1. OUTLINE OF PROJECT AND CURRENT STATUS

Establishing coherence between theory and practice is one of the main problems in mathematics teacher education. In Denmark more than four out of ten student teachers experience a lack of coherence between the general education taking place at the university college and teaching practice in schools (Jensen et al., 2008). Throughout the last decades teacher education has become increasingly academic - which I find positive. Theories on pedagogy and learning are introduced in the general and common part of teacher education and in mathematics in particular didactical theories on the teaching and learning of mathematics are introduced.

However, the lack of coherence between theory and practice is a dominant in teacher education and it occurs in many ways. Bergsten and Grevholm (2005) point out two different didactical divides. The first divide is between the theoretical knowledge learned in the study of mathematics or pedagogy and the practice of mathematics teachers in school. Mathematics which is an academic subject mainly developed through research at the universities (but also in e.g. commercial and technical contexts), must be adapted to school mathematics suited for the particular age and aim. Student teachers will in most cases meet with both kinds of mathematics in teacher education, but it is absolutely essential for them to learn to transform from one to the other e.g. when they have to derive the mathematical points from teaching materials or elaborate concrete teaching from a national curriculum.

The second divide is between pedagogical and mathematical knowledge. Student teachers are supposed to combine their knowledge from the two diverse disciplines in common teacher knowledge usable for teaching practice where problems occur in varied, complex forms. Bergsten and Grevholm (ibid.) point out the lack of theory to unify these two kinds of knowledge in a common pedagogical content knowledge about teaching and learning mathematics in school. Without this unfixing theory teaching and communication in classroom often end up being instrumental.

Teacher knowledge - and ensuing practices of mathematics teachers - is a very complex matter. According to Schulman (1987) teacher knowledge is comprised of three separate strands:

- Subject matter knowledge (SMK). In this case mathematical knowledge.
• Pedagogical knowledge (PK).
• Pedagogical content knowledge (PCK).

At the universities the three strands are researched and taught separately and rarely combined. One of the main problems in mathematics teacher education is to establish coherence between the teacher knowledge taught in universities or teacher colleges and teaching practice. Preparatory lessons at the teachers college and teaching practice are often mentioned as one of the best opportunities to build a bridge between theory and practice but research is inconclusive on this matter (Bergsten et al., 2009, p. 60).

In Denmark, mathematics teacher education for primary and lower secondary school is located in university colleges and, as in most other countries, consists essentially of three key strands; mathematics, pedagogy and teaching practice. This is what Tato et al. (2009, p. 18) call concurrent preparation - a joint occurrence of the three strands.

Although, concurrent preparation - compared to consecutive preparation with three independent periods (ibid., p. 18) - is supposed to better enable the students to connect theory and practice, many student teachers in Denmark, as previously mentioned, still experience a lack of coherence between the general education located at university colleges and teaching practice.

Subject matter knowledge, pedagogical knowledge and pedagogical content knowledge are taught separately at university colleges but is in reality inextricably entwined with each other and therefore must be researched together (in practice). The main purpose of my project is to develop teaching and research methods where student teachers and teachers work together to develop mathematics teacher knowledge and practice in a Danish context.

I have just started my PhD project in August 2012. My first task is to write a paper to analyse national and international experiences and research results into learning from practice in mathematics teacher education based on the 15. ICMI study (Even and Ball, 2009). In particular, I’ll study and analyze the conditions for teaching practice in Danish teacher education including aims and relation to the rest of the education. The purpose with this paper is to formulate research questions in the present state of national and international knowledge of mathematical teachers’ teaching knowledge and to design models and tools to develop student teachers’ learning in and from teaching practice.
2. CENTRAL PROBLEMATIQUE

Inevitably, teachers learn through everyday teaching but their experiences are rarely shared with colleges or other professionals and the knowledge therefore remains individual (Skott, 2001). Lack of explicit knowledge about teacher practice complicates the transition from student teacher to in-service teacher (Winsløw, 2009) and makes the profession vulnerable to criticism (Stiegler og Hiebert, 2009).

The purpose of my project is to develop knowledge about how teacher knowledge and teaching practice can be developed in a Danish context. The basic idea is that teacher knowledge is simultaneously connected to teaching practice and teachers’ subject matter knowledge, pedagogical knowledge and pedagogical content knowledge. It is of crucial importance for teachers in mathematics to develop their teacher knowledge through a lifelong career and therefore teacher education must contain tools to learn in and from teaching practice.

It is a current research topic to identify conditions for teachers to learn in and from a mutual practice. This project will contribute to this topic by researching and developing tools, models and strategies to support student teachers’ learning in and from practice in Danish teacher education across mathematical themes, the age of schoolchildren and school cultures.

3. HOW/WHERE IN YOUR PROBLEMATIQUE DO YOU SEE AN OPPORTUNITY TO APPLY ONE OR MORE NOTIONS FROM THE ATD FRAMEWORK?

Since ATD is concerned with coherence between theory and practice and didactical and content knowledge, it is a valid idea to use it in my project. I consider using ATD as a theoretical framework for my research into how teaching practice can contribute to develop teachers’ knowledge of teaching mathematics and prepare him or her for lifelong learning together with colleagues and other presences in school.

As previously described, the aim of my project is to develop new knowledge about how teacher knowledge and teaching practice can be developed in a Danish context. My empirical research will be carried out in the mathematics lessons, the preparatory lessons at the teachers college and teaching practice. I consider applying both the notion of praxeology and didactic transposition in my study. This will be elaborated in the next section.
4. OUTLINE OF THE APPLICATION OF NOTIONS FROM ATD AND SUGGESTED OUTCOMES

My research will be into the coherence between student teachers’ theoretical studies in teacher education and teaching practice in the classroom using the notion *praxeology* and its division in the four-tuple *type of task, technique, technology and theory* (Winsløw, 2011, p. 124) in my study analysis. I’ll use the four-tuple as a tool to model, analyse and design blocks of teacher knowledge and teacher practice on an empirical basis. I find ATD’s division in practice and theory block highly suited for my research and analysis of the divide between academic and school mathematics. Similarly the divide between pedagogical and mathematical knowledge can be analyzed with the notions *mathematical and didactic organisations*; especially the interdependence of mathematical and didactical organisations is of crucial importance in my research. The point is that usable theory about mathematics teaching emerges through a complex interplay of teachers’ mathematical and didactical practice. It is vital to develop institutional possibilities for co-operation between teachers, especially at particular schools, to make sure that the emerged knowledge will be shared and not remains individual. One of the aims of my research is to establish a higher degree of coherence between theory and practice. In order to reach this goal it is necessary to design and establish learning communities that enable student teachers and teachers to try out, discuss and develop theories about teaching and learning in practice. Teachers must learn to develop teaching through a lifelong career and this starts during teacher education. In terms of Stigler and Hiebert:

*Teacher learning is the key to improve teaching. But not any kind of teacher learning will do. (...) Schools must become places where teachers, not just students learn”.* (Stigler and Hiebert, 2009, pp. 36-37).

My idea is to create different cooperation communities where student teachers, in-service teachers and, if convenient, teacher education teachers acquire common teacher knowledge based on common experiences with mathematical education explicitly and systematically planned on a well-founded hypothesis.

Second notion from ATD to apply is the didactic transposition. The didactic divide in mathematics content knowledge is to some extent similar to the didactic transposition. Student teachers must learn to adapt academic mathematics to school mathematics and to relate different concepts from school mathematics to academic concepts and with each other e.g. when they must state in detail the reasons for their teaching. I consider using the notion didactic transposition and the division in *external* and *internal* (Winsløw, 2011, p 121) transposition both in the theoretical and practical education of student teachers and in connection with description and analysis in my research, to help the students and myself understand this key-issue.
Next, I intend to work out tools or models for teaching practice to help the student to adapt academic mathematics to school mathematics in practice.

A crucial problem in mathematics teacher education is selection of mathematical content for teaching pupils - “knowledge to be taught” (Bosch and Gascón, 2006, p. 56). The “classical paradigm of visiting monuments of knowledge” (Chevallard, 2012, p. 3) where content is “sanctified by tradition” (ibid., p. 3) is questioned by pupils, parents, society and researchers and therefore teachers have to justify their choices of content. At first student teachers are supposed to read the curriculum but professional teacher knowledge includes a deeper understanding of why exact content is chosen. This problem can be analyzed with the notion didactic transposition. At first glance it might look as a problem determined by conditions and restrictions “immediately identifiable in the classroom; teacher’s and students’ knowledge, didactical material available, software, temporal organization, etc.”, (Bosch and Gascón, 2006, p. 61) but the main point in didactical transposition theory is, that selection of mathematical content is determined by institutional factors (ibid., p. 56, and Winsløw, 2011, p. 122) which includes both conditions and restriction inside and outside the classroom (Bosch and Gascón, 2006, p. 61). This cause a need for an analysis of the influence from factors outside the classroom on the selection of mathematical content e.g. school traditions and society norms. These conditions and restrictions can be analyzed and researched by applying Chevallards “scale of levels of determination” (Bosch and Gascón, 2006, p. 61) to justify, question and argue for or against a selected mathematical content.
5. REFERENCES


