How do different modalities of pedagogical practices within teacher education shape student teachers?

An empirical study of secondary mathematics teacher education

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Abstract

This paper aims to show how ethnography is used to explore the pedagogical practice in teacher education, how it is structured, transmitted and acquired. It has two foci, which gives the paper a dual purpose: to identify and describe (even theoretically) a key substantive issue and to reflect on the use of ethnography in this.

The empirical material is drawn from an ethnographic study where a group of students were followed 20 weeks during a mathematic course. The material discussed here, represents 20 hours of participants observations from lectures in mathematics, and 8 conversional interviews with students.

The paper uses Bernstein’s concepts of code and the modalities of pedagogic transmission and acquisition, and his typology of vertical and horizontal discourse, to show how a strong classified and framed practice block student teachers from developing vertical knowledge structure in mathematics. The mathematic knowledge that students are subjected to takes more the form of a horizontal discourse and that is problematic for their professional development in that a horizontal discourses reduce student access to important forms of knowledge by which they can challenge tradition and consciously change their practice (Bernstein, 2000, 2003).

Introduction

This paper examines the ongoing process of education in a number of lectures where student teachers are supposed to learn mathematics theory. It draws from a selection of empirical data from an ethnographic study that will be part of my forthcoming thesis and is concerned about messages carried within teacher education.

Teacher education in Sweden is organised in two broad areas: university based education and field-based education (practicum). The university based studies are given in a number of combinations of enrichments according to firstly the age-range of the teacher specialisation (e.g. infant/junior, junior/secondary, upper-secondary, pre and leisure) and secondly the study
enrichment (arts and crafts, science and technology, social and civic studies, Maths-English and Swedish, People and their environments, and so on) and complimentary studies (in science, maths, history, environmental studies and so on: these are similar to the study enrichments but have no practicum). The subject enrichment has in its turn two component parts: subject studies and subject curriculum theory. In addition to the subject enrichments university based studies also contain a common professional studies component called the common educational area. This contains pedagogical studies, psychology of learning and so on (Regeringens proposition 1999/2000:135, 2000).

In this paper I will take a closer look at lectures, which are part of a course in subject studies. Subject study is a combination of subject theory, pertinent to instruction in academic subjects at the university, and curriculum theory, concerned with theories of teaching processes consisting of how the school subject is organised and taught. Classrooms activities in subject theory were essentially based on lectures. (The course consisted of lab work were students work with computers, seminars and practice in compulsory school as well.) The reason for the selection of lectures was to explore contradictions between what is described in the curriculum as the main objective with the course, objectives that student teachers an teacher educators seemed to agree with when talking about the course, and what was really going on in practice during lectures.

The main objective with the course as expressed in the curriculum is: “…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”.

The most preferred classroom activity according to interviews and participant observation was subject theory lectures. This was something also identified by Beach (1995, 2000). Common comments on why this was so popular were that they needed the subject knowledge contained there for their future work as teachers, and that it was important. However there was a paradox issue. The paradox is that there is a lack of evidence in the data that these activities will ever lead to a deepening understanding of mathematics and teaching and learning of mathematics. Lectures are according to this study powerfully classified and framed; highly paced practices where students don’t have the time to enter deeply in content, such that the preference of these traditional highly structured practices is based on students’ experience of education where accumulation of educational capital is gained through exposition of extensive ‘facts’, evaluation and examination, and that this education leads to an atomistic view of knowledge (Beach, 2000, 2008).
My argument is that there is a need for deeper understanding of what is really going on in the teaching-learning situation of the messages carried within the pedagogical discourse of teacher education, including what teacher repertoires this pedagogic discourse transmits to student teachers, and how they are acquired by the students.

**Theoretical framework**

The work of Basil Bernstein provides a conceptual framework for the analysis of the pedagogic discourse enacted during teaching learning of mathematics. Pedagogic discourse is according to Bernstein a recontextualisation principle, which means that it rests on the rules through which pedagogic subjects are selected and created. The pedagogic discourse describes the form and structure of what is actually going on in the process of education and is in line with Bernstein taken to refer to the embedding of two discourses, the instructional (skills of different kind), within the regulative (social order) discourse. The character of the pedagogical discourse, in terms of relations between students and teachers, selection of subject content, and rules for transmission and acquisition could be described using the concepts of codes\(^1\) and modalities.

Different modalities of pedagogical discourses are formulated using the concepts classification and framing, where classification describes how power relations are transformed into specialised discourse and framing is taken to refer to principles of control over selection, sequencing, pacing, and rules of the pedagogic communication. A teaching-learning situation under conditions of

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\(^1\) Code is defined as a regulator between categories of discourses, and through those relationships, a regulator of relations within a discourse, that selects and integrates relevant meanings that are tacitly acquired. Relationships between discourses, defined as the degree of insulation between categories of discourses, are defined as varying strengths of classification. Strong classification means strong insulation between discourses and regulates the power and the position of the discourse. This provides recognition rules for teachers and students in a teaching-learning environment. Relationships within a discourse are defined as framing and refer to the rules of the pedagogic communication that provides the realisation rules for the production of messages. Varying strengths of classification and framing generate different modalities of the pedagogical discourses and can be viewed as variations of educational power in the processes through which legitimate meanings are generated, distributed and reproduced. Analysing the code modality makes it possible to understand different principles of pedagogic transmission/acquisition, their generating contexts and even change (Bernstein, 2003).
strong classification and framing is characterized by teacher control over the selection of subject content, what the basic messages are and how it should be understood, who is allowed to speak and when and what classroom activities are legitimate for transmission (Beach, 1997; Bernstein, 2000).

The concepts of code and modalities describe how the pedagogical discourse is realised but to understand how the pedagogical discourse is constructed, what is transmitted, the analysis must proceed by analyzing the pedagogic discourse in terms of what knowledge forms and knowledge structures they represent. The relations of power in combination with an understanding of the forms the different discourses represent could be used to understand how reproduction and the legitimating of meanings about teaching and learning in mathematics are acquired by student teachers (Bernstein, 1999, 2000). Bernstein (2000, pp 157-159) distinguishes between two fundamental forms of discourse’ arising out of forms of knowledge usually typified as everyday, commonsense knowledge and school knowledge.

The discourse arising from common-sense knowledge is a horizontal discourse. This discourse 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. This common-sense knowledge is likely to be oral, local, context dependent and specific, tacit, multi-layered, and contradictory across but not within contexts. Another essential feature is that the knowledge contained in a horizontal discourse is segmentally organized, which entails that the knowledge is transmitted tacitly within the context of performance by means of modelling and showing and that the acquisition is also likely to be segmental and context specific (Bernstein, 1999, 2000).

Vertical discourse, arising from school knowledge, has its origin in official institutions and takes the form of a coherent, explicit, and systematically principled and hierarchically organized knowledge structure (as in the natural sciences) (Bernstein gives physics as an example) or a horizontal knowledge structure with a grammar and robust conceptual system (syntax) that is used to describe and model empirical situations, as with the series ‘of specialized languages with specialized modes of interrogation and specialized criteria for the production and circulation of texts’ in the social sciences and humanities. Circulation of knowledge contained in a vertical discourse is generally accomplished through recontextualisation affecting distribution in terms of time, space and agents, and is characterized by strong distributive rules regulating access, transmission and evaluation (Bernstein, 2000).
The distinction between vertical and horizontal discourse described above 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 directly and inextricably linked to a material base and is therefore powerful in dealing with immediate concrete situation in specific contexts but is limited as being unable to transcend to different contexts. On the other hand, 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 meanings that make it easier to select relevant knowledge in unfamiliar contexts or to engage in critical enquiry. This is one of the main reasons why it is meant to be included as subject theory knowledge in teacher education (Regeringens proposition 1999/2000:135, 2000; SOU 2008:109, 2008). Bernstein calls this indirectness of the vertical discourse the ‘distance’ between this discourse and the ‘real world’. It is often considered to be a problem by teachers, and by student teachers in particular, who talk about the problem of coupling the general principles expressed in and by university content to what teachers do as professionals in the schools they work in (also Beach, 1995, 1997, 2000). However, Bernstein regards this distance not as a weakness but as strength. It is 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 is the crucial site of the yet to be thought.

A deeper understanding of mathematics and teaching and learning of mathematics is, building on Bernstein’s analysis, student teachers need to access to a vertical discourse because it can provide them with mechanisms for generating new knowledge beyond specific and isolated contexts and content. Horizontal discourses reduce student access to important forms of knowledge by which they can challenge tradition and the status quo. Again, these are principle reasons behind the inclusion of subject theory content accordingly to formal police texts (Regeringens proposition 1999/2000:135, 2000; SOU 2008:109, 2008).

**Method**

Ethnographic methods including observational fieldwork, and interviews were used. Ethnography is grounded in participation in the context of social action and involves the study of and interaction with people in their everyday activities. The empirical material in this study was drawn from first-hand experience on the basis of participant observation in the social setting. They consisted of teacher-learning environments in the frame of a mathematical course in teacher education. Data was collected using field notes in combination with a digital sound recorder. Interviews were conducted in order to gain deeper understanding of social life and
personal experiences. The ambition with the study was to listen to, take part in and in other ways observe and becoming involved with the 'structuration' of the learning environment of mathematics education.

An important aspect of social ethnographic research in general, and for this study in particular, is 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 is about reflection at fundamental, methodological and interpersonal levels. These influence all choices that I make during research and thus also affect the results. Reflexivity aims to provide a basis of rigour in ethnography, an essential aspect of its validity.

**Analysis**

The data for the present investigation has been developed and analysed with the ambition to meet the three main design principles for ethnography identified by Bob Jeffrey, Geoffrey Troman and Dennis Beach to help shape guidelines for research² (Jeffrey & Troman, 2004).

In this study, as in many other ethnographic research studies, descriptions, theories, data production and analysis were intertwined with each other. The aim was to find patterns in the material that could be used to understand what has happened and why, and the process could be viewed as an interactive process between the researcher, the collected material and theory (Trondman, 2008). It involves a continuing shift between induction, deduction and abduction.

² These ethnographic principles are: 1. Ethnography needs to take place over time to allow a fuller range of empirical situations to be observed and analysed and to allow for the emergence of contradictory behaviours and perspectives. (Time in the field, alongside time for analysis and interpretation, allows continuous reflections concerning the complexity of human contexts.) 2. Ethnographers need to consider relations between the appropriate cultural, political and social levels of the research site and the individual's and group's/community's agency at the research site. 3. Ethnographers need to include 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) develop new theory.
where described experiences are illuminated by theory and where theory in other cases is used to
discover new patterns in the registered experience. This means that theory is used in two
different ways, for teasing out patterns from the texture of everyday life and to signify the main
organizing features, principles or outcomes of education within contemporary society (Willis &
Trondman, 2002). Theory and the empirical data inform each other or as Trondman (2008)
describes it, if the ethnographic study is the heart, than theory is the blood. The embedded
empirical and the theoretically informed constitute two ‘unavoidables’ in ethnographic research.
“Blood really needs heart; heart needs blood (p.120)”. This course of action could be described
as iterative, reflexive and complex (Beach, 2010; Trondman, 2008; Willis & Trondman, 2002).

**Teaching-learning in mathematics**

This study has an interest in what people do, how they do it, under what conditions, why they do
it and what the consequences of these acts might be. What emerged during this study shows that
the dominating teaching model during lectures allows an un-reflective subject theory to dominate
student teachers experience. Beach has found similar relationships in studies conducted in the
frame of teacher education (Beach, 1997, 1999, 2000, 2008). The aim of the following section is
to represent the patterns I have found.

**Course literature**

The field of knowledge was objectified for the students by the course book, that played a central
role as a contextualizing base for the social practice of theory lectures (Dowling, 1998). The
book defines mathematics for the students. Participant observations showed that the course
book in many ways established what was counted as legitimate content in the course (Beach,
1995; Bernstein, 2003). For the teacher (Anders), it seemed to be what the course was all about:

> The aim of the course is the whole book…what’s in the book…then you
should learn more or less all of the different parts (Anders).

Both lectures and examinations were structured on top of the texts and the mathematical
problems in the book.

> …my intention is to start with limits today…on page 89. We have a problem
on that page…lets start to solve that problem (Anders).

The book also has a disciplining function in learning in subject theory. It defines for the learner
the amount of stuff that is to be absorbed, remembered and even recalled by them in
examinations (Beach, 1995). The body of knowledge that the book defines is extensive. This
gives rise to a constant lack of time, something which the teacher often used to excuse the high paced instruction and homework.

...there are a lot of things to do during next week so you have to practice at home...I write down some problems here...and you have to repeat logarithms, I don't have the time to repeat that part...and derivative...you have to look at that at home to (Anders).

The body of knowledge was objectified for the learners through the book and was presented to them as true facts that were never criticized by the teacher or by the students. The book seems to make possible what Bernstein pointed out as powerfully classified and framed teaching-learning practice. It both realizes and creates the classification, that is the voice of the subject, by both its forms and expressions. The form involves for example arithmetical symbols, set theoretical concepts for defining mathematical concepts, that contribute greatly to classification or specialisation of mathematical knowledge to a particular context (Bernstein, 2003; Dowling, 1998). This context is the maths class or lab. The activities engaged in there are highly technical and rarely occur outside this context.

**Pedagogic communication, classroom activity**

The lecture activities are mainly concerned with the transmission of mathematics defined by what is written in the course book (above). The following excerpt shows how subject theory lectures were constructed in terms of their classification and framing (Beach, 1995; Bernstein, 2003).

Anders (Teacher) : …lets look at this (writes on the board while he is talking $3^2 = 9$, $5^2 = 25$)… the square of odd numbers …what will the answer be?

Johan: odd?

Anders: Do you believe that...will it always result in an odd number? Two multiplied with one number $n$, if $n$ belongs to $Z$ (writes on the board as he speaks $2n = "even number" \ n \in Z$), will this always result in an even number?...could you picture that? /* silence...that for example three multiplied with two equals six, seven multiplied with two equals fourteen... */ no answer. Well..let` s look (writes $2(n+1)$)... $n+1$ is always odd isn’t it? /* silence...if we square an odd number (writes while he speaks $(2n+1)^2 = 4n^2 + 4n + 1 = 2(2n^2 + 2n) + 1$) ...I removed number two...what happens? We could name this $n$ (points at $2n^2 + 2n$) ..then this will equal (writes and talk $2n+1 \in Z$)... Now we have proved that an odd number
squared will result in an odd number and that number belongs to Z… any
questions /*/ silence … lets talk about divergence…

The teacher has control over selection of subject, sequencing and pacing. The character of the
teacher style could be described as: teacher talks, poses a question, makes a short pause, didn’t
seem to expect any answer. Sometime a short answer appeared from a student but most of the
time the teacher answered his own questions. The pacing was high and there was no obvious
time to think. As one of the students put it “…there is little time for this (thinking and
reflection) inside lesson time…it has to be done at home”.

Examination
The course examination can be described as a formal examination in the traditional sense, which
means that they are a written form of post-test in which students ability to reproduce
mathematical problems and concepts is examined. Examination is a form of control of whether
students have learned or understood what teacher has felt they should know (Beach, 1995). The
following conversation has been taken from the digital recorder:

Asta: I think you should tell us what you would bring up on the exam… The
exam is anyway only about checking us up… Actually you can’t measure
anything at all.
Anders: The intention with the exam is to measure some important issues. I
can’t tell which issues I am going to check because I want you to learn
everything in the book…
Asta: But I am only interested in passing the exam…if I learn something more
it is just a bonus for me…The only thing that really matters is to pass the
exam…that’s the only thing that’s counts in the end anyway…
Anders: You must understand why I cant tell you what to read in the book…if
I do you skip the rest and you only learn small pieces…the aim with the course
is to learn the whole book.

The excerpt above captures that the written examination has a disciplining effect on students
learning. To pass the exam is what the whole course is about. Students are forced to pass the
examination and this also seems to lead students to trying to seek examination knowledge from
their teacher. According to Beach (1995) this pressure to pass examinations has a potentially
vicious pacification effect that excludes criticism and other voices essential to reflection.

It is also important to consider what is being tested exactly. According to the data in this study it
seems like the exam to be about reproduction of problems presented in the course book.
Learning mathematics became very much about learning to reproduce the solutions to problems presented in the book. These things are considered in the next section.

Construction of knowledge
Examining what’s going on in the classrooms during lectures not only tells us about how the pedagogical discourse is realised it also tells us how the pedagogical discourse is constructed and what is transmitted.

Anders: Is there any difference between functions and graphs? /*/ no answer I make a picture (writes two different system of coordinates on the board)…do you remember?…What is the difference? /*/ silence. What do you thing this one represent? (points to the graph)… is there any difference between them?…I mean in a mathematical way difference? /*/ silence.

Johan: …yes…it moves backward.

Anders: Backward?…There are three x-values in this one, but in this only one (points on the board). So what shall we write? (Reads the text load, as he writes it on the board) A function f(x) has for every x-value exactly one y-value. This means that x belongs to the domain and y to the range (writes \( x \in D_f, y \in R_f \) on the board)…

Michael: Domain?

Anders: Yes domain…do you understand the difference between graphs and function now? /*/ no one answers

The form of the discourse transmitted to the students during lectures is hierarchically structured with a specialised language in terms of time, space and actors, which according to Bernstein (2000) defines a vertical discourse. However the discourse received by the students seems to have another form. During lectures students and the teacher seem to agree upon the teachers right to control interaction, dominate talk and have control over selection of subject, but there is nothing in the data showing that students appropriate a vertical discourse themselves. In fact quite the opposite seems to occur. They are only subjected to this discourse not producers of it. This is also present when talking to students during interviews (below).

When it comes to learning mathematics students are urged to solve problems from the book. Problem solving is much about learning to handle strategies presented in the book or by the
teacher. Those strategies are even reproduced during the written exam. The following excerpts are pieces from interviews with the students about the course and the exam:

This (the exam) wasn’t about understanding, it was about doing…You never had the time…there was always something new…You don’t have time to think about how it worked or how you should solve the problems…You don’t have the time it was too much to learn (Bella).

It was only about rules…don’t even try to understand no one cares…you should know how to solve problems that’s all (Lotta).

The exam was very hard…I passed this time but if someone ask me to do it again I would never make it…If you succeed the first time you should be lucky…I could never do it again…and it was only two weeks ago (Johan).

The data above exemplifies arguments about learning mathematics that was indicated several times in data during the course. Students talked about learning mathematics as not having time to really learn something and mainly being about passing the exam by solving mathematical problems. Mathematical problems, which according to one of the students “will probably never need to be solved again after the examination”. These arguments represent four classic problems of learning in teaching-learning practices that are powerfully classified and framed:

- There is no time for reflection.
- It’s all about following rules.
- It seems to end in short-term learning.
- The content only is relevant in specific contexts (Bernstein, 2000).

Mathematical problems are presented in the course book in blocks of content, each of which is preceded by an example demonstrating a procedure that can be used. The teacher also demonstrated how to solve problems during lectures:

I will show you some examples from the book…there are many problems here…you have to practice at home…I will read from the book. (the teacher read out load one example about functions) …how do we solve this? /*/ no answer… lets start with a table… than you put in x-values… what do you get?.. (Anders writes on the board and poses questions that no one answers) …practice this at home. There are several problems of this kind in the book...(Anders).
Once again mathematics is constructed as a form of repetitive problem solving using strategies demonstrated by the teacher or by the book. The same structure exist in the upper secondary school (Beach, 1999, 2003). Students learn to handle these strategies to pass the exam and get their grades.

When students are leaving the context where this type of knowledge is constructed they seem to have difficulties in using it again and in using it for other purposes as well. Students’ knowledge is highly specific to a particular context in this sense and often has little relevance outside of this context. Mathematics takes in this way more the form of a horizontal discourse in that it is segmental, transmitted in the context of performance by means of modelling or showing, directed to the immediate goal, to solve the problem, and also seemed to be embedded in the on-going-practice of mathematics education (Bernstein, 2000; Thompson, 2009). The horizontal discourse is also the one student teachers seem to reproduce themselves in their teaching, with concomitant effects on their practices.

Dowling (1998) uses the terms proceduralizing and particularisation to describe how the use of examples and mathematical problems leads to fragmentation of mathematical knowledge. The notion of ‘coding’ mathematics into a percept or procedure by using examples and problems is defined with the term proceduralizing. Proceduralizing leads to particularisation of mathematical knowledge and renders the message to be more contexts dependent, the inverse are defined as principling. Exemplars are used to make mathematics more explicit. The problem here is that there seems to be no connection between the principled message and the particularized.

**Closing reflections**

In this paper the process of teaching and learning mathematics in teacher education have been observed and analysed using observational fieldwork, and interviews. Theories and foreshadowed problems in classroom practice framed the initial foci and gave direction to the study. For the following production and analysis of the material Bernstein’s theoretical concepts were used mainly in two different ways: for teasing out patterns from the texture of everyday life and to signify the main organizing features, principles or outcomes of education within teacher education (Beach, 2010; Trondman, 2008; Willis & Trondman, 2002). The analysis shows how teaching and learning of mathematics take form in lectures and how it might block the development of deeper understanding of mathematics and teaching and learning of mathematics, which is in line with Beach (1995, 1999, 2000), research on teacher education.
The course book constitutes the body of knowledge to which students are exposed to and seems to be the prism through which past and future interactions with the subject are refracted. This strictly classified knowledge is forced on the students. The constant lack of time and the rushed pace reinforced by timely reminders from the teacher about how much they have to learn for passing the examination seems to prevent students from considering content either critically or reflexively (Beach, 1995). Learning was focused on problem to be completed under time pressure resulting in students seeking to get the right answer instead of reflecting on and developing a systematically principled and hierarchically organized knowledge structure. This kind of learning is more focused on the knowledge products instead of production processes that could lead to developing a deeper knowledge (Dowling, 1998).

The mathematic knowledge that students are subjected to should according to the principles of inclusion of subject theory expressed in national policy, (Regeringens proposition 1999/2000:135, 2000; SOU 2008:109, 2008), take the form of a systematically principled and hierarchically organized knowledge structure. But in practice it doesn’t. It takes more the form of a horizontal discourse and can be characterised as segmental, and context specific. Moreover, because horizontal (tacit) knowledge is related not by integration of meanings but through the functional relations of segments or contexts to everyday life, it is generally transmitted tacitly, within the context of performance and by means of modelling or showing (Bernstein, 1999). There is a danger that both the knowledge to be transmitted and its pedagogy can become segmented if it alone predominates: i.e. fragmentation occurs. This can undermine professional development in understanding learning conditions they will meet in school such as understanding of subjects and student learning which will in turn leave them unprepared for consciously changing their practice.


