003). A process conceptualized by Bernstein as recontextualising, where relations between government agencies (in the ORF) and those active in the educational field (in the PRF), including for example educational researchers, university departments, and teacher education, through symbolic modality (power and control) construct different forms of pedagogic discourses, knowledge and pedagogic practices (Bourne, 2008; Singh, 2002). To understand the pedagogic discourse enacted in teacher education was an important part of the research to make sense of and understand the struggle between actors in the field of recontextualising. This was done through reading and analysing numerous books, dissertations and articles in the field of research that the dissertation focuses on. However also important was the reading and analysis of government policies that have structured the pedagogic discourse in the teacher education setting under study.

Two large meta-analyses of literature have been made for this purpose that have also been presented as separate papers at conferences recently. Parts of them will be presented under the headings: Literature review of

relations between ICT and education[3] and Literature review of Teacher education change in Sweden[4]. The section also contains a more 'conventional' literature review of research in mathematics for teaching.

LITERATURE REVIEW OF THE RELATIONS BETWEEN ICT AND EDUCATION

The starting point for this research project concerned questions about how ICT can revitalize education, with a specific interest in what skills the teacher needs in order to bring about this revitalization. This is also reflected in the content of the thesis as two of the empirical studies reported on address questions about ICT use in relation to educational settings. These studies have their respective empirical base in different contexts: namely compulsory school on the one hand and mathematics teacher education on the other. In slightly different ways they each however problematize teachers' skills in using ICT in education and ask questions about teaching, learning and possible educational changes with the support of information technology. These are issues that have interested many researchers over the past decade, not the least as a result of technological developments and how these technologies affect virtually all-societal activities and there have been huge investments made since 1970 on ICT in education and on education research focusing on this relationship.

The focus for researchers' interests in educational technology has usually been on what is anticipated to be the outcome if technology tools are

3 Presented at the recent ECER conference in Berlin (Player-Koro, 2011). The paper had its focus on the last decade of research on educational use of ICT. The intention was to examine the rhetoric around how the rule and nature of information and communication technology (ICT) use in education is constructed in the research field. A key question concerned whether the ICT narrative about the ICT revolution and the information society that continues to brand new technology as innovations with the possibility to inevitable change educational practice is still the most dominant discourse or is there another story to be told?

4 This section has drawn on materials produced in a recent research paper presented at the Oxford Ethnography and Education Conference, New College Oxford, Oxford University in September of 2011 (Beach, Eriksson & Player-Koro, 2011).

used appropriately by teachers and learners, in learning at school. Occasionally however, studies about how technology is actually perceived and used in educational settings, by teacher and students, and what impact this use has had on teaching learning and educational outcomes have also been forthcoming.

A prominent feature that is evident is the polarization between these two areas of research. As Selwyn (2011) has put it, there is a clear distinction between the optimistic view of the potential of education and technology on the one hand and the realities of educational technology use in educational practice on the other. I would argue that this polarization is alarming because it seems to lead to a deadlock in the development of knowledge about how ICT can improve education, teaching and learning. This was also the main the reason behind the design of one of the studies in the present thesis, *Hype, Hope and ICT in Teacher Education*.

I have tried to understand this in some way contradictory picture based on a relatively broad reading of literature related to it. The way of sense making chosen was through literature review and analysis based on a systematic database search[5] of research published in the area of use of ICT for educational purposes that resulted in a sample of just over 600 articles. The identified sample of articles was then analysed and categorised. The analysis undertaken was based on an examination of the main goals of the research considered in relation to the rhetoric around the rule and nature of digital technology use in education. This section aims to describe the main findings from this analysis.

What has emerged during my reading and analysis of literature can be presented in two ways. Firstly, research about educational technology is similar regardless of whether it concerns teacher education or school education. Secondly that unfortunately there also seems to be a distinct authorial bias in the research field (Selwyn, 2011b). In the following I will try to describe this picture and argue that elaborating on this story may be a way to generate new research issues from other perspectives and

5 The search was divided into two parts, one general and one specific. The general search was made in the citation database ISI Web of science. The aim with this search was to make a comprehensive review of the research. The more specific search was made in ERIC.

thus contribute to enhance knowledge development in this field. However, research where school education provides the context for research is far more frequent. The literature review is divided into two sections. The first section aims to provide a more general picture of research and of the pattern that emerged during the analysis. In the second section ICT and teacher education shows how this pattern recurs in studies directed to teacher education.

RESEARCH IN THE FIELD OF EDUCATIONAL TECHNOLOGY AS A POSITIVE PROJECT

It is not particularly controversial to say that research in the field of educational technology is mainly a positive project (see for example Cuban, 1986, 2001; Selwyn, 2001, 2011; Nivala, 2009, Robertson, 2003). There is a strong belief in the capability of educational technology to improve education and this is expressed in a well-recognised 'general ICT impact' discourse that seems to be the most prevalent discourse in the vast majority of research. This position was also confirmed when an examination of the identified sample articles was undertaken. In fact just over 95 percent of the articles that have their basis in researchers' interests in educational technologies and what is supposed to be the outcome when the technology is used in teaching and learning tell optimistic stories about the changes that the successful integration of ICT in education will bring about.

The overwhelming dominance of the optimistic rhetoric of research was, I thought, a good reason to analyse this literature further. From the articles that framed this optimistic tale (95 % of the sample of articles) a simple random sample of 100 articles was drawn. These articles were read in more detail with particular interest in finding themes in the text.

A theoretical concept that describes linguistic structures that produce and constitute various forms of 'truths' is discourse. Discourse is expressed in for example speech, texts, writings and in forms of action and are productive in the way that these expressions constitute objects of which they speak. Analytical approaches that aim to identify and analyse different discourses could be described with the general term discourse analysis (Fairclough, 1992, 2003). The analytic viewpoint used here draws

from the tradition of discourse analysis, even if discourse analysis per se is not employed.

A 'GENERAL ICT IMPACT' DISCOURSE

The analysis showed evidence that the articles were framed in a similar discourse that tells a story about present society, digital technology and what could and should be happening with teachers, students, learning and schools, if the technology is used in educational settings. Four different themes were identified as a framework for the analysis. These were: (1) information society as a premise for ICT use in education, (2) education in the information society, (3) the role of teachers in information society, (4) the role of students in information society. How these themes were expressed in the research accounts will be presented next.

(1) Information society as a premise for ICT use in education. Information society discourse was frequently used in articles to reinforce the necessity of implementing ICT in education. In this discourse a relation was made between ICT, the information society, globalization and a risk for the country to be left behind economically. This is illustrated with the citations below:

> We live in an ever changing world in which knowledge, power and productive capability will be more dispersed than at any time in our history, a world where value creation will be fast fluid, and presciently disruptive, a world where only the connected will survive. In business, in education, and in our personal lives, those who fail to grasp this truth will find themselves ever more isolated, cut off from the network that are sharing, adapting, and updating knowledge to create value (Thomas & Li, 2008).

> The use of ICT in the modern world has helped the human race improve many things and has claimed to improve thinking communication and problem solving skills,…society is undergoing a fundamental transformation from the industrial age to information age.

> Those who realign their practices most effectively to the information age will reap substantial benefits (Thomas & Stratton, 2006)

The last citation also illustrates how ICT use is linked to Western thinking stemming from the enlightenment informed ideal of 'techno-romantic'. This optimistic belief in technologies as a means to make progress for humans is perhaps one reason behind the linkage between new technologies and educational change that often carries overtones of change 'for the better' (Fisher, 2006; Selwyn, 2011a). The hope to transform education through technology use is also expressed in the next theme.

(2) Education in information society. Educational change and transformation is a notion that is frequently expressed in connection with use of new technologies and education. Striking views in these arguments are how agency seems to be ascribed to the technology.

> In the last 20 years technological advances have resulted in new opportunities to use technology to improve learning and instruction (Kim & Baylor, 2008)

> Education will become more global in perspective and more enriched by local issues, values and traditions (Thomas & Li, 2008)

> Nowadays multimedia computers and Internet lead to new perspectives on technology and language learning…increase of students learning efficacy…online self-assessment can measure students performance …facilitate teachers creativity (Chen & Liu, 2008)

> In the last 20 years technological advances have resulted in new opportunities to use technology to improve learning and instruction (Kim & Baylor, 2008)

The citations above also reflect changes for learning, teachers and students as well as wider changes in society that are related to how ICT will change education.

(3) The role of teachers in information society. The premise that technology will have an impact on and change education also assumes, as mentioned already, that technology will have an impact on teachers, their teaching methods and their social relations with students.

> Computer-assisted education brings benefits to teachers and students …Teachers can experiment with alternative methods related to the individual student… (technology) offers enormous resources they can use to make their subject matter come alive…motivating learning…. (through) rich and compelling problems…modelling….more sophisticated assessment (Rosas et al., 2003)

> Personal entrepreneurship turns out to be the key factor for the integration of the innovative use of ICT into the learning process (Drent & Meelissen, 2008)

However, when studies of the classroom use of ICT show evidence that ICT has not given rise to predicted changes and impending transformations, teachers are often seen as the major hindrance in implementing ICT in schools.

> Teachers are resistant toward technology centred learning environment…(Rosas, et al., 2003)

> There are promising examples of ICT use in support of new learning arrangements. So why is the use of ICT by these teachers still very limited, despite governmental encouragement, the available infrastructure and positive attitudes of teachers? (Drent & Meelissen, 2008)

(4) The role of students in information society. When it comes to students, technology based learning is often presented as an individual right in the twenty first century to:

> Equip students with collaborative learning skills, which are key skills for the workforce of the 21:st century (Looi, Chen, & Ng, 2010)

Technology is also assumed to help students overcome barriers of learning, promote social inclusion and change student learning bringing 'positive changes to students epistemology and attitudes toward science learning in contrast to traditional learning' (Looi, et al., 2010).

> Computer mediated communication has been shown to increase learner interaction and facilitate critical thinking (Jeong & Joung, 2007)

> Computer games make learning meaningful and create a learning culture that is more in correspondence with students interests (Rosas, et al., 2003)

> Students already use social software…digital natives…learning to learn…different learning (Minocha, 2009)

The story told by the 'general ICT impact' discourse could be summarized as describing how technology is expected to bring about positive changes to all aspects of education that are necessary for both the education system and for the individual to contribute to a competitive community development. This optimistic discourse could probably be due to most researchers in the field being, in one way or another, driven by an underlying belief that use of technologies will improve education, which in turn becomes their driving force for exploring possibilities with new technologies and makes them highly susceptible to tell stories about new and changing opportunities for schools, learning, teachers and students, which will be realized in the near future (Selwyn, 2011b). Selwyn

(2011b) refers to descriptions such as 'technology-enhanced learning' or a previously used term 'computer assisted learning' as examples where this inherent connection between technology and improvement of teaching and learning is evident. Another origin for the positive claims about technology and improvement of education has been established by the ICT industry, where part of their marketing strategy has been to redefine educational goals and problems in ways that can be solved with the use of new technology. This is also part of the tale about our contemporary society as an information society (Cuban, 2001; Nivala, 2009; Robertson, 2003; Selwyn, Gorard, & Williams, 2001).

I will argue that even if this mind-set stems from a desire to improve education, through its dominance it may still lead to some negative consequences for knowledge development in the research field. This is also claimed by an array of editors from academic journals during the past decade. The editors for British Journal of Educational Technology provide an example (Nichol, Watson, & Waites, 2003). They wrote in 2003 that:

> Optimistic-rhetoric has launched a huge flotilla of qualitative evidence about the nature of an impact of ICT in the educational arena, often dressing up the rhetoric in the garb of a research report. Yet even here there is a deep cause of concern - the 'research' is in many instances deeply and fundamentally flawed (p. 131).

The editor for Learning, Media and Technology wrote recently, that there are too few studies with a critical eye towards the optimistic rhetoric, and that this limits the validity and credibility of the field as a serious academic endeavour (Selwyn, 2011a). Moreover, it also seems difficult for dissenting voices to be heard researchers with critical or negative analyses were often ignored by the research field or accused of being 'luddite', 'technophobic' or 'naysayers' (Nichol, et al., 2003; Rushby, 2005; Selwyn, 2011a).

A concept that describes this kind of unilaterally written text that by its dominance may also distort the research record is authorial bias. A known consequence of this is that it creates systematic exclusions of research findings and could cause, amongst other things, a waste of research resources. This serious possibility was reported by Randolph and Bed-

narik as evident in publications in computer science education (Randolph & Bednarik, 2008).

In the following, I will develop the argumentation about the consequences this dominant representation of reality may create for knowledge development by first giving an overall description of the research on learning and ICT use and how the 'general ICT impact' discourse is used in the research. After this I will then more specifically describe research on teacher education and ICT on the same premises.

RESEARCH ON LEARNING AND ICT USE

As already mentioned one important focus for researchers' interests in educational technology in many cases is forward-looking, toward embedded possibilities and what is anticipated to be the outcome if technologies are used in educational settings by teachers and learners in learning in school. Questions put forward range from simply asking if a technological device or application could be used for educational purposes on the one hand, to having a focus upon the gains and effectiveness achieved when technology supports or enhances educational work on the other.

A common research design in these traditions is that of small-scale case study research, which is motivated as a means to embody examples of the use of ICT for teaching and learning. The production of a corpus of case studies is argued as important for providing an evidence base for generalisation and for the dissemination of good-practice (Lyons, 2009; Poland, la Velle, & Nichol, 2003). Conclusions from this kind of studies often show promising opportunities for use in educational settings. What is also evident is a pattern in research where research goals, and the rhetoric around the rule and nature about use, forms waves that can be followed.

This pattern typically starts with research exploring emerging technologies, and results in high expectations for reforming education, followed by studies where the use of technologies is shown to be just as effective as promised. In the wake follows surveys noting that despite all the potential opportunities that technology will bring about, ICT has had comparatively little impact on teaching and learning. This in turn diverts attention to interest in studies about implementation and to interest into what is

influencing technology use in education, where shortcomings are seldom attributed to technology compared to the ability to make effective use of it (Cuban, 2001).

Amongst others Larry Cuban addressed this phenomenon when he wrote about the history of technology (such as film and radio, television and computers) and education. Cuban traces cycles where enthusiastic visions of new technology sadly end up in disappointment and limited substantial educational change (Cuban, 1986). More recently the editor of the British Journal of Educational Technology wrote on the same theme when he wondered about 'the cyclic nature of learning technology…that around intervals of three to four years promised to deliver revolution in learning' (Rushby, 2005 p. 135) and the depressing fact that when a new wave starts the lesson from previous cycles seems to be forgotten. My argument is that it is the 'general ICT impact' discourse that enables and drives these cycles. This will be described next.

Some emerging technologies could be described as technologies that are expected to open a new era for education. When a new technology innovation is launched research is often aimed at developing knowledge necessary before technology or an instructional approach can be used in educational settings (Alfonseca, Rodriguez, & Perez, 2007; Chen & Liu, 2008; Kim & Baylor, 2008). This means that these studies are often conducted outside of the educational context. The research questions that are asked tend to have a close link to the technology, such as whether or not a technology tool works, how people work with it and under what conditions it works.

A striking feature in this kind of research is that there seems to be no space for critical or negative views of using the technology innovation in education. Instead a huge flotilla of potential benefits and opportunities for how technology will enhance teaching and learning are presented. Research can be summarised as having the following characteristics:

- The research is conducted outside the classroom or educational context
- Yet, potential benefits and opportunities with the technology for teaching and learning in educational contexts are presented

- The educational opportunities offered by the technology are described as in-built properties

These characteristics are illustrated here with citations taken from research that examines potential educational values with web innovations that have been cast in a new light by the emergence of so-called 'Web 2.0' technology[6]. So-called social software, where users are connected to and collaborate in a variety of group interactions is an example of this kind of application. Another example is virtual environments, or virtual worlds. These are three-dimensional worlds that allow users to interact with one another with a greater sense of presence than in video or web conferencing (Jones, Blackey, Fitzgibbon, & Chew, 2010).

The citation below illustrates how studies concerned with Web 2.0 technologies are remarkably often more or less speculative in nature. Several of the studies are based on investigations of how these technologies are used outside educational institutions and situations by mainly young people. Speculations about possible opportunities for education are made on the basis of these investigations (Jones, et al., 2010; Lewis, Pea, & Rosen, 2010; Wehrli, 2009).

> …Web 2.0's unique capabilities and youth's proclivities in using it influence learning and teaching. Two important themes, learner participation and creativity and online identity formation, emerged from this analysis and support a new wave of research questions (Greenhow, Robelia, & Hughes, 2009).

There is a widespread agreement in these studies that it is the interactive possibilities that Web 2.0 services offer that creates opportunities for education and learning. These opportunities are often described as in-built in this kind of technology (Lewis, et al., 2010).

The next citation makes another common feature visible, namely that often a relation is made in the text between technology, the information

6 O´Reilly (2005) What Is Web 2.0 Design Patterns and Business Models for the Next Generation of Software [http://oreilly.com/web2/archive/what-is-web-20.html]

society, globalization and a risk for the country to be left behind economically or developmentally.

> We are nearly a full decade into the 21st century and unfortunately many schools are still using the term '21st Century teaching' as a… futuristic idea. The fact of the matter is that the longer schools wait to use technology in their classrooms, the further behind their global peers students will become (Byrne, 2009).

Another striking feature in this kind of research is that there seems to be no space for critical or negative views of using the technology innovation in education. This is especially prominent in investigations where research questions about an innovation are to be compared against a control group. In most cases the experiment manifests expected opportunities and the stories told by the research could more or less be defined as success stories (Alfonseca, et al., 2007; Looi, et al., 2010; Margolis, Nussbaum, Rodriguez, & Rosas, 2006). These initial exploratory studies are often followed by studies exploring in-context use of the new technology in education and issues of practice. Small-scale case studies are frequently used even in this category.

Results from case studies often show evidence of promising opportunities for use in educational settings, even though a number of inhibiting factors are also taken into consideration. The promises of transformation are common and the rhetoric also carries overtones of technological determinism with agency being ascribed to the technology. The results can be summarised as follows:

- Small scale studies show promising opportunities for use in educational settings
- Positive effects on students, teachers and learning that have the potential to inevitable change educational practice are suggested
- Fundamental changes to structures for teaching and learning are implied
- If it fails, it is not due to technology

In other word it could be said that those previously identified opportunities for education that technology use would enable, are in this step confirmed through studies on technology use in teaching and learning situations. This will be illustrated below with citations from studies where web 2.0 is used for educational purposes. These citations show how the in-built two-way communication provided by the software is proved to facilitate collaborative learning by encouraging active learning for students and facilitating tutor-student interaction and so on.

> Web 2.0 is an umbrella term for technologies that support individuals' social participation…Web 2.0 provides support for students reflection…enhances identification and collaboration…(Augustsson, 2010)

> Overcoming barriers of lifelong learning requires innovation to keep pace with technological and social realities…The ability to share work in progress…is something that technology facilitates. However the use of IT tools is circumscribed be the inherent benefits, limits and even risk of each technology…many educators need to understand this…their practical experience is lacking (Durkee et al., 2009)

The citations make visible how the information society discourse was frequently used once again to reinforce the need to implement ICT in education. However, the last citation also illustrates the way problems are addressed. In most cases these are not assumed as related to technologies and even if they are, they are often described as minor errors that can be corrected in the next update (Jeong & Joung, 2007). More often it is claimed that all educational benefits will be met as soon as teachers and students have the right skills and full access to technology (Thomas & Stratton, 2006). In other words, if technology fails, it is not due to technology but to user shortcomings (La Velle, McFarlane, & Brawn, 2003). The research thus strengthens ideas about the possibility of using digital technologies to enhance teaching and learning practices and increase student motivation and engagement. Inherent in this enthusiasm is also the word transformation, which is also frequently used, with the underlying

meaning transformation 'for the better' (Barak, 2005; Draper, 2009; Pol, Harskamp, Suhre, & Goedhart, 2009; Poland, et al., 2003).

There are also examples illustrating how transformations of mathematics education can be accomplished when ICT is used in teaching and learning. In these cases ICT is assumed as having the possibility to enhance students' conceptual understanding and problem-solving skills, to affect students' attitudes toward mathematics in a more positive way, and to have the capability to transform the way they understand and learn mathematics (Cifarelli, Goodson-Espy, & Jeong-Lim, 2010; Hwang, Chen, & Hsu, 2006; Portnoy, Grundmeier, & Graham, 2006; Reed, Drijvers, & Kirschner, 2010).

An example that sheds further light on this is a study by Li (2005), where integrating multimedia and online discussion into a mathematics methods course was examined and where guiding principles for the future design of those courses were suggested. Results showed positive effects on student teachers' knowledge of mathematics education and their attitudes toward educational technology. Instructors became better teachers in that the use of technology made them rethink pedagogical issues such as course content and goals. This study underscored the importance of infusion technology. Not using technology was the only negative aspect mentioned here (Li, 2005).

Also important to note is how predictions are made about how teachers will transform their work when technology is used. Technology use should make teachers re-work their lesson plans and pedagogy in ways that facilitate new classroom activities, increase the productivity of pupils and improve the quality of work (Hartley, 2007; Karasavvidis, Pieters, & Plomp, 2003; Ottestad, 2010; Ruthven & Sara, 2003). This can be seen in relation to how teachers are described in the results from studies in the other main strand of research that will be described next.

RESEARCH ON HOW TECHNOLOGY IS PERCEIVED AND USED

The other main strand of research is research that is aimed at finding out how technology is actually perceived and used in educational settings by teachers and students and what impact this use has had on teaching learn-

ing and educational outcomes. It is very different to the above category. In it, in opposition to the optimist rhetoric, it is very difficult to find evidence that confirms that ICT actually has enhanced educational standards in any way, and the process of the integration of technology is also often described as unsatisfactory. The conclusion from the research is often summarized in the following way. ICT is used 'less than expected' or/and 'not as expected' (Nivala, 2009; Ottestad, 2010; Teknikdelegationen, 2010; Volman, 2005). These studies are often larger evaluations where data are collected using surveys.

An investigation showing this dilemma is a report from an ImpaCT2 project in the frame of the National Grid for Learning (NGfL): an initiative from the UK government in order to stimulate ICT use in education (Harrison, Lunzer, Tymms, Fitz-Gibbon, & Restorick, 2004). For mathematics teaching and learning these kinds of evaluation show that technology is used infrequently in classrooms and that traditional structures of teaching and learning mathematics persists as the most common way of teaching and learning mathematics (Forster, 2006; Reed, Drijvers, & Kirschner, 2010). Studies describing this disappointment are illustrated by the following quotation. The first citation relates to the expression 'less than expected' and the second to the expression 'not as expected'.

> Through surveys...this study examines technology adoption at a large Canadian University ten years after setting a strategic plan…Results showed that whilst 90% of respondents were using computers in teaching there is still much to do in helping them to increase the effectiveness of their use of technology (Zhou & Xu, 2007).

> …a survey was conducted amongst 570 respondents in a stratified sample of 53 primary schools. Result showed that teachers mainly focus on the development of technical skills, whereas the ICT curriculum centres on the integrated use of ICT within the learning process. This indicates the existence of a gap between the proposed and the implemented curriculum for ICT (Tondeur, van Braak, & Valcke, 2007).

The last quote also shows how the blame for the disparity between the enthusiastic rhetoric and rather more mundane use of technology has frequently been attributed in research to deficits in skills, motivation and know-how on the part of teachers and students.

With reference to studies that highlight the problematic relation between technology use and teachers, and that add that potential educational benefits have not been realised, Russell et al. (2003) employed a study to explore issues related to teachers' ability to use technology in the classroom. The analysis showed that generally technology is used on a limited scale in educational practice (less than expected), that teachers use technology more outside school, that beliefs and attitudes are important predictors for technology use in classrooms and that newer teachers use ICT less than experienced teachers in classrooms (Russell, Bebell, O'Dwyer, & O'Connor, 2003).

A typical study where the conclusion falls into the term 'not as expected' is Louw et al's (2009) investigation of teachers in South African Universities, who were reported as having high self-efficacy in terms of using ICT both generally and for teaching. Even if use of computers was pervasive the use was narrow and infrequent. Constraining factors were according to teachers in the study lack of time, inadequate technology and problems with students copying/plagiarism and pedagogical considerations (Louw, Brown, Muller, & Soudien, 2009).

RESEARCH ON REASONS WHY ICT HAS NOT CHANGED EDUCATION

'Less than expected' and 'Not as expected' appears in the literature as an accepted truth and is also in many studies used as a point of departure for the research. Cuban (2001) represents these arguments with his investigation that came to the conclusion that computers have been 'oversold' as a vehicle for reforming educational practices and are for the most part 'underused' as an instructional tool by teachers at all levels of education. He pointed to two dimensions in this problem that are often prevalent in surveys. These are respectively teachers' *inadequate skills*, both technical and pedagogical, in how technology can be used in instructional practices,

and the *educational system* that has not been restructured to support the integration of technology during instruction.

These 'blaming' arguments often derive from research that follows in the wake of investigations showing the lack of impact of ICT. These studies aim at searching for reasons why ICT has not changed education and solved many of its problems, despite the growing number of computers in schools and their increasing use. What is remarkable here is that almost none of these studies contradict the core beliefs and values about educational technologies as a force for positive change. Instead, they often come to the conclusion that the school does not live up to expectations because teachers lack sufficient interest and/or skills (Bryson & De Castell, 1998; Cuban, 2001; Divaharan & Koh, 2010; Hennessy, Ruthven, & Brindley, 2005; Kiridis, Drossos, & Tsakiridou, 2006; Park & Ertmer, 2008). Teachers are in other words singled out as being both the cause of the limited integration and its possibility. It is by educating teachers, it is said, that the promises of ICT use will be fulfilled (Gouseti, 2010; Selwyn, Dawes, & Mercer, 2001; Selwyn, Gorard, et al., 2001). Articles 2 and 3 in present thesis look at this issue through ethnographic research.

SUMMARISING RESEARCH ON ICT AND EDUCATION

In summary, the idea that educational technology will solve pedagogical problems and significantly reconfigure education is a recurring theme in texts from research literature. In fact this idea has been there for a long time and is rather to be regarded as a historical phenomenon (Cuban, 1986). It can be identified in marketing strategies from the industry (Robertson, 2003) and has been picked up by policymakers and researchers and transformed into a belief system which seems almost impossible to criticize (Nivala, 2009; Robertson, 2003; Selwyn, 2011b). Moreover, unlike most other fields of academic studies its seems as if the educational technology appears particularly resistant to viewpoints that contradicts this belief system about technology as a potential force for positive change (Selwyn, 2011a).

I would say that there is reason to believe that the field of academic study about the use of digital technology in education suffering from authorial bias (Randolph & Bednarik, 2008; Selwyn, 2011b) and that this

has serious consequences for both research and practice. Most studies are focused on possibilities for the future and there is a lack of studies about what actually takes place when technology is used. The optimistic view of the potential with technology runs counter to many of the recent realities of digital technology use in educational practices according to for instance Gouseti, (2010) and Selwyn, (2011a, 2011b).

ICT AND TEACHER EDUCATION

When it comes to research in the area of educational technology use in teacher education and in mathematics teacher education, the same pattern as described above emerges once again through numerous examples of successful practices from small-scale studies (Abramovich, 2004; Alagic, 2006; Divaharan & Koh, 2010; Forster, 2006). For example, in studies where spread-sheet applications are used in mathematics teacher education the research shows that the spread-sheet environment facilitates the development of conceptual understanding in mathematics, provides a venue for visualisation and promotes problem solving processes (Abramovich, 2004; Alagic, 2006; Frith, Jaftha, & Prince, 2004; Gierdien, 2010). In addition, technology use is also said to create potential opportunities for future mathematics teachers to develop their professional knowledge and identity as well as new perspectives about mathematics teaching that include exploration, investigation, and modelling (Forster, 2006; Ponte, Oliveira, & Varandas, 2002).

Again the picture emerging from evaluation studies contradicts these positive visions. A fairly homogenous picture emerges about a limited use of educational technology in teacher training and that student teachers were not satisfied with ICT integration courses and called for a need of more training and support for effective ICT integration in their future classrooms (Drent & Meelissen, 2008; Enochsson, 2009; Enochsson & Rizza, 2009; Goktas, Yildirim, & Yildirim, 2008; Jung, 2005). For mathematics teacher education, as with schools, it seems that although ICT-optimistic research expresses with certainty that ICT use will change teaching and learning for future mathematics teachers, so far changes with or through technology remain hard to be seen (Selden, 2005; Steketee, 2005).

RESEARCH ON HOW ICT IN TEACHER TRAINING SHOULD BE ORGANISED

Another general trend in research relates to recommendations for how teacher training should be organised in order to distribute adequate knowledge and skills to prepare student teachers for the use of technology in teaching and learning. One of these trends concerns whether ICT training should be integrated as isolated ICT courses or if it should be integrated across the entire teacher education curriculum (Goktas, et al., 2008; Jung, 2005). Many studies supported the view that emphasizes the importance of integration of technology with pedagogy and subject content studies, where students experience ICT skills as a part of training methods (Enochsson, 2009; Goktas, et al., 2008; Haydn & Barton, 2007; Jung, 2005). The latter organization was the same suggested in the course syllabi and planning of the teacher-training course in my research.

The recognition of the central role of content and pedagogy in uses of educational technologies have been given more attention through Schulman's (1987) proposal that crucial aspects of pedagogical practice are uniquely connected to specific content areas conceptualized as pedagogic content knowledge, (PCK). This concept will be elaborated on under the heading *Mathematics teacher education as a field of practice*.

An extension of the concept of PCK was made by Koehler and Mishra (Koehler & Mishra, 2009). Their concept emphasized even technology and was termed technological pedagogical content knowledge (TPACK). TPACK takes it's point of departure from an optimistic rhetoric such as that presented earlier, that technologies indeed have the capability to improve teaching and learning but content and pedagogy are crucial parts in this success.

From this follows that although the knowledge about teaching a specific subject is specific, the way in which ICT may best be used for that subject may also differ. For mathematics teachers this means that there is a specific knowledge needed to teach mathematics with digital technologies and that this knowledge is different from conventional maths didactics. The TPACK framework has developed different models directed to mathematics teachers and teacher education in relation to this, with the intention to enhance teaching and learning and transform school and education (Marino, Sameshima, & Beecher, 2009; Niess et al., 2009). These develop-

ments have shown some early promise but have not as yet however been extensively empirically researched.

CONCLUDING REMARKS

To summarize this examination of research about educational use of ICT it could be said that there seems to be a paradoxical discrepancy between the rhetoric underpinning studies in the research field and what many students and teachers in the on-going educational practice in different educational institutions experience. It has also become increasingly clear to me that this discrepancy between the 'general ICT impact' discourse and the mundane reality may play a major part in the creation of the reported failure of technology integration in education. Therefore, as an array of other researchers suggest, there are reasons to challenge the essentially optimistic narrative of digital technology and education that is heralded in the public discourse about the information society, not least because of the dominant position this discourse has, but also because of the fact that it may perhaps be driven more by economic than educational concerns (Nivala, 2009; Robertson, 2003; Selwyn, Gorard, et al., 2001). This can also be argued in relation to what Ball writes of as being problematic with dominant discourses in the way they constrain possibilities and tend to bring about idealised solutions to diagnosed problems, which may lead us to risk missing 'the bigger picture' (Ball, 1990). 'Missing the bigger picture' is however of course also consistent with the implications for research in which authorial bias occurs (Randolph & Bednarik, 2008).

RESEARCH IN MATHEMATICS FOR TEACHING

The focus on ICT is one main focus in the thesis. However, the thesis is also very much concerned with teacher education policy and practice and the position of both teacher education and mathematics education in the political debate.

To assert that teacher and mathematics education are political should not surprise many nowadays. Mathematical competence is singled out in official education discourse as the specifically most important general competence for citizens in the twenty-first century (Valero, 2007b) and drives the call for increasing mathematical subject content in teacher education by politicians and policymakers. However, in this call for an increased focus on subject knowledge in mathematics what math skills are in demand is rarely reflected on. Instead there seems to be an unreflective view that more mathematics automatically leads to better mathematical skills for schoolchildren that ultimately will lead to individuals and society both becoming more successful. I will return to this in the section *'Literature review of Teacher education change in Sweden'*, but first I will describe the research that problematizes subject knowledge in mathematics in relation to teaching mathematics.

Research in mathematics for teaching provides evidence that the kind of knowledge needed for being able to teach mathematics is complex and that there is a need to better understand how mathematics and teaching is combined in teacher development and teachers' identities (Adler, 2006; Adler, et al., 2005). The aim with the present section is to describe this. It deals with research about what teachers need to know and know how to use in order to become good professionals in mathematics teaching. The reading of this literature was also highly motivating for the thesis studies (especially in relation to article 2, 3 and 4) where the ideas about mathematics and mathematics teaching were analysed in a mathematics course designed specifically for prospective teachers.

Mathematics education in general and mathematics teacher education in particular, as a field of study, is according to Valero (2007) conducted from two different domains, each of which refers to different ways of defining mathematics education. In the dominant definition of mathematics education as a field of study mathematics is taken for granted and the

space of research enquiry involves relationships between teachers, learners and the mathematical content. This technical relationship is termed the didactic triad. In the area where research is concerned with practices within mathematics teacher education and what teachers need to know about mathematics, it is often underpinned by an assumption that there is a certain specificity regarding the mathematics that teachers need to know and know how to use (Adler, 2006).

The epistemological assumption that underpins this view was identified and described by Shulman (1987). He described the teacher's professional knowledge as a complex knowledge about teaching and learning, which he termed Pedagogical Content Knowledge (PCK) and he also signified the centrality of the integration of this kind of knowledge with subject knowledge (Shulman, 1987). The term Mathematics knowledge for teaching (MKT) emerged from this as a distinctive form of mathematical knowledge. MKT is produced in and used for the practice of teaching and is said to differ from the way mathematicians use mathematics (Furinghetti, 2007; Hill et al., 2008). One of its most distinctive features includes the ability to unpack and decompress mathematical ideas. This is in contrast with how mathematicians work with mathematics, as this work relies on the capacity to compress information into abstract and highly usable forms (Adler, 2006).

The subject of mathematics in my investigation was taught by faculty members from mathematics departments and organised around lectures as a kind of tertiary study of mathematics. The characteristics of this were thus more in line with mathematics for mathematicians. It was complimented however by the subject of mathematics didactics as a mathematics for teaching, which was often taught as part of the same course, but this time by mathematics teacher educators who were specialised in the teaching and learning of mathematics in school.

This organisation, although recommended in national policy for teacher education and very common in teacher education institutions across the country, is problematic according to a growing number of researchers in the area of research on MKT (Adler, et al., 2005; Hill & Loewenberg Ball, 2009; Hill, et al., 2008). For instance, results from a study that was theoretically informed by Bernstein's educational code theory (se section *Theory*), reported by Adler (2006), revealed starkly that there is a limited

presence of opportunities for teacher students to unpack or decompress mathematical ideas in these courses, which thus run counter to how mathematics is described as needing to be understood so it can be used effectively to teach (Adler, 2006; Adler, et al., 2005; Furinghetti, 2007; H. Hill & Loewenberg Ball, 2009; Persson, 2009). Moreover, these studies also point to a lack of understanding regarding necessary competencies in mathematics for teachers in current policy initiatives in many countries today. These policy initiatives advocate more mathematics knowledge in the conventional form (mathematics for mathematicians) and as a school subject. But more mathematics per se does not guarantee better mathematics teaching (Adler, et al., 2005; H. Hill & Loewenberg Ball, 2009).

Many other forms of research have come to the same conclusion. That is, that there are some very good reasons to question assumptions about the singular value of increasing subject content generally and mathematics subject content specifically. As an array of researchers have suggested, there is considerable contradictory evidence see e.g. (Cohen, 2008; Davies, Davies, Hutton, Adnett, & Coe, 2009; Edwards & Whitty, 1997) as well as lessons to be learned from previous cycles of policy into practice. For instance UK government agencies set requirements in place over fifteen years ago to crack down on primary school teacher trainees whose own knowledge of mathematics was considered to be weak, but neither then nor now has the emphasis on more mathematically-strong education led to better mathematics performances in schools or amongst student teachers in the UK or elsewhere (Henderson & Hudson, 2011; Murray, Nuttall, & Mitchell, 2008).

RESEARCH ON THE POLITICS OF MATHEMATICS EDUCATION

I started this section with the statement that mathematics education and mathematics teacher education are highly political practices, by which I mean that mathematics and mathematics education are social activities and practices, where the meaning of teaching and learning of mathematics is constituted. Mathematics education is in this sense understood as a field of practice. It is a space where people engage in the teaching and learning of mathematics that as a consequence also broadens the definition of

mathematics as a form of socially constructed knowledge (Henderson & Hudson, 2011) and invites researchers to engage in political dimensions of mathematics education practices (Skovsmose, 2011; Valero, 2007b). However, when mathematics is considered as one of many social practices it also becomes situated in a wider context, which in turn opens up the possibility to pose new questions that are not confined to the space of the classroom. One could consider, for example, how textbook writers shape teachers' practices, what influence policy-makers in mathematics education have on teaching and learning and how expectations from politicians influence both policy making and practice. Attention is thus directed to other aspects of mathematics learning beside cognitive problems. Examples include how learners' backgrounds may influence mathematical learning and what effects the social, political and cultural complexity of mathematics education has on learners' performances (Beach, 2003; Valero, 2007a, 2007b).

Findings from this kind of research could be useful to underpin studies concerned with how much and what kind of mathematics teachers need to know and know how to use in order to teach mathematics successfully. This applies particularly for considering the effects of teacher education on students' understandings of mathematics and teaching and learning of mathematics (as is the case is in present research), where a broader definition inherent in the definition of mathematics education as a field of practice is clearly needed. This view implies an analysis of different actors within the site as well as the connections between this site and its context, and means that the cognitive subject matter knowledge of teacher students is only one of many factors that have an impact on what mathematics teacher education conveys (Bernstein, 1999a). This broader analysis allows for a critical examination of official discourses, policymaker practices and the recommendations and decrees proclaimed by politicians.

Valero (2007b) argues that there is a lack of studies with this kind of broad perspective and she calls for more studies that emphasize research with a serious concern for the political and social nature of mathematics education, which she sees as necessary in order to fully understand the effects of this education. This theory is also supported by Lundin (2008), who argues that the narrow view of mathematics may be a contributing

factor to the constant criticism of mathematics education that has been going the last 150 years (Lundin, 2008).

SUMMARISING RESEARCH IN MATHEMATICS FOR TEACHING

In summary, as research in the field of mathematics for teaching shows evidence of, there seems to be reasons to problematize and challenge the common view in policy and the public debate that an increase of mathematics subject courses in teacher education per se will lead to quality teaching in school, and that mathematical proficiency will become a widely held competency in society. For me this became even more urgent in relation to the most recent policy cycle directed to teacher education in Sweden, where arguments put forward for the need to change teacher education went through the argumentation that prospective teachers need access to relevant and deep understanding in subject knowledge, in mathematics in particular, in order to be prepared for teaching in school (SOU 2008:109, 2008).

In this latest Green Paper the definition of the professional knowledge base for teachers is constituted by a very technical understanding of didactic relationship between the teacher, the students and the specific subjects taught (Beach & Bagley, 2012), and there is no attempt to make what kind of mathematics that teachers need to know and know how to use specific, nor are the complexities of the socio political characteristics of mathematics and mathematics education taken into account. Instead what is proposed is a switch back to conventional subject studies with a view of subject knowledge as relatively straightforward, neutral and objective content that should form the basis for professional development and teaching skills (Ellis, 2007; Hayes, Capel, Katene, & Cook, 2008). This applies not just in mathematics teacher education but it is emphasised specifically for this education. These changing policies will be discussed and analysed in the next section.

LITERATURE REVIEW ON TEACHER EDUCATION CHANGE IN SWEDEN

One of the two subfields of the recontextualising field, namely the official recontextualising field (ORF), is where the state regulation of the pedagogic discourse is undertaken. In this sense Bernstein uses the term 'official pedagogic discourse' to categorize State discourses on education as revealed in for example government policy documents.

The official pedagogic discourse is part of the link between macro social structures in the distributive field and micro classroom interaction processes and is important because of its role in establishing relationships between government agencies and those active in the field of education and teacher education. Through the official discourse and the impact this has on the pedagogic discourse more or less agency or status is created for the teacher profession and the constitution of teacher students' identities and the legitimate knowledge that is needed for teachers in their work in classrooms (Bernstein, 2000; Bourne, 2008). Bernstein also talks about this as a balance between two different discourses (as described under the sub-heading *Trivium and Quadrivium*) inherent in teacher education, namely the teacher education Trivium, consisting of a body of knowledge about education practices, and a discourse for specialised subjects (Quadrivium) that teachers should be teach in school. Moreover, what is also important to take into account is the multi-vocal struggle in the ORF and between the ORF and the pedagogic recontextualising field (PRF), which means that for example policy outcomes for practice are always unpredictable (Bernstein, 2000). Ball talks about this in terms of policy discourses and policy effects, where he stipulates that polices have implications but that these are rarely fully in line with or easily read off from the intentions expressed in policy texts (Ball, 1993).

POLITICAL STEERING OF TEACHER EDUCATION

The steering of teacher education has always been political according to for instance Arreman (2005) and Erixon Arreman and Weiner (2007), and has (therefore) been alternatively shaped and reshaped by a variety of often competing policies. In recent years, this political management has become

clearer (Arreman, 2005; Erixon Arreman & Weiner, 2007). An increasing number of policies have been produced directed to teacher education and the call for a need to change teacher education has become more a part of a political power struggle. This has had many consequences. One of these is that policies have often been produced without support from research. Another is that the argument for the need for a transformation is made on assumptions that lack scientific foundation. The latter is also in line with findings from studies 2, 3 and 4 in this thesis.

It is against this background of the political nature of teacher education policy making that the present literature review was made. Bernstein's theorising of the historical shift between the two discourses Trivium and Quadrivium have been used to describe and understand policy intentions in relation to policy effects that are made visible in the pedagogic discourse, which was the main object for the research (Bernstein, 2003). Moreover, the identification of changes on the political level was also important for understanding interrelated mechanisms between policy and curriculum and the formation of teacher-student identities. The use of Bernstein's concepts has been particularly important in relation to article 2, 3 and 4 in the thesis.

SIXTY YEARS OF CHANGE THROUGH POLICY IN TEACHER EDUCATION

According to recent research on teacher education change in Sweden there is a distinction within teacher education in Sweden today that derives from the historical roots of teacher education as partly in a seminar tradition, focusing on practical aspects of teaching directed to teaching of younger children, and partly in an academic tradition focusing on subject studies and directed toward the teaching of adolescents (see also Jedemark, 2006; Åstrand, 2006). Bernstein (2000, 2003) has suggested that these historical distinctions are international. Also suggested is that they are stubbornly resilient to change (Eriksson, 2009).

The organisation of knowledge has been very different in these two traditions. The seminar tradition has been based on a practice-oriented model for professional knowledge and a school teaching content related subject knowledge curriculum, that generally consisted of the same lit-

erature that the prospective teachers could use in their future teaching (Jedemark, 2006). It was aimed at the teaching of younger children and historically also children from low social-economic backgrounds in the so-called *folkskolan*. The content of education was in line with what Bernstein defined as the first historical stage of teacher education characterized with a pedagogic discourse that was dominated by a Trivium and consisted of methods for how to teach a specific set of subject knowledge that regulated the body of knowledge communicated. The knowledge base of the Quadrivium was the same textbooks used by schoolchildren in school (Bernstein, 2003 p. 162). The academic tradition on the other hand emphasised formal subject (academic) knowledge for teaching older children, mostly from the middle and upper-middle classes, in the so-called *realskolan* and *läroverk* institutions (Beach & Bagley, 2012). Knowledge of teaching as a professional practice was regarded as scientifically unproblematic in this tradition and treated more as a personal orientation (Jedemark, 2006). The organisation of knowledge for these teachers was unlike the seminar tradition dominated by Quadrivium.

Over the past sixty years a series of policies have been identified that comprise a policy trajectory (after Ball, 1997). Work by Beach (2011) and Beach and Bagley (2012) illustrate this. What is shown is that until recently policies have been at least in part designed for and committed toward eliminating the above distinction, by creating preconditions for a more unified teaching profession that shared a common fond of scientifically grounded professional knowledge of teaching. This content was also intended for communication in teacher education to all prospective teachers, regardless of their age-range or subject specialisations (Beach, 1995, 2000, 2011a; SOU 1999:63, 1999a).

With Bernstein's definition the policy trajectory could be described as part of a struggle to reach an organisation of knowledge where teacher education is characterised by a strong Trivium with a specialized discourse composed of expertise from the academic sub-disciplines of the philosophy, psychology, sociology and history of education (Bernstein, 2003). With the use of another concept defined by Bernstein it could be said that the policy intention was to develop of a vertical (scientific) professional discourse (Beach and Bagley 2012). This is in line with what has been one of the intentions in teacher education in highly advanced knowledge-

based societies like Sweden, Finland and several other European countries (Mueller & Bentley, 2007). Another tendency was also to put primacy on the development and communication of strong structures of discourse for the development and evaluation of teacher competence and the development and communication of a professional knowledge base (Beach, 1995, 1997, 2000).

Beach (2011) identified the following inquiry commissions and their subsequent Green Paper recommendations as central to this. These are presented next in order to provide a historical dimension and a foundation for the description of the implied policy trajectory. The five reform cycles are comprised respectively by the Green and White Paper productions from the 1946 School Commission's *Teacher College Delegation*, the 1960 *Teacher Education Expert Committee*, the 1974 *Teacher Education Commission* (LUT 74), the 1997 *Teacher Education Committee* (LUK 97) and most recently the 2007 *Commission on Sustainable Teacher Education*.

THE 1946 SCHOOL COMMISSION'S TEACHER COLLEGE DELEGATION

The Teacher College Delegation (TCD) was established under the National School Commission in 1946. The report that came out of the school commission's work (SOU 1948:27, 1948) contained guidelines for what would shape several decades of Swedish school development toward a primary goal to create a more progressive school that fosters democratic citizens (Beach, 2011a). It contained guidelines for a common school for all children and young people, and for a common teacher education for all teachers in compulsory school (Jedemark, 2006).

Two main intentions were expressed in relation to teacher education. One was to help break the previously bifurcated holding on professional knowledge from the seminarian and academic traditions and the other was to develop a scientifically grounded professional knowledge base for the teaching profession (Beach, 2011a). Courses in pedagogical and psychological content areas were introduced to these ends to improve common understandings of the purpose of schooling and to support cooperation between different teacher categories as a foundation for the implementation of school development projects in the context of on-going educa-

tional reforms. According to the TCD these required new dimensions in teacher competence for a more progressive school.

Teacher education was linked very distinctly and explicitly through both the directives from the Government to the TCD and recommendations from the enquiry commission to national educational politics and school development (Härnqvist, Achtenhagen, Rosengren, & Öhngren, 1997). As part of this one proposal of the TCD was that research closer to teacher education delivery should be established through setting up full research professorships in new teacher training institutions called Teacher Colleges, as part of an intention to develop and communicate a more applied (praxis focussed) research that was more relevant to teachers' work than other more abstract forms of psychological research might be (Askling, 2006; Beach, 2011a). This new praxis based research was intended to mainly involve scientific investigations of general pedagogical questions, but it also pointed to the value of a full scientific study of teaching method and an intention to develop content-related analytical skills (Beach, 2011a).

As is discussed in article 2, 3 and 4, it seems to have been very difficult to fulfil these intentions in practice (see also Beach, 1995, 2000; Gran, 1995; Eriksson, 2009). The Commission report could be seen as the first step toward a strengthening teacher knowledge by forming an academic disciplinary knowledge of teacher education Trivium. The pilot project with teacher colleges started in 1956. Teacher colleges then became the common institutional framework for teacher education. However, this education still remained divided into two separate programmes one for teaching of younger children (class teachers) and one directed towards teaching for older ages (subject teachers) (Jedemark, 2006).

THE 1960 TEACHER EDUCATION EXPERT COMMITTEE

The 1960 Teacher Education Expert Committee (TEEC 60) followed up the development of teacher education after the establishment of the Teacher Colleges and the hoped for grounding of a scientific professional knowledge base for teachers' professional knowledge. It submitted its recommendations for teacher education in 1965 (SOU 1965:29, 1965) and as the TCD had done it emphasised the need and value of scientific psycho-

logical and pedagogical content for professional knowledge for a more reflective teaching practice (Beach, 2011a). However, the TEEC report also noted that further efforts were needed in order to form a unified basis of scientific knowledge for teacher education to support this professional reflection and also noted that in its present form the content of pedagogical and educational/learning was dominated by psychological research at the expense of other potentially valuable content such as the sociology, philosophy and history of education and that the content presented was often too abstract toward and far-removed from teaching as praxis (Beach, 1995).

To solve this problem a new teacher education subject was recommended. This subject was called teacher methodology (Sw: metodik) and through it the intention was that a scientific interconnection between theory and practice should be developed (Beach, 2011a). The key fields were the teaching process and its objectives, conditions and results and the subject was to be taught as a compliment to subject studies and study units on philosophical, sociological and historical knowledge of education practices, interactions and systems (Eriksson, 2009). Recommendations were also made for strengthening the professional knowledge base (Trivium) within two directions: one for general pedagogical research and one for research related directly to refining teaching methods. The developments outlined were to be accomplished within existing faculty and disciplinary structures. During the late sixties the work of creating a unified teacher education with the same basic goals for all prospective teachers began in earnest. Assessing the development and further needs of this process was one of the tasks for a new teacher education commission that was appointed nine years after the TEEC report.

THE 1974 TEACHER EDUCATION INVESTIGATION

The new commission, the 1974 Teacher Education Investigation called LUT 74 (SOU 1978:86, 1978), was given as its main task to propose a new model for teacher education that involved a re-examining teacher education objectives, structure and content for a school in transition (Askling, 2006). The commission's recommendations were published in November 1978 and formed the basis of Government Bill 1984/85: 122 for a unified

teacher education with the same basic goals for the training of all teachers for the comprehensive school (Government Bill 1984/85:122, 1985). This training was to replace the previous class and subject teacher education and the aim was to get away from the bifurcation in the profession and the knowledge base that teacher education programmes rested on (Beach, 2011a).

In the recommendations from the commission in SOU 1978:86 the subject of teacher methodology, which since the enactment of the TEEC 60 recommendations had borne the main responsibility for ensuring the scientific foundation of theory and practice (Eriksson, 2009), was to be replaced by a component called didactics (Sw: didaktik). Although drawing heavily from the German tradition of didactics this new subject corresponded roughly with advanced curriculum studies (approx subject and/or general methods and pedagogy) in Anglo-Saxon teacher education traditions and thus had a general and a subject specific element (Beach & Bagley, 2012). In other word didactics emphasized the complex relation between subject and teaching in particular subjects. However, LUT also added a critical dimension. This was that although one view of the function of research in society is that research must be highly specialized and oriented toward technological and economic progress, and that schools should teach research-based-knowledge of this kind, another position is that research is also a natural part of professional activities like teaching with its own value for and in that profession (Beach, 2011a).

On these grounds the LUT commissioners recommended that training in systematic analysis and in developing constructive criticism of prevailing societal and professional conditions should become part of teacher education (Beach, 1995; Eriksson, 2009; Fransson & Lundgren, 2003). LUT wrote about stimulating a meaningful research-career-connection in this vein and added that this is valuable in that much of the work carried out by teacher professionals also has a research character through the systematic recording, monitoring and analysis of observations (Beach, 2011a). Most of the recommendations from LUT 74 were halted after a change in government in the mid-seventies.

The new right-centre coalition government that came to power between the appointment of the LUT commission and the submission of its recommendation, meant that the detail steering implied by LUT was

not enacted and that the three-tier system of teacher education (infant-primary, primary-middle, secondary/subject) that LUT wanted to abandon was maintained (Beach & Bagley, 2012). It did however, in line with LUT recommendations, pass a bill to incorporate teacher education into the university and university college system in 1978. In the Bill it gave a charge to the universities and colleges to develop the scientific knowledge base of teacher education.

The recommendations of LUT 74 informed several changes to teacher education brought about through the 1984/85 Teacher Education Reform Act in 1988. This was after the return to power of the Social Democratic Labour Party in 1982 (Beach, 1995). One of these was the introduction of curriculum theory (described above) as university content in teacher education. This content area was formed between the Trivium and Quadrivium contents. It can be seen as part of the rise of curriculum studies, which was, according to Bernstein (2003), 'the beginning of the technologizing of teacher training and the shift to the importance of the Quadrivium of professional studies' (p. 163). The global development of teacher education identified by Bernstein (2003) and the state perception of the teachers' profession is thus also reflected in the Swedish policy trajectory. The organisation of knowledge proposed in next policy cycle is in line with the organisation described in stage 4 (p. 161-163) of Bernstein's model for this development (Bernstein, 2003).

THE 1997 TEACHER EDUCATION COMMITTEE

The teacher education inquiry committee called LUK 97 was appointed by the Government in conjunction with a series of reforms in the school sector that were felt to place new requirements on teacher competence and teacher education (Beach, 2011a). It was LUK's responsibility to outline the objectives and principles for this education and to make suggestions about its content and scope and to create a stronger link between teacher education and the education sector in the now decentralised and municipally run schools (Fransson & Lundgren, 2003). The final report (SOU 1999:63, 1999b) was delivered after two years. In this report the Committee noted that the conditions for teachers' work had changed profoundly not at least because of changes in the system of governance that had

developed towards an increased emphasis on goals and results but also because the education sector had been decentralised and new national curricula had been introduced. These factors, together with criticism that had been levelled at teacher education in several evaluations were reasons for the need to change teacher education according to the Committee (SOU 1999:63 p. 9).

The recommendations suggested by LUK were said to be aimed at strengthening the school-based part of teacher education to these ends and broadening the general professional knowledge base and competence of each teacher, through curriculum theory and cross-disciplinary thematic subject studies. However the LUK members went further than the directives they had been given. They also recommended the establishment of a new research field, educational sciences (Beach, 2011a).

However, the Government did not endorse LUK's proposal to set up a new research area (Askling, 2006; Fransson & Lundgren, 2003). Instead, it suggested that a special Education Science Committee (Sw: Utbildningsvetenskaplig kommitté: UVK) should be formed within a new organization for research funding called *Vetenskapsrådet* (Government Bill 2000/01:3, 2000), with the task to promote the development of educational research and research training by economically supporting high quality research in close proximity to teacher education and directly relevant to teachers' professional needs (Beach, 2011a). This cycle of reform thus added somewhat of a new twist to the policy trajectory for a unified professional knowledge based on the scientific study of teaching as praxis from the TCD onwards. This twist was provided by the suggestion for the creation of a new field of research and subsequently a new university subject; education science (ibid). The recommendations made by this commission proposed strengthening of the Trivium in relation the Quadrivium but this suggested change was however not fully reflected in the Bill.

CHARACTERISTICS OF CHANGE IN POLICY

In line with Beach (2011a) some common features can be identified in terms of teacher development in relation to the policy texts that have been discussed so far. These are:

1. That facts and principles derived from systematic theoretical and empirical disciplinary investigation and analysis (scientific knowledge) of formal education are valuable if not essential components of professional knowledge for teachers.
2. That this knowledge should be taught by research competent and aware staff in formal university based teacher education and is essential for good professional development and the smooth running and effectiveness of schools in the interests of all pupils and broader society.
3. That there has been an ambition to create a unified teaching profession with a common knowledge base related to educational work for these reasons.

Similar identifications to these have also been made about teacher education internationally according to Beach and Bagley (2012) by among others Bernstein (2000, 2003), Apple (2001), Darling-Hammond (2006), Gore et al (2004), Lee (2011) and Ken (2010). They concern the development of an education for teachers as institutional communicators who can conduct research, develop new knowledge and take an active role in school development in collaboration with colleagues, parents and others (Apple, 2001; Beach & Bagley, 2012; Bernstein, 2000, 2003; Darling-Hammond, 2006; Gore, Griffiths, & Ladwig, 2004; Ken, 2010; Lee, 2011).

However, these developments have proved difficult to fulfil (Ahlström, 2008; Kallós, 2009) in that the scientific part of the professional knowledge base for teachers has never significantly shifted to this kind of shared (unifying) critically reflective (praxis) knowledge, but has instead always retained an emphasis on the initial dualism established by the seminar tradition on the one hand and the academic on the other (Beach, 1995, 2000; Eriksson, 2009), which thus seems to have survived expressed policy ambitions to develop a common knowledge base for all teachers in compulsory school. This is also in line with the results from article 2, 3 and 4 in this thesis.

The policy ambitions of the nearly sixty year period from the TCD report to LUK 97 are interesting to consider in relation to the most recent cycle of reform. This cycle breaks with the historically established efforts towards a research based professional unification and turns back towards

a dualist policy. But it also does so in a very particular and in some senses peculiarly deceptive way (Beach, 2011a; Beach, et al., 2011). This, in that first of all a common shift toward shared progressive professional values and practices is described as having taken place through previous policy when, as is also suggested above, most research on this subject claims the opposite. Secondly that some very negative consequences are graphically described to have arisen from this common shift, in that the 'progressive' attitudes and content therein developed have been said to have led to a watering down of disciplinary knowledge, a lack of attention to how pupils learn effectively and poor performances in international comparison studies like PISA (SOU 2008:109, 2008)[7].

THE 2007 COMMISSION ON SUSTAINABLE TEACHER EDUCATION

The return to a formally endorsed dualist knowledge base in teacher education can be illustrated with two short extracts from the recent Committee for Education for Sustainable Development (HUT) report (SOU 2008:109 p 375 and 376), where the value of research products (science based content) in relation to the school subjects (as discipline content), on the one hand, and research-based teacher behaviour in relation to pupils' subject learning, on the other, are stressed (Beach 2011a), as is what this means for how teacher training should be designed. HUT suggests that:

> In its simplest terms teacher education is seen as consisting of two parts: first knowledge in the subjects… and second knowledge on how teaching is shaped in relation to pupil learning... These two parts have different research conditions. School subjects are not abridged copies of scientific disciplines (but) should be built on this scientific knowledge. This has implications *for how teacher training should be*

7 What I am trying to suggest here is that firstly, there has been a call in the recent round of reform from the right-center coalition government for what they term to be a highly needed return to basics for reasons of social democratic policy failure, and a return to a teacher education structure that reflects the dualist structural characteristics (i.e. primary – secondary school) and related knowledge needs of the school system (Government Bill 2009/10: 89) such as this. Secondly, there is no evidence that the shift to a common and undisciplined progressivism has ever taking place in practice.

> *designed*… Teachers need to have knowledge of how a given subject affects the conditions for learning... and knowledge of the social and administrative nature of teaching, i.e. they need to be able to manage conflicts, assessment, evaluation and so forth.

This citation illustrates how a final weakening of the Trivium of teacher education has taken place. The Trivium is in this text replaced through the dominance of curriculum theory together with the rise of subject studies in the Quadrivium. Another facet of the new policy relates to psychology as the dominant discourse of Trivium, which ensures a technical training of teachers where a more competence-oriented knowledge and a more functionary role concerning teacher behaviour is emphasised as opposed to critical reflection (Sjöberg, 2011). This coincides with a large reduction in general pedagogical knowledge. However, another central point in the HUT is also the need for different skills and training courses for teachers depending on the age group they are to teach in and it therefore proposes a return to a divided teacher training that in many ways mirrors educational traditions from the early nineteenth century.

These latter developments are clear in policy in that according to HUT, teachers do not need to be particularly aware of or sensitive toward cultural, historical, economic and philosophical aspects of education in order to teach well, as was suggested in the cycles of reform from TEEC 60 to LUK 97. Instead it is mainly knowledge of the biology/maturity and psychology of the child and pupil groups and how this maturity impinges on 'what and how they can learn effectively' that is most important. A kind of re-traditionalisation is identified (Beach, 2011a; Beach & Bagley, 2012). The ideal teacher is described as a psychologically knowledgeable person with good subject knowledge and specific skills tailored to pupil learning. The skills that are projected as the starting point for achieving this ideal image are described in terms of innate ability and personal talent (Sjöberg, 2011).

It is in this way that HUT thus breaks against the previously established reform trajectory. From LUT 74 to LUK 97 teaching was described in official policy-texts as moral-intellectual work that primarily required broad scientific knowledge rooted in educational psychology, sociology and other topics relevant to school and teacher training (Beach, 2011a;

Beach & Bagley, 2012). HUT 07 redefines this primary mission as to provide a subject matter to students together with the skills of effective teaching tailored to pupil age and maturity. However, also important is the way in which this shift was presented as necessary, which was 'in order to counter the loosely structured quasi-progressivism of pervious eras', which, according to the present government, left beginning teachers 'with weak guidelines for practice, limited knowledge of subjects and a weak relationship to the value of formal-traditional academic knowledge' (Government Bill 2009/10:89, 2010; SOU 2008:109, 2008).

SUMMARY

This review makes visible how the development of teacher education in Sweden, in line with several other countries has followed a policy trajectory that seem to have a particular historical form that seems to be influenced by government politics. Also suggested is the recent neoliberal turn in government and government policies have been moving toward a weakening of the political, cultural and academic professional knowledge base in teacher education. The next step in this development is, according to Bernstein that teacher education will be a professional training for teachers that is carried out almost wholly in the schools.

There is, according to Bernstein, every sign that teacher education will enter into this sixth stage, where teacher training becomes a horizontal discourse of school-based training managed by teachers in the school (Bernstein, 2003). What we get is a profession that is easy to control and where the ability for teachers to criticize and influence the education system, its effects and their own professional role is limited.

CHAPTER 6

PRESENTATION OF THE ARTICLE SUBMISSIONS

There are four studies reported in the form of article submissions in the thesis. These, together with two other studies that have formed part of the cover paper or 'wrapping', provide the overall rationale of the research and draw out the main implications from the findings there. The articles are appended in their original version in the third part of the thesis. Here I will give a summary of them. The four articles are:

1. Factors influencing Teachers use of ICT in Education (Player-Koro, 2012a).
2. Hype, Hope and ICT in Teacher Education: A Bernsteinian perspective (Player-Koro, 2012b).
3. Marginalising students' understanding of mathematics through performative priorities: a Bernsteinian perspective (Player-Koro, 2011).
4. Authoritative Knowledge in Initial Teacher Education: Studying the Role of Subject Textbooks through Two Ethnographic Studies of Mathematics Teacher Education (Beach & Player-Koro, 2012)

The first study formed, as already mentioned, the initial foreshadowed problem that gave early direction to the research. It is based on the research interest that was the starting point for my doctoral studies, namely the complex relation between education and the information and knowledge society and the role of digital technology and teachers work in educational

settings in this society. However, new questions arose during the data production and analysis, which turned the interest slightly and helped form the starting point for the ethnographic study of mathematics teacher education. The engagement in the fieldwork entailed that the initial problem was refined, changed and renewed. This process is mirrored in the three other studies, which are the result of subsequent data production.

ARTICLE 1

FACTORS INFLUENCING TEACHERS USE OF TECHNOLOGY

The first study (Player-Koro, 2012a), was conducted in the wake of the fourth national campaign that since the 1970th has added considerable funds, effort and resources to Swedish school development. This national campaign was called 'The National Programme for Information and Communication Technology (ICT) in Schools, ITiS'[8]. Sixty percent of the teachers in compulsory school participated in the venture.

The initiative for ITiS came from the Swedish Government and from the School Minister and it was evaluated as successful according to the evaluation report (Jedeskog, 2005; Tebelius, Aderklou, & Fritzdorf, 2003). Nevertheless, a few years after the campaign there were few signs that ICT had changed educational practices in school in line with what had been the intention with the ITiS programme, namely that ICT was to be a means to develop lifelong learning, team teaching, project work etc. There was instead evidence that ICT was not used as much as anticipated in schools, even if it was suggested that ICT had taken hold there and had become a common way of working (Skolverket, skolutveckling, kompetensutveckling, & Microsoft, 2005).

This way of infusing technology into education through governmental funding has become an integral part of the reform agenda for many countries around the word. This global phenomenon has also spawned a myriad of research studies and reports on ICT implementation that often

8 'ITiS stands for Information Technology in School.

come to similar conclusions to those in Sweden. That is, that the permeation of ICT into compulsory educational settings has been, as best, limited (this phenomenon has already been elaborated on earlier in this text under the heading *Literature review of the relations between ICT and education*).

When assessing, evaluating and commenting on these 'failures', the traditional response from the research field has been to highlight deficiencies in various aspects of educational practice as the main underlying cause. In this study however I tried to distance myself from these constructions of teachers and schools as the major hindrance in implementing ICT in education and focus on teachers who do use ICT as a teaching and learning tool in their daily work in their classrooms or when connecting classroom work to work and learning by students outside of classrooms. The investigation was in other words interested in factors that could contribute to explain why these teachers have elected to make use of ICT in education when the majority have not.

In line with what many other studies have already implied even this study showed evidence that teachers' intentions, attitudes and perceptions influence their use of digital tools in teaching. But the investigation also raised questions, at least to me, not only about how teachers develop digital skills relevant to their profession, but also about the role teacher education has in these regards. Thus, the results from the first study formed a new problem and gave a new direction to the research, which was subsequently organised as an ethnographic investigation of teacher education and, at least initially, the possible role of ICT in that education. This investigation included the research articles 2, 3 and 4 in the present thesis submission and also some on-going research production. These articles are primarily concerned with the effects of education for future mathematics teachers in the context of the Swedish teacher training (Government Bill 1999/2000:135, 2000).

The selection of mathematics teacher education was made partly because of my own background as a mathematics teacher for secondary school. However, entering into the context of teacher education meant that I became increasingly aware of how teachers' knowledge and profession was part of a larger arena of political struggle that seeks to implement ideological changes in society (this is elaborated more on in the *Introduction*). To study the effects of that from the standpoint from those who

are involved in the on-going process of education becomes therefore an important part of the research.

It probably has not escaped anyone's attention how school mathematics and mathematics teacher education has had a prominent role in the education debate during recent years that has been caused in large part by how the results of the international study – 'Trends in International Mathematics and Science Study (TIMSS)'[9] – had been reported by the government and the media back to the population as a whole.

In these reports it was highlighted, only partly correctly, that Swedish school students' knowledge of physics and advanced mathematics had deteriorated markedly in comparison to students in other nations' school systems since 1995, when the previous TIMSS study had been completed, and that this must be a result of deficiencies in teacher training. The debate accompanied the Swedish Ministry of Education call for increasing and re-emphasising the value of traditional subject knowledge generally, and of mathematical subject content in particular, not only in schools but also in teacher education. Teacher education was to be made more sustainable by being more discipline focussed.

ARTICLE 2

HYPE, HOPE AND ICT IN TEACHER EDUCATION: A BERNSTEINIAN PERSPECTIVE

The second study (Player-Koro, 2012b), is related to the above points. It is based on an almost classical question for educational ethnographic research on teacher education and asks what is really going on in pedagogical practices there? One pedagogical practice was in focus for this study.

9 TIMSS stands for Trends in International Mathematics and Science Study. It is an international study that examines proficiency in mathematics and science among students in grades 4 and 8th. The study is organized by The International Association for the Evaluation of Educational Achievement (IEA) and is conducted every four years. Sweden participated in TIMSS for the fourth time in the spring of 2011.

This was a workshop setting where student teachers were working with spreadsheet applications on the computer as part of their subject studies in mathematics in teacher education.

Bernstein's theoretical framework for knowledge production and reproduction in education was used for the analysis, and the study made visible how a traditional subject culture was reproduced in mathematics teacher education while using digital technology. This was contrary to the intention written in the course syllabus, which was to present mathematics in a different way compared with the standard format, with the anticipation that this new format would lead to new ways of seeing and understanding mathematics. It was also opposite to the repeated and re-pledged view of what could and should be happening with teachers, students, learning and schools, when digital technology is used. It tells another story, and shows that ICT use per se is not transformative and that neither students nor teachers were disappointed with that. In this case the common and often media promoted image of digital literacy and the revolutionary changes made possible by digital technology in respect of learning, education, teaching and the student role is challenged.

ARTICLE 3

MARGINALISING STUDENTS UNDERSTANDING OF MATHEMATICS THROUGH PERFORMATIVE PRIORITIES; A BERNSTEINIAN PERSPECTIVE

Study three (Player-Koro, 2011), builds onto the disclosures from study two. Its main concern is with the most common form of teaching and learning of mathematics in the teacher education programme researched, namely formal lectures. The research examined in the main how these lectures took form and how the content of classroom interactions was established and maintained. The use of educational material, the characteristics of examination and the effects these things seemed to have had on student learning of mathematics and mathematics teaching and learning were considered in particular.

Formal lectures were chosen for deeper analysis because of their role as both central yet even contradictory events for teachers and students, as demonstrated in previous research (Beach, 1995, 2000). Teachers and students expressed the centrality of these classroom activities both early on and throughout the fieldwork period. They were judged as being the most important part of the course and they also seemed to be the most important arena for establishing what counts as the legitimate meanings of mathematics.

The contradiction becomes apparent in the relationship between two different data sources. These are on the one hand what is said in interviews with teacher educators and students and what is happening during lectures and, on the other, what is written in the curriculum as the main objective with the course. These were objectives that students and teachers seemed to agree with when talking about the course and they are also in line with the principle reason for the inclusion of subject theory in teacher education as expressed in national policy (Government Bill 1999/2000:135, 2000; Government Bill 2009/10:89, 2010). This is namely to treat mathematics from both a theoretical and a didactical perspective with special emphasis on aspects that will contribute to students developing a deepened understanding of mathematics and teaching and learning of mathematics. This did not happen.

A closer look at lecture room practices through the lens of Bernstein's (2000, 2003) concept of the pedagogic device revealed that instead of developing a deeper understanding of the syntax and rules of grammar of mathematics as a field of knowledge, the kind of educational practices observed and analysed led to an atomistic view of knowledge, as students don't have the time to enter deeply in content. Moreover, reward in the programme was obtained through a direct accumulation of educational capital based on examinations of external 'facts' and how these have been remembered and recalled. This also seems to block the development of what was stipulated as another main objective with the course, which was to develop a deeper understanding of teaching and learning of mathematics.

These findings not only question the traditional form of mathematics teaching and learning, they also call into question the causal relation made in the education debate by the Government, through the media, regarding

the need for more mathematically trained teachers as a means to guarantee better mathematical learning in school and a need for increasing subject content in teacher education to these ends. I could find nothing in the data to support these ideas. The research in this way raises and addresses questions about what kind of educational practice and what professional knowledge teachers really need for their professional work as mathematics teachers in compulsory school.

The process of data production and analysis in this study of the way of organising subject studies in teacher education also made visible how important the subject textbook was in the process of creating legitimate meanings about what mathematics is and what teaching and learning of mathematics entails. The way of structuring mathematics teaching through the textbook is the most common way of teaching mathematics as a school subject in Sweden, as well as in many other countries. Students in schools on different levels spend much of their time in classrooms working with textbook tasks even though this type of teaching is heavily criticized in the didactic research field as leading to a fragmented knowledge of mathematics (Lundin, 2008; Pepin, 2009; Valero, 2007b). So, there were many reasons to take a closer look at the effects of textbook use in teacher education.

ARTICLE 4

AUTHORITATIVE KNOWLEDGE IN INITIAL TEACHER EDUCATION: STUDYING THE ROLE OF SUBJECT TEXTBOOKS THROUGH TWO ETHNOGRAPHIC STUDIES OF MATHEMATICS TEACHER EDUCATION

The fourth study (Beach & Player-Koro, 2012), is focused on the use of subject textbooks as authority knowledge and the effects of this. The main question concerns how subject textbooks were used and what meanings and understandings were generated by this use.

The data for the analysis behind study four was produced in two different ethnographic studies across two decades, in two PhD projects, over two successive rounds of teacher education reform - the Comprehensive Teacher Education Reform enacted in 1988 (Government Bill 1984/85:122, 1985) and the Renewal Reform of Comprehensive Teacher Education (Government Bill 1999/2000:135, 2000) based on the 1997 Teacher Education Committee recommendations from 1999 (SOU 1999:63, 1999a). It focuses specifically on book-based practices in mathematics teaching and learning and makes visible how these practices make possible what Bernstein (2000) terms as a strongly classified and framed education in which an authoritative source presents the objects of knowledge of subject studies and, reinforced by lectures and examinations, acts as the voice of the subject.

What our analyses suggested was that through these processes student learning became very product focussed but that students often complete their courses without grasping the meaning of what they are studying or the relation of this mathematical knowledge to their future professional work' as math teachers. This calls into question what value the maths textbook and other forms of learning have and the investigations caste some light on this.

Two things in particular seem important. One is that the value of math and the maths textbook seems only to be seen and acted towards in terms of memorising and reproducing the content of a dead subject that has been entombed in textbooks and reinvigorated through examination based instruction (Henderson & Hudson, 2011). The other is that this in turn points out that the way mathematics is taught and learned may create obstacles towards the development of capacities for (critical) reflection (Marcos, Sanchez, & Tillema, 2011) and knowledge production (Lee, 2011) and that it actually seems counter-productive in relation to the development of understanding of mathematics or how to teach it well.

Once again the findings from the investigation conducted belie anticipations from written formal national policy and the recommendations this policy is based on (i.e. Swedish Government Bill 2009/10:89 and SOU 2008:105 respectively). Our suggestion from this investigation was that we may need to radically rethink why we need more subject studies content in teacher education and for what reasons authoritative knowledge sources

like textbooks are chosen and used. More profoundly, we may also need to question what the current basis for informing teacher education reform actually is; it seems to be nothing more than political ideology and how reliable it may be(Beach & Bagley, 2012; Erixon Arreman & Weiner, 2007).

CHAPTER 7
CONCLUDING DISCUSSION

There has been a powerful policy turn in recent years back toward a more conservative policy agenda in teacher education that re-emphasises a professional duality between primary and subject teaching and the importance of subject studies in the second of these traditions. This turn has been accounted for in the review of teacher education policy making and literature about teacher education presented earlier. Although the present investigation was mainly conducted before this policy turn, the results have implications that may be problematic both in relation to the rhetoric behind the new policy and the impact this reform may have on the knowledge base of future teachers. However, more broadly than this what I suggest we are seeing at the present time in teacher education is part of a political struggle over the future direction of education itself. A number of tools emerge in the debate some more often and with greater clarity than others. One of these is a media and political discourse on poor performance of Swedish pupils as identified through international knowledge assessments. Another is that teacher education is being made into a scapegoat for this alleged failure due to alleged deficiencies in the training of teachers. Allied to this is a discourse on the need to subordinate these institutions to almost constant audits and inspections. ICT has had a prominent role in this debate, where use of new technology in education is portrayed as revolutionary in the transformation of teachers, students, learning and school to the better.

Apple (2001) calls for the urgency to understand these momentous ideological transformations. In the present thesis this call has been heeded through research that creates direct involvement with teachers, students and their educational practice in relation to the larger social field of power

in which they operate. The hope was that this research would contribute in the important and crucial debate about the means and ends of educational institutions in present times. In the following I will construct my conclusion and discussions of the main findings from the thesis and the implications these results may have. This is followed by a reflection over the selected research approach.

SITUATING THIS RESEARCH IN ITS LARGER CONTEXT

The thesis has been produced during a period when knowledge has become to be considered more as a way to increase economic growth and improve competitive advantage in the global market economy than as a way to create opportunities for people to develop in ways that offer possibilities to interpret, understand and influence their own existence. We could speak of the concept of the knowledge economy, where knowledge and education have become possible to market as innovative intellectual business products or services for sale for a high value return. They are productive assets that have been developed from the intellectual labour of various knowledge workers. This new view of knowledge is reflected in the main trends and discourses in present society and has implications both for what the educational system is supposed to do and what identities education should provide and that in turn has implications for what professional knowledge teachers need for their work.

One of the trends that have altered the terrain of education is what Apple (2009) defines as 'conservative modernization', which is a political project that 'creates imagined pasts as the framework for imagined futures' (Apple, 2009). It is a neoconservative trend that has been evident in recent reform cycles in education, such as the Swedish Government Bill 2009/10:89 for changing teacher education and the Green Paper recommendations that preceded it reviewed in previous chapters. These documents describe a return to a more competence-oriented knowledge base for teachers that involves a switch back to subject studies, psychology and a technical curriculum theory (didactics) as the main content areas in teacher education at the cost of other areas and a view of subject knowledge as relatively straightforward, neutral and objective content that

should form the basis for professional development and teaching skills (Ellis, 2007; Hayes, et al., 2008; Sjöberg, 2011). As two of the articles presented illustrate there are problems in this.

The project of 'conservative modernization' in the recommendations of the commission to the government and then the subsequent changes to teacher education expressed in the reform were very different to those of previous commissions and reforms (Ahlström, 2008; Beach, 2011a; Beach, et al., 2011; Kallós, 2009; Sjöberg, 2011) in that they turn the tide against the previous mission of developing a distinctly unified scientifically founded professional research base for professional knowledge that is in large part common for all teacher categories. Instead emphasis has been placed on the value of academic subject knowledge and technical and behavioural content related to how to choose and 'teach' this content effectively in different subject areas and to children of different ages and levels of attributed maturity and motivation (Sjöberg, 2011). As HUT states (SOU 2008:109, 2008):

> In its simplest terms teacher education is seen as consisting of two parts: first knowledge in the subjects… and second knowledge on how teaching is shaped in relation to pupil learning... These two parts have different research conditions. School subjects are not abridged copies of scientific disciplines (but) should be built on this scientific knowledge... (p. 375)

What is implied here, is a move from knowledge about research perspectives in relation to teaching and learning (as described in previous reform, se section *Literature review on Teacher education change in Sweden*) back to a content that primarily stresses the value of research products (i.e. science based disciplinary content) in relation to the school subjects on the one hand and research-based teacher behaviour on effective forms of teaching in relation to pupils' subject learning on the other: so-called evidence based practice research (Beach & Bagley, 2012; Government Bill 2009/10:89, 2010). Competence-oriented behavioural knowledge is once again emphasised as opposed to critical thinking (Sjöberg, 2011) and a marginalisation of abstract and theoretical disciplinary-based thinking and of know-why professional-knowledge has been established by filling the

suggested course time available with audited concrete practice related and behavioural content (Beach & Bagley, 2012).

In other words it could be said that in this policy reformulation the discursive notion of 'trainability' is central and related to what Bernstein (2000 p. 59) terms 'generic' pedagogic modes based on a new concept of 'work' and 'life' (which Bernstein called short-termism), where skills, tasks and areas of work undergo continuous development, disappearance or replacement and must be continually updated in order to cope with new requirements. Moreover, these changes are not specific to Swedish conditions. Ball et al (1994), Apple (2001), Delandshere et al (2004), and Garm and Karlsen (2004) have pointed to similar developments in the UK, the USA and Norway recently, where, as in Sweden today, the reform of teacher education has taken place alongside processes of (re) construction in education generally that are aligned to ideologically informed technologies associated with neo-liberalism and that subvert and subsume education as an economic imperative through prescriptive government criteria and various inspection and appraisal regimes (Apple, 2001; Ball, Bowe, & Gewirtz, 1994; Beach & Bagley, 2012; Delandshere & Petrosky, 2004; Garm & Karlsen, 2004; Ken, 2010).

These changes in recent policy have been motivated by their proponents from an assumption that they were necessary because of the previous era of quasi-progressivism that had resulted in beginning teachers being given weak guidelines for practice, limited knowledge of subjects and a weak relationship to the value of formal-traditional academic knowledge (Government Bill 2009/10:89, 2010; SOU 2008:109, 2008). These ideas can be re-evaluated against the research results provided by the thesis. The main empirical base for this investigation has been in the university-based part of mathematics teacher education where student teachers are supposed to learn subject theory and subject curriculum theory in mathematics. The outcomes from the investigation that has explored, uncovered and challenged the on-going practice of subject studies provides serious concerns that need to be emphasised in the argumentation that teacher education is suffering from progressivism and that more subject studies per se will lead to a more qualitative knowledge base for teachers that will lead to raised standards in schools. Such an examination is characteristic for policy eth-

nographic approaches to educational research and can be considered both essential and important (Troman, et al., 2006).

THE RESEARCH RESULTS

With the exception of the research behind the first article I chose an ethnographic approach for my investigations. The intention was that through this approach to education research, important first hand involvement in a particular institution can be developed, from which to try to illuminate and understand the effects of teacher education on educational participants and processes. Through this involvement close-up, detailed research interaction is developed. My anticipation was that in this way I might become able to show what impinged on the on-going educational practice and in what way. Trying to gain understanding into how larger institutions and power relations outside the educational institution may impact on practices was part of this.

EFFECTS OF MATHEMATICS TEACHING IN TEACHER EDUCATION

There are several main outcomes from the research process. I will start with ones that are associated with the first of the two questions that were given specific attention, namely; what is really going on in mathematics teacher education? The main analytical outcomes from this can be summarised as follows:

- The regulative part of the pedagogical discourse enacted in mathematics teacher education constituted a consistently traditional powerfully classified and framed teaching-learning practice that was built around highly ritualized and structured rules for the transmission of mathematics. This was based on solving exercises related to an examined-textbook-based content (articles, 3, 4)
- The instructional discourse embedded in the regulative discourse produced a fragmented form of mathematical knowledge (the knowledge structure takes more the shape of a horizontal knowl-

edge discourse), and legitimated traditional ways of teaching and learning mathematics (articles 3, 4)

- The (horizontal) form of mathematics that is recontextualised in the teaching situation has several counterproductive effects on the development of professional knowledge among student teachers. One of them is that this type of knowledge is strongly linked to mathematics classroom and is a far cry from a general powerful vertical knowledge discourse of mathematics and mathematics teaching that teachers need for understanding the subject and its relations to society. The pedagogical discourse, through its third embedded discourse (Ensor, 2004a), reproduced traditional school mathematical discourse as a legitimate way of teaching and learning (articles 2, 3, 4)
- Finally, the use of ICT didn't seem to have any substantial effects on these traditions of practice (article 1, 2)

The 'ritualization' of mathematics practices seems to have a long history of 'routinisation' of the above kind and has proved difficult to shift (Beach, et al., 2011). This finding emerged when data production from two decades of ethnographic fieldwork in mathematics teacher education where compared. As discussed in the previous chapter, these comparisons showed identical pedagogical practices and forms of recontextualising in data that had been produced across twenty-five years of practice and three rounds of reform. For students studying to become secondary school mathematics teachers in particular, these could be described in the same way, in terms of an authoritative book-based examination-steered approach that is not only the most common, but also the most criticized way of teaching mathematics (Black, Mendick, & Solomon, 2009; Lundin, 2008; Skovsmose, 2011). Practices were very traditional, as were the teaching ideals and values expressed by student teachers about their knowledge needs and how the demands of learning to teach mathematics should be dealt with in teacher education through its curriculum organization. And it is also important to accentuate what worth, qualities and values were distributed to student teachers through this pedagogic discourse of strongly

regulated mathematics education that emphasises performative[10] priorities like 'passing the exam and making the grade'. The next set of important outcomes relate to this.

These studies clearly evidence that performative regulations do not lead to the benefits they are suggested to. Instead, as discussed for instance in articles 3 and 4, they set serious limitations on student development in several ways. One of these is related to students' possibilities to gain access to a vertical knowledge discourse both in terms of a deeper understanding of mathematics and for becoming critically aware professionals for a modern school. These were two of the objectives in the policy for teacher education from 1999 (Government Bill 1999/2000:135, 2000) that reach back to recommendations from the 1974 Teacher Education Commission (SOU 1978:86, 1978). The findings provide clear evidence that current performative culture seems to inhibit these things through the way it puts a focus on the work that needs to be done to get the grades students need to pass courses, which in turn seems to be the most foreshadowed use value of the education for both students and teachers[11]. Inside this exercise of power and control in a disempowering practice the research also showed evidence that teacher students become confused about, frustrated by and anxious over their learning and even their health.

What emerged from these studies, in other words, was an account of a pedagogical practice that showed no signs whatsoever of being progressive or even quasi-progressive in the senses hinted at in the most recent policy cycle in teacher education from HUT 2007 onwards. These are

10 Performativity is according to Ball (2003) a culture in which qualities is measured on the basis of an individual's (or organization's) productivity or outputs measured in terms of performances Ball, S. J. (2003). The teacher's soul and the terrors of performativity. In S. J. Ball (Ed.), *Education Policy and Social Class The selected work of Stephen J. Ball.* Abingdon: Routledge Taylor & Francis Group..

11 Beach (1999) spoke of an educational potlatch as characteristic for this situation, where symbolic exchange value from educational interchanges have out-stripped other use values in education culture and the meaning of education as a practice for itself has been completely hollowed out. In these circumstances values coupled to 'softer' issues that are said to be difficult to externally grade and examine, such as self-awareness and critical reflection, are pushed aside Beach, D. (1999). Alienation and Fetish in Science Education. *Scandinavian Journal of Educational Research, 43*(2), 157..

issues that will be reflected on more in the coming pages and that could be seen as related to the second question that has been given attention to in this research.

TEACHER EDUCATION AND THE KNOWLEDGE NEEDS OF TEACHERS AT THE PRESENT TIME

As already mentioned, the findings from my research are highly significant in relation to the most recent round of reform and they completely hollow out the argumentation behind this reform for the need of a new direction for teacher education that is motivated by the absence of conservative values in the national teacher education system. These needs could not be verified here. On the contrary, it seemed as if the way of organizing teaching – at least in relation to the learning of mathematics for preservice student teachers - and the effects of this organization of content on students' learning, was already very much in line with what the government and the new policy were suggesting we should strive for, and that the reviled progressivism which government and media discourses argued were undermining schools, performances in them, and above all performances on PISA[12] and TIMSS[13] and the economic future of the country as a knowledge economy, had no actual foundation in practice. They were instead ideological and socially constructed elements in a 'mediatisation' of education policy. This is, I suggest, a very important point that is worth dwelling on further.

If we borrow the rhetoric from the current educational debate and from the Swedish government about the relationship between teacher training and school children's performances, an argumentation that could be made on the basis of the present research is that it is the traditional teaching and learning of subject content in mathematics that is reproduced as legitimate ways of teaching and learning mathematics through teacher education that causes the bad results for Swedish school pupils in international assessments, not the progressivism that can be identified in the policy chain for teacher education from 1946 to 1999. This progressiv-

12 PISA, Programme for International Student Assessment.

13 TIMSS, Trends in Mathematics and Science Study.

ism never actually materialized in practice (Beach, et al., 2011). In the light of such an argumentation it becomes very difficult to defend the changes that are presently being suggested.

The call for change and for a return to traditional subject-based teacher centred 'teaching from the front' is though very clear. In the context of teacher education and in relation to the Swedish school system it can be illustrated with a citation from a recent article written by Sweden's Minister for Education in which he also makes connection to mathematics teaching and learning:

> …the teacher's most important tool is that during each lesson teach and lead the class. Educational trends have long pushed teachers away from the classroom. The trend must be reversed and the teachers have to re-take their place in the classroom. By teaching and instructing the teaching staff may become teachers who can turn the school's negative trend.[14]

The motives for driving these suggestions need to be seriously questioned on the basis of the present thesis. To recap, the motivations are:

- Falling performances due to progressive methods
- A lack of authority based learning
- The need of disciplined study methods and high stakes testing

In accordance with the thesis-studies these things are already in place and falling performances on PISA and TIMSS, if there actually really is evidence that performances have fallen in anything but the most relative of senses, are not due to the lack of these markers at all. The markers were present both at the time that Swedish pupils were performing well and at the present time, when they are said to be performing less well. One could also argue in relation to the outcomes of present investigations, that the government alleged and by them criticized progressive ways of teaching math does not seem to have had any impact on prospective teachers' mathematics teaching. On the basis of this, it seems rather more sensi-

14 "Time for the teacher to re-take place in the school's lectern" Björklund, Jan in Dagens Nyheter 2011-03-13

ble to try something new than to return to a proven practice that does not result in meeting the expected objectives. Might this be accomplished through the use of ICT? The thesis affirms this as a possibility but shows that this renewal does not occur in practice.

IF ICT IS NOT THE ANSWER, WHAT COULD IT BE?

I want to return for a minute to the study reported on in article 2 and its suggestions that ICT is not transformative in relation to education in the senses promised by much educational technology research, and that it rather seems instead as if teaching and learning with digital technology operate as a relay in the reproduction of traditional practices. This is a surprising finding in some senses that runs counter to both the intentions with the use of ICT in the pedagogical practice under study and the rhetoric that has often been repeated and re-pledged in research on ICT in education for the past forty years. This rhetoric is defined in this thesis as a 'general ICT impact' discourse. It tells a story about how educational technology will significantly reconfigure and revitalise education and leaves no space for critical or negative views of using technology innovations in education. This and other research outcomes related to ICT use in education will be discussed next.

The role of education in information society has been discussed earlier in the thesis, where it was described as defined through the premises of Human Capital Theory (HCT) and its implications for educational policy, not the least in respect of the use of ICT in enhancing education. Here, ICT is seen as a simple answer to complex societal and educational problems (Nivala, 2009) and this element of discourse has been used to reinforce the necessity and urgency of implementing ICT in education. A merger of discourses about the information society and the 'general ICT impact' has been important here (Robertson, 2003; Selwyn, 2011a). It has pushed ICT into the educational system and has placed high demands that have also led to the blame of the educational system for not living up to these expectations (Brown, et al., 1997; Olaniyan & Okemakinde, 2008).

There is a similar rhetoric in both the 'general ICT impact' discourse and the neoliberal, neoconservative rhetoric regarding the problems and possibilities of education, where education is considered important on the

one hand, but on the other is blamed for being unable to live up to these expectations (see for example Apple, 2001 and Sutherland et al. 2004). This 'blaming' emerged in the 'general ICT impact' discourse discussed in the previous chapter, where the lack of evidence in research that the potential of ICT had been fulfilled in education is often attributed to skill deficits and lack of motivation and know-how on the part of pupils/students, teachers/educators, and educational institutions (Sutherland et al., 2004).

There is however also a fundamental difference between the two discourses. On the one hand the retrofitting of schools in the neoconservative discourse has an 'imagined past' of traditional values where schooling is seen as a way to higher achievement and a more competitive economy and an immediate presence in that, according to the thesis these values currently seem to condition education practice the most. On the other hand, in the 'general ICT impact' discourse, these traditional practices are critiqued as being out-dated and thus opposing the development of skills that people and the nation need in the modern information society. Traditional 'teaching from the front' is viewed as out-of-date and is contrasted against a new techno-enhanced constructivist classrooms that is pictured – somewhat ironically given the treatment of progressivism in both social and discursive practices in and about teacher education today - as student-centred, active places where collaborative meaning making is taking place.

Do these contradictions lead to what is the most prominent message from my research, namely that ICT use does not lead to futuristic forms of education and nor is it a simple solution to educational problems? In fact ICT per se doesn't create anything at all and the belief that it does or can represents a naïve form of technological determinism. ICT can however be part of a progressive development of educational practices if appropriate forms of use can be put into practice, critiqued and developed in supportive arenas.

There is clear constructivist logic to this. Educational practices develop in a struggle between agents who try to interpret and deal with the different demands posed through different education discourses and in this sense the present research therefore implicates, in line with previous research findings, the claim that ICT use in education cannot be separated from the social and structural conditions that affect the reality for teach-

ers, students, learning and schools more broadly (Nivala, 2009; Robertson, 2003; Selwyn, 2011a). When these conditions were taken into account, as they were in the present studies, a space is created in which critical questions about ICT use in education can be formulated. The mission of research in the educational field can then be to identify these questions in order to find fruitful ways for the use of technology.

An example of this kind of critical question is provided by for instance Nivala (2009) and Robertson (2003). As they point out, the 'general ICT impact' discourse is basically part of a marketing strategy and as such lacks an anchorage in any kind of strong educational ideology. It merely expresses that educational goals and problems can be solved with ICT without defining in any sense what education actually is or what being educated actually means, needs (materially, socially and discursively) and involves (politically). Education is simply appropriated by the discourse in different ways. This can be seen several times during the history of ICT in education and there may be signs that the rhetoric is once again going to change. In an interview in one of the teachers union Journals[15] a researcher from Norway claims that if the use of ICT in education is to succeed it must be related to traditional school-subjects, which in turn places heavy demands on teachers' subject knowledge. This rhetoric is more in line with the call for a turn back toward traditional teaching and learning argued for in the neoconservative discourse, in contrast to the progressive characteristics formerly implied.

PROPOSAL FOR FURTHER RESEARCH

The work with this thesis has raised many questions that haven't been possible to answer here, but which nonetheless are interesting for further studies. Firstly, studies are needed where the critique addressed to traditional ways of teaching and learning mathematics in the past 150 years are seriously analysed beyond what is perceived as the didactic triad (the relationship between teacher, student and content) (Lundin, 2008). I would say that the present thesis, through its concern with the political dimensions of mathematics education, is an example in that it includes social actors

15 Lärarnas tidning (Teachers' Newspaper), No 19 2011

and institutions located in different spheres and levels (Valero, 2007b). In that way it enhances knowledge development in the research field about the practices of mathematics teaching and learning that also allows for call into question the instruction of a given and rarely questioned mathematics content to students who are engaged in learning of that content. There is room for much more of this kind of research (Lundin, 2008).

It is also important to continue research on educational policy that is concerned with uncovering and challenging processes where policy reforms are introduced into institutions. In relation to the present studies, further research is needed that aims to identify, make sense of and understand which main-players and decision-making processes have affected reforms directed to teacher education and what consequences these may have on the teachers' mission and professional expertise. The role of the media should be included in this.

Questions about the use of digital technology in education and teacher education also need further research. The use of digital technology in education isn't simply about whether this technology should be used or not, or how to identify examples of best practices. The claims that digital technology can be a formula for overcoming social, political and cultural problems need to be more seriously and critically addressed. Through the past 40 years of technology use in educational settings there are a lot of critical issues and themes that need to be brought to the foreground. My proposal is to leave the optimistic rhetoric behind and in line with Selwyn (2011 a,b) propose a shift in the field from asking 'state-of-the-art' questions about technology toward questions concerned with 'state-of-actual' (p 715). This means a call for researchers to refocus their efforts to what is actually going on in educational settings in order to advance our understanding different dimensions of learning and technology.

REFLECTION ON RESEARCH METHODS AND DESIGN

This thesis project has been a journey of investigation and discovery. This doesn't mean that this research process has involved aimless meanderings. Instead, the intention behind the work was to achieve a science-approved

quality. The question that follows from this is what is good research in this scientific sense?

No matter in which field research is carried out there is an on-going discussion about what should be considered scientific knowledge and good research. These are often, but not always exclusively in all research traditions, based on different philosophical positions where the question that the philosophy of science has tried to answer has been about finding the demarcation line between scientific knowledge and other forms of knowledge, such as metaphysics, religion, or ideology. The content of the critique of the recent round of policy in the present thesis underlines the importance of this. Present policy is, it is suggested, primarily if not only ideological.

Within the field of educational science, there are two often-competing views of how good research should be conducted. The difference between these perceptions is often, as with other kinds of epistemological positioning, based on different philosophical assumptions about ontology and epistemology (Pring, 2004). However, there is another position that is not always necessarily linked to this. It could be called an ethical position that questions the views that advocate a scientific model for embracing educational practice and emphasizes that human beings should not be made the objects of science and that research must focus on the subject meanings of those who are under study.

Moreover, there are also two different opinions on whether researchers must adhere to one view or the other. One side believes that every individual researcher must position themselves in their epistemological perspectives (Cohen, et al., 2000). Another position is to rely on the research questions and how they are determined, formulated and answered in a stringent manner (Pring, 2004). The former notion means that the researcher's choice of research method is based on philosophical positions while with the latter approach it is the research question that will determine which method will be used in the research.

Personally, I have chosen to associate myself with the latter view, where a number of different research questions are posed and answered with the use of a number of different methods and research approaches. This view supports assertions that it is up to me as a researcher to make informed choices based on insights from the philosophy of science and its

history and complexity guided by an ethical holding towards other people who are touched by or become involved in the research. It is an approach that also involves an ambition to treat these people as human subjects not as scientific objects of study. In addition, I also think it is a strength that various problem areas can be illuminated by using a variety of research questions, which in turn can be investigated with various procedures in the research process. Credibility and good research becomes in this way largely dependent on how well one can follow and communicate about the research process in the statements made. The hope is that I managed to do this in the present text (in for example section *Research methods*) and thus ensured this research quality, even if traditional quality concepts that are often described in method books such as validity and reliability are not used here, at least not in conventional positivist or revised positivist senses.

Part Two

SUMMARY

SUMMING-UP

During recent decades fundamental societal changes have been reflected in educational policy and education reforms that have changed the meaning and practice of education. The most recent is the project of 'conservative modernization' (Apple, 2009). This thesis is primarily concerned with the effects of education for future teachers in the context of the Swedish teacher training (Government Bill 1999/2000:135, 2000). It belongs to a theoretical tradition in which the education system is viewed upon as a key factor in the cultural production and reproduction realized in educational practice through symbolic control (Apple, 2009; Ball, 2006; Bernstein, 2000, 2003). Symbolic control defines how the forms of social interactions affect what is possible to think, say and do in different situations. It has investigated teacher education at the very time in which it has become part of what seems to be a conservative modernisation project.

The thesis is focused specifically on student mathematics teachers learning to become teachers of mathematics. It has a particular focus on the materials used in this, the meanings given to these materials and the identities produced through the possible embodiment of these meanings. It aims therefore to understand both how mathematical discourses are produced and reproduced, in teacher education and how this colours student teachers' views on mathematics and their professional identity (Bernstein, 2000, 2003; Valero, 2007b). Another ambition has been that from this empirical standpoint of those who are involved in the social and cultural process of education also make visible, describe, analyse and understand the impact of educational reforms and policies on the process of education and to understand what outcomes this has had for those who are involved. This is done by describing; analysing and reflecting over the political, social and cultural foundations that structure educational practice and, from a critical perspective, by problematizing what happens in social relations close to on-going and often quite complex educational practices. The intention with this is to be able to better understand and write about the development of education and student subjectivity.

The research has been conducted as an ethnographic study. It began in 2007 and has lasted for four years. The study design is influenced by the Scandinavian educational ethnographic tradition (Beach, 2010), which

is broadly about developing theoretical and practical descriptions of education lives, identities and activities through detailed situated investigations that produce knowledge about the basic conditions of education systems, practices and set ups, the perspectives of the participants and the latent meanings of education contexts (Beach, 2010; Walford & Delamont, 2008). These are then synthesised to 'ground' research accounts that expand ideas about the education practices, places, institutional rules and identities concerned (Gordon, et al., 2003; Larsson, 2006).

In the thesis specific theories and foreshadowed problems of the education field have framed the initial foci in relation to the above and given direction to research. This was done initially in relation to an interest for why teachers who use ICT in their teaching elect to do so and what the most significant motivating factors for this practice were. However, as in all ethnography this initial question was modified and the subsequent production and analysis of materials then developed on other lines.

Bob Jeffrey and Geoff Troman (2004) have collaborated extensively with researchers from Denmark and Sweden (Beach, 2010). They have identified three main design principles for ethnography, partly based on this collaboration, which they have then used to help shape guidelines for ethnography development (Jeffrey & Troman, 2004). These principles have been important in guiding my work on the thesis. They are that research:

- Takes place ideally over two or more years in order to allow a fuller range of empirical situations and transitions to be observed and analysed and to allow for the emergence of contradictory behaviours and perspectives
- Allows time for continuous reflections concerning the complexity of human contexts and for considering relations between the appropriate cultural, political and social levels of the research site and individual and group agency there
- Includes explicit theoretical perspectives in order to sensitize field research and analysis and provide an opportunity to use empirical data for the interrogation of macro and middle range theories and to develop (or ground) new ideas.

The fieldwork and analyses I have done reflect these commitments and have involved direct and sustained social contact and meetings with students and teacher educators in their everyday encounters. I have then tried, as fully as possible, to respectfully record and represent their experiences and their implications, theoretically and comprehensively.

PRESENTATION OF THE ARTICLE SUBMISSIONS

There are four article submissions in the thesis. These and the thesis cover paper or 'wrapping' provide the overall rational of the research and draw out the main implications from the findings. The four articles are:

1. Factors influencing Teachers use of ICT in Education.
2. Hype, Hope and ICT in Teacher Education: A Bernsteinian perspective.
3. Marginalising students' understanding of mathematics through performative priorities: a Bernsteinian perspective
4. Authoritative Knowledge in Initial Teacher Education: Studying the Role of Subject Textbooks through Two Ethnographic Studies of Mathematics Teacher Education.

The first article, *Factors influencing Teachers use of ICT in Education*, is based on the research interest that was the starting point for the thesis. It is formed around a questionnaire administered to practicing teachers dealing with their understanding and use of digital tools in their daily work with students in school. Teachers' intentions, attitudes and perceptions influence their use of digital tools in teaching according to the findings but the investigation also raised questions about how teachers develop digital skills relevant to their profession, as matters of more general nature relating to the teacher's role in shaping teachers' views of teaching and learning in general and the learning of mathematics and mathematics education in particular.

In the second submission, *Hype, Hope and ICT in Teacher Education: A Bernsteinian perspective*, the common and often media promoted image of digital literacy and the revolutionary changes made possible by digital technology in respect of learning, education, teaching and the student role is

challenged. The study is based on participant observation and interviews in digital laboratory contexts where student teachers work with computers and the data produced has been analysed using Bernstein's theoretical framework and his concept of the pedagogic device (Bernstein 2000). The results show that behind the facade of digital technology, there is a traditional mathematics teaching that is neither problematized nor challenged by either teachers or students.

Harsh criticism is often directed against the teaching of mathematics where mathematics teaching is accused, among other things, of being overly conservative and traditional, fragmented and textbook bound. Teachers are often singled out as the cause and possible solution to the problem, as is reforming and improving teacher training. The improvement is often formulated in a requirement for increased subject studies in mathematics. It is this simplified relationship between more academic subject studies in teacher training and improvement of mathematics teaching in schools that are challenged in both the third and fourth articles, *Marginalising students' understanding of mathematics through performative priorities: a Bernsteinian perspective*, and *Authoritative Knowledge in Initial Teacher Education: Studying the Role of Subject Textbooks through Two Ethnographic Studies of Mathematics Teacher Education*, which is co-authored together with Dennis Beach.

The articles thus follow two main directions. The first is mathematics education and the other is learning supported by digital tools. A common characteristic of both is that they have a prominent position in the current official neoliberal, conservative modernisation discourse in which they are presented as representing central knowledge and skills for present and future citizens for an active citizenship and for strengthening the nation's productivity and competitiveness. Knowledge in these areas therefore becomes connected with a number of higher goals (Lundin, 2008) with an indirect relation to the respective area of expertise that is rarely justified, but which by its discursive strength creates ideological truths in different ways. My hope is that the thesis may help to make visible and challenge certain contradictions and inconsistencies in this practice.

SUMMARIES OF THE ARTICLES

FACTORS INFLUENCING TEACHERS USE OF ICT IN EDUCATION

This study investigates the motivations teachers have for using ICT in education and proposes a model about how different variables are related to this. This model suggests that positive attitudes related specifically to ICT as a useful tool for teaching and learning and feelings of self-efficacy in using computers in education seem to influence the use of ICT the most. Also suggested is that positive attitudes to ICT in general don't seem to contribute very much to the use of ICT in classrooms by teachers. This is a surprising finding. The distinction between the importance of specific and general attitudes toward ICT use and the emphasis on self-efficacy contributes to contemporary research. Self-efficacy and attitudes are suggested to be mutually related to ICT use.

HYPE, HOPE AND ICT IN TEACHER EDUCATION: A BERNSTEINIAN PERSPECTIVE

This article is based on research that has used ethnographic methods in an attempt to make visible what educational technologies might offer for teaching and learning of mathematics. It offers critical considerations of the official discourse about this practice, stemming from economic interests, exhorting the field of education to adopt and integrate information and communication technology (ICT) in teaching and learning and calls for an alternative, reflexive and critical approach where questions about different technology uses in education are emphasised. By examining the on-going process of education in laboratory settings where a group of teacher students and their teacher work with spread-sheet applications in a mathematics course, the article aims to uncover what ICT use actually offers teaching and learning in practice.

The main finding was that behind the curtain of ICT use a traditional educational practice was enacted. The social relations relayed through distribution, recontextualising and evaluation of knowledge and knowledge

forms gave at hand that the form and structure of instruction in many ways were similar to the most common ways of organising teaching of mathematics in Swedish classrooms, and in many other countries as well. What appeared during the analysis could be summarised as a learning situation guided by the logical order of the written task that also functioned as a distributor of strongly classified subject content. Communication of knowledge between students and teachers was constituted by strong classification and framing, even if in some part of the labs it seemed to be the opposite.

MARGINALISING STUDENTS' UNDERSTANDING OF MATHEMATICS THROUGH PERFORMATIVE PRIORITIES: A BERNSTEINIAN PERSPECTIVE

This article draws from data produced during subject theory lectures and in conversional interviews with students in an ethnographic study of mathematics teacher education at a Swedish university. Using Bernstein's language of description of the pedagogic device the article describes how the recontextualising of mathematics in the education ends up in a strongly classified and framed practice that may have obstructed student teachers from developing a vertical knowledge structure. The mathematical knowledge that students are subjected to and develop takes more the form of a horizontal discourse and this is problematic for their professional development. A horizontal discourse reduces student access to important forms of knowledge by which they can challenge tradition and consciously change their practice. The organisation of subject theory based on traditional and highly structured lectures has thus been both empirically explored and challenged in the research.

AUTHORITATIVE KNOWLEDGE IN INITIAL TEACHER EDUCATION: STUDYING THE ROLE OF SUBJECT TEXTBOOKS THROUGH TWO ETHNOGRAPHIC STUDIES OF MATHEMATICS TEACHER EDUCATION

This article has been developed from ethnographic studies on learning in mathematics in teacher education across two decades and from two PhD projects. The construction of a discourse of mathematics and the role and use of maths textbooks has been of particular interest. Maths is described in the contexts researched as a book-learning-based and examined practice that leads to a fundamentalist approach to and understanding of mathematics and strong senses of alienation. Based on the research our suggestion is that we need to radically rethink the position and role of mathematics subject theory in teacher education and seriously address how and to what ends textbooks in it are chosen and used. Two authors have been involved in this piece of work. The total workload behind the production of the article has been equally shared and evenly spread.

SUMMARISING THE COVER PAPER

In addition to the articles is the cover paper or 'wrapping'. This presents the methodology and rationale of the research and discusses the main findings. In addition there are reviews of previous research that sets the background to the aims of the thesis and provides motivations for and descriptions of the key questions.

Part of this work has involved production of an outline and some content and analysis for a fifth article in the future relating to previous research on ICT and Education. Just now this article idea is used to present an overview of the last decade's research, and to do a more thorough analysis of the discourses that the research carries in order to illustrate how the rhetoric around the rule and nature of information and communication technology (ICT), use rather seems to be part of the neoliberal narrative that actually sidesteps and disguises rather than answers important questions about technology use in education. The overview looks across the work from different research schools in ICT and education in order to identify patterns and implications for future research and

practice. It involves considerations of underlying relations and structures that shape and restrict technology use in education for a host of macro-, meso-, and micro level actors. In addition to an overview analysis (a kind of meta-ethnography in a way) of research on ICT and education similar analyses were conducted with respect to Teacher Education Policy Development over the most recent policy cycles of teacher education reform and in relation to research on Mathematics teacher Education.

SUMMARISING FINDINGS

One of the main findings from the thesis can be summarised as indicating that through the way that mathematics is taught and learned, mathematics teacher education in practice reproduces traditional ways of teaching and learning. This, in that mathematics instruction is built around a ritualized practice based on the ability to solve exercises related to an examined-textbook-based content. Also signified is that ICT use in this context is not transformative. Rather it seems as if the use of digital technology operates as a relay in the reproduction of traditional ways of teaching and learning. This is contrary to the intentions to renew and revitalise mathematics education and the thesis thus suggests that there is a need to scrutinize the way the use and use-value of new technology is formulated in official discourse.

Two other things are also noteworthy in the thesis findings. The first is an increased emphasis on formal subject content in teacher education through recent policy developments. This re-emphasis reaffirms the value of authoritative subject studies content as the central and most important component in the professional knowledge base of teachers. On the basis of the finding from the thesis the logic of the reform may be questioned. Also important is the ICT discourse that is constituted in wider society by selected agents. In this discourse digital technology often in many ways defines (post)modern society and the position education has in it as a driving force toward economic competitiveness. An alternative, more reflexive and critical approach where questions about technology uses in education are emphasised is suggested to be highly desirable by the thesis.

FUTURE RESEARCH

As ever there are many questions that are raised by research such as that presented here. Amongst the more interesting of these, which could also be the subject of future research, is that the traditional way of teaching and learning mathematics that could be described as 'ritualised' and 'routine' seems to have a long history and to be difficult to change. Research on why this is the case and what can be done about it to improve the situation is needed. In this research mathematics education as a field of practice should be widened to include elements beyond what is perceived as the didactic triad (the relationship between teacher, student and content), to include social actors and institutions located in different spheres and levels (Valero, 2007b) of the current (and indeed in a policy historical interest also past) political economy.

This research could join up with research on educational policy that is concerned with uncovering and challenging processes where policy reforms are introduced into institutions in order to identify, make sense of and understand which main-players and decision-making processes affect reforms directed to teacher education and what consequences these may have on the teachers' mission and professional expertise.

Finally, there has been a substantial increase in research related to ICT and learning underpinned with an optimistic rhetoric about a wide range of opportunities that ICT use in education will bring about. At the same time it seems difficult to find hard and substantial research-based evidence that ICT actually has enhanced educational standards. Instead, most substantial research suggests that the process of integration has often been unsatisfactory. Proposed here is that there is a need to leave the optimistic rhetoric behind and refocus research efforts on what is actually going on in educational settings in order to advance our understanding of different dimensions of learning and technology use in education settings.

REFERENCES

Abramovich, S. (2004). Developing Technology-Mediated Entries into Hidden Mathematics Curriculum as a Vehicle for "Good Learning" by Elementary Pre-Teachers. *Journal of Computers in Mathematics and Science Teaching, The, 23*(3), 299-322.

Adler, J. (2006). Opening Another Black Box: Researching Mathematics for Teaching in Mathematics Teacher Education. *Journal for research in mathematics education, 36*(4), 270-296.

Adler, J., Ball, D., Krainer, K., Lin, F.-L., & Novotna, J. (2005). Reflections on an Emerging Field: Researching Mathematics Teacher Education. *Educational studies in mathematics, 60*(3), 359-381.

Ahlström, K.-G. (2008). HUT! Något fattas. *Pedagogisk forskning i Sverige, 13*, 296-301.

Alagic, M. P., D. (2006). Teachers Explore Linear and Exponential Growth: Spreadsheets as Cognitive Tools. *Journal of Technology and Teacher Education, 14*(3), 633-649.

Alfonseca, E., Rodriguez, P., & Perez, D. (2007). An approach for automatic generation of adaptive hypermedia in education with multilingual knowledge discovery techniques. *Computers & Education, 49*(2), 495-513.

Apple, M. W. (1992). The Text and Cultural Politics. *Educational Researcher, 21*(7), 4-19.

Apple, M. W. (2001). Markets, Standards, Teaching, and Teacher Education. *Journal of Teacher Education, 52*(3), 182-196.

Apple, M. W. (2009). Can critical education interrupt the right? *Discourse: Studies in the Cultural Politics of Education, 30*(3), 239 - 251.

Arnstberg, K.-O. (1997). *Fältetnologi*. Stockholm: Carlsson.

Arreman, I. E. (2005). Research as power and knowledge: struggles over research in teacher education. *Journal of Education for Teaching, 31*(3), 215-235.

Askling, B. (2006). *Utbildningsvetenskap : ett vetenskapsområde tar form*. Stockholm: Vetenskapsrådet.

Atkinson, P. (2007). *Handbook of ethnography*. London: SAGE.

Au, W. (2008). Devising Inequality: A Bernsteinian Analysis of High-Stakes Testing and Social Reproduction in Education. *British Journal of Sociology of Education, 29*(6), 639-651.

Augustsson, G. (2010). Web 2.0, pedagogical support for reflexive and emotional social interaction among Swedish students. *The Internet and Higher Education, 13*(4), 197-205.

Ball, S. J. (1990). Discipline and chaos The New Right and discourses of derision. In S. J. Ball (Ed.), *Education Policy and Social Class*. Abingdon: Routledge.

Ball, S. J. (1993). What is Policy? Texts, trajectories and toolboxes. In S. J. Ball (Ed.), *Education Policy and Social Class. The selected works of Stephen J. Ball*. London: Routledge Taylor & Frabcis Group.

Ball, S. J. (1998). Big Policies / Small World. An introduction to international perspectives in education policy. In S. J. Ball (Ed.), *Education Policy and Social Class. The selected work of Stephen J. Ball.* (pp. 67-80). London: Routledge.

Ball, S. J. (2003). The teacher's soul and the terrors of perfomativity. In S. J. Ball (Ed.), *Education Policy and Social Class The selected work of Stephen J. Ball*. Abingdon: Routledge Taylor & Francis Group.

Ball, S. J. (2006). *Education policy and social class : the selected works of Stephen J. Ball*. London ; Routledge.

Ball, S. J., Bowe, R., & Gewirtz, s. (1994). Market forces and parental choice. In S. Tomilson (Ed.), *Educational reform and its consequences* (pp. 13-25).

Barak, M. (2005). From order to disorder: the role of computer-based electronics projects on fostering of higher-order cognitive skills. *Computers & Education, 45*(2), 231-243.

Beach, D. (1995). *Making sense of the problems of change : an ethnographic study of a teacher education reform*. Göteborg: Acta Universitatis Gothoburgensis.

Beach, D. (1997). *Symbolic control and power relay: learning in higher professional education*. Göteborg: Acta Universitatis Gothoburgensis.

Beach, D. (1999). Alienation and Fetish in Science Education. *Scandinavian Journal of Educational Research, 43*(2), 157.

Beach, D. (2000). Continuing Problems of Teacher Education Reform. *Scandinavian Journal of Educational Research, 44*(3), 275-291.

Beach, D. (2003). Mathematics goes to market. In D. Beach, T. Gordon & E. Lahelma (Eds.), *Democratic Education : Ethnographic Challenges*. London: the Tufnell Press.

Beach, D. (2008). Ethnography and representation: About representations for criticism and change through ethnography. In G. Walford (Ed.), *How to do Educational Ethnography*. London: the Tufnell Press.

Beach, D. (2010). Identifying and comparing Scandinavian ethnography: comparisons and influences. *Ethnography & Education, 5*(1), 49-63.

Beach, D. (2011a). Education Science in Sweden: Promoting Research for Teacher Educationor Weakening its Scientific Foundations? *Education Inquiry, 2*(2), 207-220.

Beach, D. (2011b). *Identifying Scandinavian Ethnography: Articulating notions of theory and objectivity in the ethnography of education*. Paper presented at the The German Commission for Qualitative Research and Biography Conference on Ethnography and Difference in Educational Fields.

Beach, D., & Bagley, C. (2012). The weakening Role of Education Studies and the Re-traditionalisation of Swedish Teacher Education. *Oxford Review of Education, 38*(3).

Beach, D., Eriksson, A., & Player-Koro, C. (2011). *Changing Teacher Education in Sweden*. Paper presented at the The Oxford Ethnography Conferense.

Beach, D., & Player-Koro, C. (2012). Authoritative Knowledge in Initial Teacher Education: Studying the Role of Subject Textbooks through Two Ethnographic Studies of Mathematics Teacher Education. *Journal of Education for Teaching, 38*(2).

Bernstein, B. (1999a). "Pedagogy, Identity and the Construction of a Theory of Symbolic Control": Basil Bernstein Questioned by Joseph Solomon. *British Journal of Sociology of Education, 20*(2), 265-279.

Bernstein, B. (1999b). Vertical and horizontal discourse: an essay. *British Journal of Sociology of Education, 20*(2), 157-173.

Bernstein, B. (2000). *Pedagogy, symbolic control and identity: theory, research, critique*. Lanham, Md.:: Rowman & Littlefield Publishers.

Bernstein, B. (2001). Symbolic control: issues of empirical description of agencies and agents. *Social Research Methodology, 4*(1), 21-33.

Bernstein, B. (2003). *Class, codes and control. Vol. 4, The structuring of pedagogic discourse*. London: Routledge.

Best, S. (2007). Basil Bernstein: agency, structure and linguistic conception of class. *Education, Knowledge and Economy, 1*(1), 107-124.

Black, L., Mendick, H., & Solomon, Y. (2009). *Mathematical relationships in education : identities and participation*. New York: Routledge.

Bourdieu, P., Nyman, L. E., & Rosengren, M. (1996). *Homo academicus*. Eslöv: B. Östlings bokförlag. Symposion.

Bourne, J. (2004). Framing talk. Towards a 'radical visible pedagogy'. In J. Muller, B. Davies & A. Morais (Eds.), *Reading Bernstein, Researching Bernstein*. London: Routledge Falmer. .

Bourne, J. (2008). Official Pedagogic Discourses and the Construction of Learners' Identities. In N. H. Hornberger (Ed.), *Encyclopedia of Language and Education* (pp. 798-809): Springer US.

Brown, P., Halsey, A. H., Lauder, H., & Wells, A. S. (1997). The Transformation of Education and Society: An introduction. In A. H. Halsey, H. Lauder, P. Brown & A. S. Wells (Eds.), *Education Culture Economy Society* (pp. 1-44). Oxford: Oxford University Press.

Bryson, M., & De Castell, S. (1998). New Technologies and the Cultural Ecology of Primary Schooling:Imagining Teachers as Luddites In/Deed. *Educational Policy, 12*(5), 542-567.

Byrne, R. (2009). The Effect of Web 2.0 on Teaching and Learning. *Teacher Librarian, 37*(2), 50.

Chen, H. Y., & Liu, K. Y. (2008). Web-based synchronized multimedia lecture system design for teaching/learning Chinese as second language. *Computers & Education, 50*(3), 693-702.

Cifarelli, V., Goodson-Espy, T., & Jeong-Lim, C. (2010). Associations of Students' Beliefs With Self-Regulated Problem Solving in College Algebra. [Article]. *Journal of Advanced Academics, 21*(2), 204-232.

Cohen, D. K. (2008). Knowledge and teaching. *Oxford Review of Education, 34*(3), 357-378.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education*. London: Routledge.

Cuban, L. (1986). *Teachers and machines : the classroom use of technology since 1920*. New York: Teachers college P.

Cuban, L. (2001). *Oversold and underused : computers in the classroom*. Cambridge, Mass.: Harvard University Press.

Darling-Hammond, L. (2006). *Powerful teacher education : lessons from exemplary programs*. San Francisco, CA: Jossey-Bass.

Davies, B., Muller, J., & Morais, A. (2004). *Reading Bernstein, researching Bernstein*. London: RoutledgeFalmer.

Davies, P., Davies, N., Hutton, D., Adnett, N., & Coe, R. (2009). Choosing in schools: locating the benefits of specialisation. *Oxford Review of Education, 35*(2), 147-167.

Delandshere, G., & Petrosky, A. (2004). Political rationales and ideological stances of the standards-based reform of teacher education in the US. *Teaching and Teacher Education, 20*(1), 1-15.

Diaz, M. (2001). Subject, Power, and Pedagogic Discourse. In A. Morais, I. Neves, B. Davies & H. Daniels (Eds.), *Towards a Sociology of Pedagogy. The Contribution of Basil Bernstein to Research*. Oxford: Peter Lang Publishing.

Divaharan, S., & Koh, J. H. L. (2010). Learning as students to become better teachers: Pre-service teachers' IWB learning experience. *Australasian Journal of Educational Technology, 26*(4), 553-570.

Dovemark, M. (2004). *Ansvar - flexibilitet - valfrihet : en etnografisk studie om en skola i förändring*. Göteborg: Acta Universitatis Gothoburgensis.

Draper, S. W. (2009). Catalytic assessment: understanding how MCQs and EVS can foster deep learning. *British Journal of Educational Technology, 40*(2), 285-293.

Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education, 51*(1), 187-199.

Durkee, D., Brant, S., Nevin, P., Odell, A., Williams, G., Melomey, D., et al. (2009). Implementing E-Learning and Web 2.0 Innovation: Didactical Scenarios and Practical Implications. *Industry and Higher Education, 23*(4), 293-300.

Edwards, T., & Whitty, G. (1997). Specialisation and selection in secondary education. *Oxford Review of Education, 23*(1), 5.

Ellis, V. (2007). Taking subject knowledge seriously: from professional knowledge recipes to complex conceptualizations of teacher development. *The Curriculum Journal, 18*(4), 447-462.

Enochsson, A.-B. (2009). *ICT in Initial Teacher Training. Sweden Country report*. Paris: OECD.

Enochsson, A.-B., & Rizza, C. (2009). *ICT in Initial Teacher Training: Research Review*. Paris: OECD EDU Working Paper No. 38.

Ensor, P. (2004a). Modalities of Teacher Education Discourse and the Education of Effective Practitioners. *Pedagogy, Culture & Society, 12*(2), 217-232.

Ensor, P. (2004b). Towards a sociology of teacher education. In J. Muller, B. Davies & A. Morais (Eds.), *Reading Bernstein, Researching Bernstein*. London: RoutledgeFalmer.

Eriksson, A. (2009). *Om teori och praktik i lärarutbildning : en etnografisk och diskursanalytisk studie [About Theory and Practice in Teacher Education. An Ethnographic and Discourse Analytical Study]*. Göteborg: Acta Universitatis Gothoburgensis.

Erixon Arreman, I., & Weiner, G. (2007). Gender, research and change in teacher education: a Swedish dimension. *Gender and Education, 9*(3), 313-337.

Fairclough, N. (1992). *Discourse and social change*. Cambridge: Polity.

Fairclough, N. (2003). *Analysing discourse : textual analysis for social research*. New York: Routledge.

Fisher, T. (2006). Educational transformation: Is it, like 'beauty', in the eye of the beholder, or will we know it when we see it? *Education and Information Technologies, 11*(3), 293-303.

Forskningsetiska principer inom humanistisk-samhällsvetenskaplig forskning. (2002). Stockholm: Vetenskapsrådet.

Forster, P. A. (2006). Assessing technology-based approaches for teaching and learning mathematics. *International Journal of Mathematical Education in Science and Technology, 37*(2), 145-164.

Fransson, K., & Lundgren, U. P. (2003). *Utbildningsvetenskap - ett begrepp och dess sammanhang*. Stockholm: Vetenskapsrådet.

Frith, V., Jaftha, J., & Prince, R. (2004). Evaluating the effectiveness of interactive computer tutorials for an undergraduate mathematical literacy course. *British Journal of Educational Technology, 35*(2), 159-171.

Furinghetti, F. (2007). Teacher Education through the History of Mathematics. *Educational studies in mathematics, 66*(2), 131-143.

Garm, N., & Karlsen, G. E. (2004). Teacher education reform in Europe: the case of Norway; trends and tensions in a global perspective. *Teaching and Teacher Education, 20*(7), 731-744.

Gierdien, M. F. (2010). Transforming spreadsheet-based numerical and quadratic sequences into pencil-paper algebraic expressions, and prospective teachers. *International Journal of Mathematical Education in Science and Technology, 41*(1), 117-122.

Goktas, Y., Yildirim, Z., & Yildirim, S. (2008). A review of ICT related courses in pre-service teacher education programs. *Asia Pacific Education Review, 9*(2), 168-179.

Gordon, T., Lahelma, E., & Beach, D. (2003). Introduction. Marketisation of democratic education: Ethnographic challenges. In D. Beach, T. Gordon & E. Lahelma (Eds.), *Democratic education - Ethnographic challenges*. London: Tufnell Press.

Gore, J. M., Griffiths, T., & Ladwig, J. G. (2004). Towards better teaching: productive pedagogy as a framework for teacher education. *Teaching and Teacher Education, 20*(4), 375-387.

Gouseti, A. (2010). Web 2.0 and education: not just another case of hype, hope and disappointment? *Learning, Media and Technology, 35*(3), 351-356.

Government Bill 1984/85:122. (1985). *om Lärarutbildning för grundskolan m.m [about teacher education in compulsory school etc.]*. Stockholm: Regeringen.

Government Bill 1999/2000:135. (2000). *En förnyad lärarutbildning [A new system for teacher education]*. Stockholm: Regeringen.

Government Bill 2000/01:3. (2000). *Regeringens proposition 2000/01:3 : forskning och förnyelse*. Stockholm: Regeringen.

Government Bill 2009/10:89. (2010). *Bäst i klassen - en ny lärarutbildning [Top of the class - new teacher education programmes]*. Stockholm: Regeringen.

Grace, J., & Bollen, K. (2008). Representing general theoretical concepts in structural equation models: the role of composite variables. *Environmental and Ecological Statistics, 15*(2), 191-213.

Greenhow, C., Robelia, B., & Hughes, J. E. (2009). Learning, Teaching, and Scholarship in a Digital Age: Web 2.0 and Classroom Research: What Path Should We Take Now? *Educational Researcher, 38*(4), 246-259.

Hammersley, M. (2006). Ethnography: problems and prospects. *Ethnography and Education, 1*(1), 3-14.

Hammersley, M., & Atkinson, P. (1989). *Ethnography : principles in practice* (P. Atkinson, Trans.). London :: Routledge,.

Hammersley, M., & Atkinson, P. (2007). *Ethnography : principles in practice*. Milton Park, Abingdon, Oxon ;: Routledge.

Harrison, C., Lunzer, E. A., Tymms, P., Fitz-Gibbon, C. T., & Restorick, J. (2004). Use of ICT and its relationship with performance in examinations: a comparison of the ImpaCT2 project's research findings using pupil-level, school-level and multilevel modelling data. *Journal of Computer Assisted Learning, 20*(5), 319-337.

Hartley, J. (2007). Teaching, learning and new technology: a review for teachers. *British Journal of Educational Technology, 38*(1), 42-62.

Haydn, T. A., & Barton, R. (2007). Common needs and different agendas: How trainee teachers make progress in their ability to use ICT in subject teaching. Some lessons from the UK. *Computers & Education, 49*(4), 1018-1036.

Hayes, S., Capel, S., Katene, W., & Cook, P. (2008). An examination of knowledge prioritisation in secondary physical education teacher education courses. *Teaching and Teacher Education, 24*(2), 330-342.

Henderson, S., & Hudson, B. (2011). What is Subject Content Knowledge in Matheamatics? On Student Teachers' Competence, Confidence, Attitudes and Beleifs in Relation to Teaching Mathematics. In E. Eisenschmidt & E. Löfström (Eds.), *Developing Quality Cultures in Teacher Education: Expanding Horizons in Relationto Quality Assurance*. Tallin: Tallinn University, Estonia.

Hennessy, S., Ruthven, K., & Brindley, S. (2005). Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution, and change. *Journal of Curriculum Studies, 37*(2), 155-192.

Hill, H., & Loewenberg Ball, D. (2009). The Curious -- and Crucial -- Case of Mathematical Knowledge for Teaching. *Phi Delta Kappan, 2*, 68-71.

Hill, H. C., Blunk, M. L., Charalambous, C. Y., Lewis, J. M., Phelps, G. C., Sleep, L., et al. (2008). Mathematical Knowledge for Teaching and the Mathematical Quality of Instruction: An Exploratory Study. *Cognition and Instruction, 26*(4), 430-511.

Hoadley, U. (2006). Analysing pedagogy: the problem of framing. *Journal of Education*(40), 15-34.

Hoadley, U. (2007). The reproduction of social class inequalities through mathematics pedagogies in South African primary schools. *Journal of Curriculum Studies, 39*(6), 679-706.

Howitt, D., & Cramer, D. (2005). *Introduction to statistics in psychology*. Harlow: Prentice Hall.

Hwang, W.-Y., Chen, N.-S., & Hsu, R.-L. (2006). Development and evaluation of multimedia whiteboard system for improving mathematical problem solving. *Computers & Education, 46*(2), 105-121.

Härnqvist, K., Achtenhagen, F., Rosengren, K. E., & Öhngren, B. (1997). *An evaluation of Swedish research in education*. Stockholm: Swedish Council for Research in the Humanities and Social Sciences (Humanistisk-samhällsvetenskapliga forskningsrådet), (HSFR) ;.

Ivinson, G. (2007). Pedagogic discourse and sex education: myths, science and subversion. [Article]. *Sex Education, 7*(2), 201-216.

James, C. (2000). Bernstein, Bourdieu and the New Literacy Studies. *Linguistics and Education, 11*(1), 65-78.

Jedemark, M. (2006). *Lärarutbildningens olika undervisningspraktiker : en studie av lärarutbildares olika sätt att praktisera sitt professionella uppdrag*. Lund: Pedagogiska institutionen, Lunds universitet.

Jedeskog, G. (2005). *Ch@nging school : implementation of ICT in Swedish school, campaigns and experiences 1984-2004*. Uppsala: Pedagogiska institutionen, Uppsala universitet.

Jeffrey, B., & Troman, G. (2004). Time for ethnography. *Brittish Educational Research Journal, 30*(4), 535-548.

Jeong, A., & Joung, S. (2007). Scaffolding collaborative argumentation in asynchronous discussions with message constraints and message labels. *Computers & Education, 48*(3), 427-445.

Jones, N., Blackey, H., Fitzgibbon, K., & Chew, E. (2010). Get out of MySpace! *Computers & Education, 54*(3), 776-782.

Jung, I. S. (2005). ICT-Pedagogy integration in teacher training: Application cases worldwide. *Educational Technology & Society, 8*(2), 94-101.

Kallós, D. (2009). Varför är det så förtvivlat svårt att bygga upp forskning och forskarutbildning i anslutning till lärarutbildning och pedagogisk yrkesverksamhet: Om myndighets missbruk, svek och andra missförhållanden. *Pedagogisk forskning i Sverige, 14*, 237-249.

Karasavvidis, I., Pieters, J. M., & Plomp, T. (2003). Exploring the mechanisms through which computers contribute to learning. *Journal of Computer Assisted Learning, 19*(1), 115-128.

Ken, Z. (2010). Competition, economic rationalization, increased surveillance, and attacks on diversity: Neo-liberalism and the transformation of teacher education in the U.S. *Teaching and Teacher Education, 26*(8), 1544-1552.

Kim, C. M., & Baylor, A. L. (2008). A virtual change agent: Motivating pre-service teachers to integrate technology in their future classrooms. *Educational Technology & Society, 11*(2), 309-321.

Kiridis, A., Drossos, Y., & Tsakiridou, H. (2006). Teachers Facing Information and Communication Technology (ICT): The Case of Greece. *Journal of Technology and Teacher Education, 14*(1), 75-96.

Koehler, M. J., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge? *Contemporary Issues in Technology and Teacher Education., 9*(1), 60-70.

La Velle, L. B., McFarlane, A., & Brawn, R. (2003). Knowledge transformation through ICT in science education: a case study in teacher-driven curriculum development - Case Study 1. *British Journal of Educational Technology, 34*(2), 183-199.

Lacey, C. (1970). *Hightown grammar : the school as a social system*. Manchester.

Larsson, S. (2006). Ethnography in action. How ethnography was established in Swedish educational research. *Ethnography & Education, 1*(2), 177-195.

Lave, J., & Kvale, S. (1995). Whats is antrophological research? An interview with Jean Lave by Steinar Kvale. *International Journal of Qualitative Studies in Education, 8*(3), 219-228.

Lee, I. (2011). Teachers as knowledge producers at continuing professional development seminars in an English as a foreign language context. *Journal of Education for Teaching, 37*(1), 107-108.

Lewis, S., Pea, R., & Rosen, J. (2010). Beyond participation to co-creation of meaning: mobile social media in generative learning communities. *Social Science Information, 49*(3), 351-369.

Li, Q. (2005). Infusing technology into a mathematics methods course: any impact? *Educational Research, 47*(2), 217-233.

Lofland, J., & Lofland, L. H. (1995). *Analyzing social settings : a guide to qualitative observation and analysis*. Belmont, Calif.: Wadsworth.

Loo, S. (2006). Adult Numeracy Teacher Training Programmes in England: A Suggested Typology. *International journal of lifelong education, 25*(5), 463-476.

Loo, S. (2007). Learning to Be Teachers of Adult Numeracy. *Journal of education for teaching, 33*(4), 425-440.

Looi, C.-K., Chen, W., & Ng, F.-K. (2010). Collaborative activities enabled by GroupScribbles (GS): An exploratory study of learning effectiveness. *Computers & Education, 54*(1), 14-26.

Louw, J., Brown, C., Muller, J., & Soudien, C. (2009). Instructional technologies in social science instruction in South Africa. *Computers & Education, 53*(2), 234-242.

Lundin, S. (2008). *Skolans matematik : en kritisk analys av den svenska skolmatematikens förhistoria, uppkomst och utveckling [The mathematics of schooling : a critical analysis of the prehistory, birth and development of Swedish mathematics education]*. Uppsala: Acta Universitatis Upsaliensis :.

Lyons, H. (2009). Case study research methodology for publishing developments in ICT-facilitated learning in higher education - a prescrip-

tive approach. *Innovations in Education and Teaching International, 46*(1), 27-39.

Marcos, J. M., Sanchez, E., & Tillema, H. H. (2011). Promoting teacher reflection: what is said to be done. *Journal of Education for Teaching, 37*(1), 21-36.

Margolis, J. L., Nussbaum, M., Rodriguez, P., & Rosas, R. (2006). Methodology for evaluating a novel education technology: a case study of handheld video games in Chile. *Computers & Education, 46*(2), 174-191.

Marino, M. T., Sameshima, P., & Beecher, C. C. (2009). Enhancing TPACK With Assistive Technology: Promoting Inclusive Practices in Preservice Teacher Education. *Contemporary Issues in Technology and Teacher Education., 9*(2), 186-207.

Minocha, S. (2009). Role of social software in education: a literature review. *Education Training, 51*(5/6).

Morais, A. (2001). *Towards a sociology of pedagogy: the contribution of Basil Bernstein to research*. New York:: Lang.

Mueller, M. P., & Bentley, M. L. (2007). Beyond the "decorated landscapes" of educational reform: Toward landscapes of pluralism in science education. *Science Education, 91*(2), 321-338.

Murray, S., Nuttall, J., & Mitchell, J. (2008). Research into initial teacher education in Australia: A survey of the literature 1995-2004. *Teaching and Teacher Education, 24*(1), 225-239.

Nichol, J., Watson, K., & Waites, G. (2003). Rhetoric and reality: using ICT to enhance pupil learning - Harry Potter and the Warley Woods Mystery - Case study 2. *British Journal of Educational Technology, 34*(2), 201-213.

Niess, M. I., Ronan, R. N., Shafer, K. G., Driskell, S. O., Harper, S. R., Johnston, C., et al. (2009). Mathematics Teacher TPACK Standards and Development Model. *Contemporary Issues in Technology and Teacher Education., 9*(1), 4-24.

Nivala, M. (2009). Simple answers for complex problems: education and ICT in Finnish information society strategies. *Media Culture Society, 31*(3), 433-448.

Olaniyan, D. A., & Okemakinde, T. (2008). Human Capital Theory Implications for Educational Development. *European Journal of Scientific Research, 24*(2), 157.

Ottestad, G. (2010). Innovative pedagogical practice with ICT in three Nordic countries - differences and similarities. [Article]. *Journal of Computer Assisted Learning, 26*(6), 478-491.

Park, S. H., & Ertmer, P. A. (2008). Examining barriers in technology-enhanced problem-based learning: Using a performance support systems approach. *British Journal of Educational Technology, 39*(4), 631-643.

Pepin, B. (2009). The Role of Textbooks in the 'Figured Worlds' of English, French, and German Classrooms. A comparative Perspective. In L. Black, H. Mendick & Y. Solomon (Eds.), *Mathematical Relationships in Education : Identities and Participation.* New York: Routledge

Persson, E. (2009). *Det kommer med tiden : från lärarstudent till matematiklärare*. Stockholm: Stockholms universitet.

Player-Koro, C. (2011). Marginalising students' understanding of mathematics through performative priorities: a Bernsteinian perspective. *Ethnography and Education, 6*(3), 325-340.

Player-Koro, C. (2012a). Factors Influencing Teachers' use of ICT in Education. *Education Inquiry, 3*(1).

Player-Koro, C. (2012b). Hype, hope and ICT in teacher education: a Bernsteinian perspective. *Learning, Media and Technology*, 1-15.

Pol, H. J., Harskamp, E. G., Suhre, C. J. M., & Goedhart, M. J. (2009). How indirect supportive digital help during and after solving physics problems can improve problem-solving abilities. *Computers & Education, 53*(1), 34-50.

Poland, R., la Velle, L. B., & Nichol, J. (2003). The Virtual Field Station (VFS): using a virtual reality environment for ecological fieldwork in A-Level biological studies - Case Study 3. *British Journal of Educational Technology, 34*(2), 215-231.

Ponte, J. P. d., Oliveira, H., & Varandas, J. M. (2002). Development of Pre-Service Mathematics Teachers' Professional Knowledge and Identity in Working with Information and Communication Technology. *Journal of Mathematics Teacher Education, 5*(2), 93-115.

Portnoy, N., Grundmeier, T. A., & Graham, K. J. (2006). Students' understanding of mathematical objects in the context of transformational geometry: Implications for constructing and understanding proofs. *The Journal of Mathematical Behavior, 25*(3), 196-207.

Pring, R. (2004). *Philosophy of educational research*. London: Continuum.

Radnitzky, G. (1970). *Contemporary schools of metascience : Anglo-Saxon schools of metascience, continental schools of metascience*. G√∂teborg: Akademif√∂rl.

Rajander, S. (2009). *School and Choice: An ethnographic Study of a Primary School.*, Helsinki.

Randolph, J. J., & Bednarik, R. (2008). Publication Bias in the Computer Science Education Research Literature. *Journal of Computer Science, 14*(4), 575-589.

Reed, H. C., Drijvers, P., & Kirschner, P. A. (2010). Effects of attitudes and behaviours on learning mathematics with computer tools. *Computers & Education, 55*(1), 1-15.

Robertson, H.-J. (2003). Toward a Theory of Negativity: Teacher Education and Information and Communications Technology. *Journal of Teacher Education, 54*(4), 280-296.

Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., et al. (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. *Computers & Education, 40*(1), 71-94.

Rushby, N. (2005). Editorial. *British Journal of Educational Technology, 36*(2), 135-136.

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use - Implications for preservice and inservice teacher preparation. *Journal of Teacher Education, 54*(4), 297-310.

Ruthven, K., & Sara, H. (2003). Successful ICT use in secondary mathematics--a teacher perspective. *Micro Math, 19*(2), 20.

Selden, A. (2005). New developments and trends in tertiary mathematics education: Or, more of the same? *International Journal of Mathematical Education in Science & Technology, 36*(2/3), 131-147.

Selwyn, N. (2011a). Editorial: In praise of pessimism—the need for negativity in educational technology. *British Journal of Educational Technology, 42*(5), 713-718.

Selwyn, N. (2011b). Technology, media and education: telling the whole story. *Learning, Media and Technology, 36*(3), 211-213.

Selwyn, N., Dawes, L., & Mercer, N. (2001). Promoting Mr. [`]Chips': the construction of the teacher/computer relationship in educational advertising. *Teaching and Teacher Education, 17*(1), 3-14.

Selwyn, N., Gorard, S., & Williams, S. (2001). The role of the 'technical fix' in UK lifelong education policy. *International Journal of Lifelong Education, 20*(4), 255-271.

Shulman, L. S. (1987). Knowledge and Teaching: Foundations of a New Reform. *Harward Educational Review, 57*(1).

Singh, P. (1997). Review Essay: Basil Bernstein1996. Pedagogy, symbolic control and identity. London Taylor and Francis. *British Journal of Sociology of Education, 18*(1), 119-124.

Singh, P. (2002). Pedagogising Knowledge: Bernstein's theory of the pedagogic device. *British Journal of Sociology of Education, 23*(4), 571 - 582.

Sjöberg, L. (2011). *Bäst i klassen? : lärare och elever i svenska och europeiska policytexter*. Göteborg: Acta Universitatis Gothoburgensis.

Skolverket. (2011). *Skolverkets lägesbedömning 2011*. Stockholm.

Skolverket, skolutveckling, M. f., kompetensutveckling, S. f. k.-o., & Microsoft. (2005). *IT och skola 2005.En sammanfattning av en enkätstudie riktad mot skolledare, lärare och elever under våren 2005*. . Stockholm.

Skovsmose, O. (2011). *An invitation to critical mathematics education*. Rotterdam: Sense.

SOU 1948:27. (1948). *1946 års skolkommissions betänkande med förslag till riktlinjer för det svenska skolväsendets utveckling*. Stockholm: Ecklesiastikdepartementet.

SOU 1965:29. (1965). *1960 års lärarutbildningssakkunniga. 4, Lärarutbildningen, 1*. Stockholm: Ecklesiastikdepartementet.

SOU 1978:86. (1978). *Lärare för skola i utveckling : betänkande*. Stockholm: LiberFörlag/Allmänna förl.

SOU 1999:63. (1999a). *Att lära och leda : en lärarutbildning för samverkan och utveckling : Lärarutbildningskommitténs slutbetänkande*. Stockholm: Fakta info direkt.

SOU 1999:63. (1999b). *Att lära och leda : en lärarutbildning för samverkan och utveckling : Lärarutbildningskommittens slutbetänkande [To teach and to govern. Teacher education co-operation and development. Final report of the Teacher Education Committee.]*. Stockholm: Fakta info direkt.

SOU 2008:109. (2008). *En hållbar lärarutbildning : betänkande [Sustainable teacher education]*. Retrieved from http://www.regeringen.se/content/1/c6/11/67/37/b4b3b355.pdf

Steketee, C. (2005). Integrating ICT as an integral teaching and learning tool into pre-service teacher training courses. *Issues In Educational Research, 15*(1).

Strauss, A. L., & Corbin, J. M. (1998). *Basics of qualitative research : techniques and procedures for developing grounded theory*. Thousand Oaks, Calif.: SAGE.

Sutherland, R., Armstrong, V., Barnes, S., Brawn, R., Breeze, N., Gall, M., et al. (2004). Transforming teaching and learning: embedding ICT into everyday classroom practices. *Journal of Computer Assisted Learning, 20*(6), 413-425.

Tebelius, U., Aderklou, C., & Fritzdorf, L. (2003). *ITiS som incitament till skolutveckling : den nationella utvärderingen av IT i skolan : surveystudien, 2000-2003*. Halmstad: Högskolan i Halmstad.

Teknikdelegationen. (2010). *Framtidens lärande, i dagens skola [Elektronisk resurs] : internationell forskningsöversikt kring IKT och skola [The future of learning, in today's schools [electronic resource]]*. Stockholm: Teknikdelegationen.

Thomas, A., & Stratton, G. (2006). What we are really doing with ICT in physical education: a national audit of equipment, use, teacher atti-

tudes, support, and training. *British Journal of Educational Technology, 37*(4), 617-632.

Thomas, D. A., & Li, Q. (2008). From web 2.0 to teacher 2.0 *Computers in the Schools, 25*(3-4), 199-210.

Tondeur, J., van Braak, J., & Valcke, M. (2007). Curricula and the use of ICT in education: Two worlds apart? *British Journal of Educational Technology, 38*(6), 962-976.

Troman, G. (2006). Editorial. *Ethnography and Education, 1*(1), 1-2.

Troman, G., Jeffrey, B., & Beach, D. (2006). *Researching education policy : ethnographic experiences*. London: Tufnell Press.

Trondman, M. (2008). Bypass surgery: Rerouting theory to ethnographic study. In G. Walford (Ed.), *How to do Educational Ethnography*. London: the Tufnell Press.

Valero, P. (2007a). A socio-political look at equity in the school organization of mathematics education. *ZDM, 39*(3), 225-233.

Valero, P. (2007b). What has Power got to do with Mathematics Education? *Philosophy of Mathematics Education Journal*(21).

Volman, M. (2005). A variety of roles for a new type of teacher educational technology and the teaching profession. *Teaching and Teacher Education, 21*(1), 15-31.

Walford, G. (2008). The nature of educational ethnography. In G. Walford & S. Delamont (Eds.), *How to do educational ethnography*. London: Tufnell Press.

Walford, G., & Delamont, S. (2008). *How to do educational ethnography*. London: Tufnell Press.

Wehrli, B. (2009). Technology as a Fence and a Bridge. *Horace, 25*(1).

Wheelahan, L. (2007). How Competency-Based Training Locks the Working Class out of Powerful Knowledge: A Modified Bernsteinian Analysis. *British Journal of Sociology of Education, 28*(5), 637-651.

Willis, P., & Trondman, M. (2002). Manifesto for Ethnography. *Cultural Studies <=> Critical Methodologies, 2*(3), 394-402.

Zhou, G., & Xu, J. (2007). Adoption of educational technology ten years after setting strategic goals: A Canadian university case. *Australasian Journal of Educational Technology, 23*(4), 508-528.

Åstrand, B. (2006). Aspects of Reforms of Teacher Education in Sweden. In P. Zgaga (Ed.), *Modernization of study programmes in teachers› education in an international context*. Ljubljana: European social fund.

Part Three

THE ARTICLES