EXTERNAL, INTERNAL AND COLLABORATIVE THEORIES OF MATHEMATICS TEACHER EDUCATION

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Theories about mathematics teacher education depend critically on how one responds to questions such as: What is the nature of teacher knowledge? And how is such knowledge to be appraised? By the external views of the researcher, by the internal views of the teacher group, or by any other way? The external perspective of the researcher is able to mobilize important theoretical and empirical tools, however, this external perspective is often unable to grasp essential elements of the complexity of teacher knowledge, practice, and identity. Just capturing the views of teachers brings with it the concern that these views are often contradictory, assuming different values, orientations, and agendas from one teacher group to another, depending on grade level, school system, country, world region, and so forth. Another approach is to combine the experiences and perspectives of teachers and researchers. This paper explores the question of relevant theories in mathematics teacher education from all three perspectives.

In this paper I sketch some elements that I regard as important to understand teacher education and to develop theories about it. These include how we regard (i) teachers and their activity; (ii) teacher education processes, including settings and contexts; and (iii) the researcher's perspective.

THEORETICAL PERSPECTIVES ABOUT THE TEACHER

Mathematics teacher education concerns developing teacher knowledge, teacher practice, and teacher identity. Therefore, theories about mathematics teacher education depend critically on how one responds to questions such as:

1. What is the nature of teacher knowledge? Is it declarative knowledge that we can assess by asking the teacher orally (e.g., interviewing) or on a written way (e.g., testing), or is it practical knowledge that must be noticed through the observation of the actual activity of the teacher?

2. How is such knowledge to be appraised? Is it by the external views of the researcher, by the internal views of the teacher group, or by any other way?

3. What is the relation between teacher knowledge and teacher practices? Are practices just framed by teacher knowledge, or are there other factors that have an essential role in framing teachers' practices?

4. How does teacher identity develop, how does it relate to teacher knowledge and practice?

Several responses are possible to these questions and the companion plenary paper by Ball et al. provides one model of teacher knowledge. Cognitive theory assumes (explicitly or implicitly) that knowledge and cognitive processes (such as knowing in action and problem solving) are the central elements that must be observed and understood to explain and to frame learning processes, including teacher education processes. For a long time, this was the dominant view about the teacher. Since the 1990s, however, we have witnessed the emergence of theories that emphasize social processes, such as social interactions between participants, communities of practice, and activity structures involving participants.

Research in mathematics teacher education has been strongly influenced by cognitive perspectives about the teacher, focusing, for example, on teachers' knowledge of mathematics, teachers' pedagogical content knowledge and teachers' beliefs and conceptions; more recently, social perspectives about cognition, including situated cognition, communities of practice, etc. are increasingly used as a lens to look at teachers (see, e.g., Ponte & Chapman, 2006). Open issues in this matter, include: a) Are social perspectives, just by themselves, a sound base to frame teacher education, or it is necessary to combine cognitive and social theories? b) If we need to combine theories, how might this be done? Is teacher development well described by general principles about learning (either cognitive or social) or do we need specific theories about it?

THEORETICAL PERSPECTIVES ABOUT TEACHER EDUCATION PROCESSES, SETTINGS, AND CONTEXTS

Mathematics teacher education is a complex process that takes place in formal teacher education settings and in informal situations that involve the teacher but also other actors (such as teachers from the same and other subjects, students, parents, and school administrators), and that is related to the social and institutional features of the society and school system in which the teacher works.
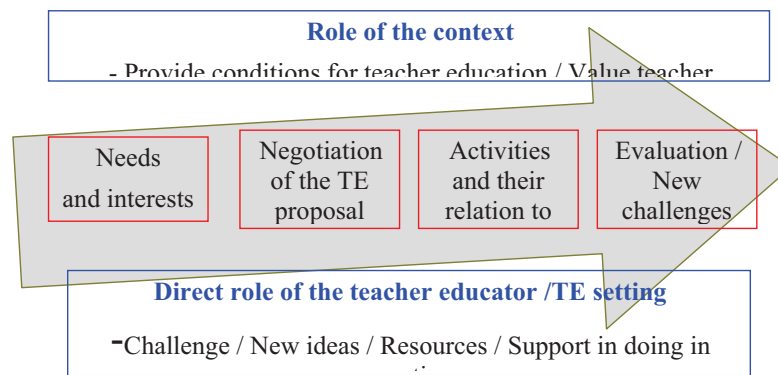
In fact, there are many elements that influence the teacher education process, either at pre- or in-service levels (see Ponte & Chapman, 2008). We must note that teachers' knowledge, teachers' practices and teachers' identity are at the centre of this process, but their development must be understood in reference to the collective identity of the professional community of teachers, including the established values and norms of the profession and the processes of professional interactions.

Elements that influence the nature of mathematics teacher education programs include, for example:

1. Teachers' characteristics, including their motives, interests, knowledge, beliefs, and conceptions.
2. The characteristics of teacher educators and of the other social actors related to the activity of the teacher.

3. Program features such as teaching approaches, purposes and objectives, curriculum and materials, assessment instruments and procedures, and their overall organization and pedagogical approach.
4. Sociocultural features of the society, including the roles and values promoted by government authorities, the media and the general public.
5. Organization of the educational system, including processes related to teachers' careers (such as recruiting and inducting into the profession, certification, contracts, promotions) and to the curriculum and evaluation system.
6. Research, including its emphases, values, priorities, and ways of disseminating results.

Teacher education, either carried out as formal processes, or just induced by informal settings, therefore, requires careful design (Loucks-Horsley, Hewson, Love & Stiles, 1998). In designing such a teacher education process, we assume an underlying theory about the needs and interests of the teachers and about the activities that they will perform to promote such development. Such activity is framed by an initial negotiation and a final evaluation that may involve the identification of new challenges. Also critical are the roles of the context and the direct and indirect contributions of teacher educators.

Role of the context

- Provide conditions for teacher education / Value teacher

| Needs and interests | Negotiation of the TE proposal | Activities and their relation to | Evaluation / New challenges |

Direct role of the teacher educator /TE setting

-Challenge / New ideas / Resources / Support in doing in

Indirect contribution of the teacher educator

Perspective about how the teacher learns, about the role of practice, reflection, collaboration, professional projects, etc.

At the core of the design of the teacher education process is a view about the relationship between theory and practice, concerning how teachers learn or develop professionally: a) Do they learn directly from practice, whether it is the practice of a mentor or of a more experienced teacher, or their own practice, with no explicit role for theory? This is the "pedagogical tradition" that informed teacher normal schools in the XIX century, and well as some views of teacher education as apprenticeship; b) Do teachers first learn theory, to apply later in practice? This is the "modern" or

"technical rational" view, still prevalent today in most pre-service and in-service teacher education courses; or, c) Do they learn theory and practice, in some combination, using theory to question practice and using practice to identify and understand empowering theory? This is an emerging "inquiry tradition", which receives currently wide support among mathematics teacher educators (Lampert & Ball, 1998; Llinares & Krainer, 2006) and is the subject of the accompanying plenary panel paper by Jaworski.

Questions to consider on this matter include, for example: a) Is there a role for each perspective, related to some kind of objectives, in some specific contexts? b) What hinders a wider dissemination of the inquiry perspective? And, c) What may be specific to designing *mathematics* teacher education processes?

THE RESEARCH PERSPECTIVE

Another dimension in which theories of teacher education differ concerns the relationship that the researcher has with the teacher education process. Is the researcher an agent external to the teacher education process that just analyses it from the outside? Is the researcher someone that tries to study the perspectives of the participating teachers, from their point of view? Is the researcher someone that studies the process essentially from the point of view of the teacher educator?

1. The researcher that adopts an external perspective is able to describe many important aspects of teaching that may be of interest to different social groups (and politicians). However, this external perspective is often unable to grasp essential elements of the complexity of teacher knowledge, practice, and identity. In some cases, it produces results that are unhelpful to support teacher development, reinforcing the view of the "deficient" teacher, so common in the research literature.

2. Capturing the views of teachers may reveal the reason why participants do what they do, showing that they are rational actors. However, teachers' views are often contradictory, assuming different values, orientations, and agendas from one teacher group to another, depending on grade level, school system, country, world region, and so forth. Inside a single school there are often teachers with opposite views and practices in relation to essential issues of curriculum, teaching and learning. As a consequence, knowing teachers' perspectives is essential to frame teacher education, but it is not enough to design it.

3. Another approach is combining the experiences and perspectives of teachers and researchers. This can be achieved in a variety of ways – educating teachers to act as researchers, letting researchers teach in elementary and secondary schools, or promoting collaborative projects involving teachers and researchers (Jaworski, 2004). To study the intricacies of teacher knowledge, practice, teachers by themselves, as it enables each one to bring their own expertise to shed light in very complex issues. Such an approach has its own problems: Who sets the agenda? How are activities negotiated? What happens to the knowledge generated? Does it have a real effect on