Analysing the architecture and epistemological foundation of Boost for Mathematics – a PD program conducted by 37,000 mathematics teachers in Sweden

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TOPIC 3, Proposal for Research-based presentation

1. State-of-the art in Sweden

Since the publication of the Swedish Government Official Report (2004) from the Mathematics committee the 2000s have been marked by national attempts to increase students' results in mathematics by strengthening the quality of mathematics teaching through profession development. However, despite major initiatives the results have not improved (OECD 2015). The initiatives have been based on the pyramid model where multipliers at municipality level disseminating materials or by support to local projects through state funding. But changes in the Education Act have meant an increased focus on the scientific base of school practice, which in turn requires that the design of national initiatives to a greater extent makes use of research findings. During the years 2012–2016, 8 out of 10 mathematics teachers have participated in the Boost for Mathematics (BM) program, which is a (to a higher degree) research based professional development program. The Government has invested 65 million euro and the National Agency has conducted the BM program during four years in cooperation with National Centre for Mathematics Education (NCM) at Gothenburg University.

2. The Architecture of the Boost for Mathematics program

The National Agency and NCM interpreted the commission from the Government and developed a Program Declaration (Swedish National Agency of Education 2012) formulating two goals: to develop the *culture of teaching mathematics* and the *culture of professional development*. These goals form the architecture for the different parts of BM and are used by evaluators, in addition to investigating students' results. The goals are based on the difficulties to break the tradition of teaching practice, the socio-mathematical norms and didactic contracts (Cobb and Yackel 1996; Brousseau 1984; Jahnke, 2014), making students work alone on tasks using mostly imitative reasoning (Bergkvist 2014; Lither 2000). The goals also challenge the Swedish teachers' lonely work in planning, conducting and evaluating their own teaching and the tradition of individual based PD. The amount of collaboration between Swedish teachers in order to improve teaching is below OCED-average (Mullis et al. 2011). The goals were meant to put focus on collaboration between teachers in teaching and to develop new knowledge – aiming for strengthening the ability to form community of practices.

2.1. Building parts: teachers, group of teachers, math tutors, principals, PD programs and material

The content of the program focuses on pedagogical content knowledge (PCK) as an important form of teacher knowledge in relation to students' learning (Baumart et al. 2011). BM is based on collegial learning with external support of a math tutor and a web-based material. The program is conducted during one year at the teachers' school during their working day and consists of a cycle; individual reading and watching classrooms films; meeting with colleagues and the tutor to discuss articles/films and prepare a classroom activity; trying out the activity and meeting again to discuss the experienced consequences (Clark and Hollingsworth 2002; Hattie 2008).

This form and content depended on three parts playing the roles of both multipliers and facilitators, i.e. *math tutors, principals and the material*. BM involved 1700 math tutors, educators of math tutors from different universities and a PD program for math tutors. Special attention was given to the importance of principals as accountable for students' results (Day and Sammons, 2013; Leithwood and Riehl 2005; Stoll et al. 2006; Hattie 2008) and therefore a specially designed PD program for principals was conducted by NCM with 3000 participants. The material was developed by a peer-reviewed process of teacher educators from all universities in Sweden and after being launched, it was revised by collecting data from school visits. The material was structured in "modules" and closely related to different mathematical areas and school years in the national syllabus. For example, "Algebra, school year 1–3" forms a module. Every module discusses at least four pre-determined didactic perspectives; socio-mathematical norms, classrooms interactions, assessment and mathematical competencies. In addition to this, other perspectives were included as for example ICT or variation theory.

3. The epistemological foundation

On what theoretical landscape of knowledge is the architecture of BM built and lived? In research on the nature of knowledge Aristotle's categorization of knowledge (based on Nussbaum's interpretation, 1992) is often addressed as *episteme* (research-based knowledge), to know 'what', *techne* (skills), to know 'how' and *phronesis* (practical knowledge) to know 'when'. Practical knowledge is not to be regarded as applied theoretical knowledge and some aspects are tacit (Schön 1983; Polynai 1963). This has similarities to what Shulman (1986) called *strategic knowledge* as one part of PCK. Practical knowledge develops by reflection and action on experienced consequences in practice, but to raise the quality of reflection colleagues and theoretical knowledge is needed. Cnversely, to reach conceptual understanding of new theories and concepts, experiences in working life can concretize abstract theories. In this way, practical and theoretical knowledge can support each other. BM is making use of an integrating strategy, mixing formal and in-formal learning and supporting an enabling learning environment, which in research on competence development in a wider range of organisations, including industries, is showed to be the most successful combination in terms of learning outcomes (Ellström and Kock 2011).

4. Analysing the correspondence between the architecture and the epistemological foundation

As a researcher of professional praxis and as a project leader of NCM's work with BM for four years, I will in my proposed paper critically analyse the architecture, the epistemological foundation and the correspondence evolved during four years of upscaling, which resulted in reaching 37,000 teachers. My analysis will involve discussing questions like: Climbing on top of the buildings of BM, do the resulting buildings fit the epistemological landscape? Are the foundations of the buildings stable or unstable? Do some buildings tilt? Or, standing on the top of the resulting constructions, does this give us a new perspective on the chosen and developed epistemological landscape?

Analysing the correspondence will give us a deeper understanding of the reasons behind the construction of BM. For example, the perspective on knowledge implies that you need to have relevant experiences to reflect on and therefore all the PD programs for teachers, tutors and principals run parallel in time, making it possible to "Learn to Do by Knowing and to Know by Doing" (Dewey, 1889, p. 1).

Analysing the correspondence will also give us a means to reach a deeper understanding of the positive short-term effects and the shortcomings highlighted by the evaluations so far conducted by Ramböll Management Consulting and Umeå University. Above all I will discuss the risks of no sustainable long-term effects despite a research-based and well-funded project (McKinsey & Co 2006). I will also suggest how to empirically study a large professional development program using narrative inquiry (Craig 2007) in order to capture, analyse and represent teachers', math tutors' or principals' knowledge and experience developed during a major PD program.

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