

THE LEARNING AND DEVELOPMENT OF MATHEMATICS TEACHERS AND MATHEMATICS TEACHER EDUCATORS: FROM THERE TO HERE TO WHERE?

MERRILYN GOOS

I cannot recall when I first saw Laurinda Brown at a mathematics education conference, but I do remember very clearly the first time we had a conversation and discovered our mutual research interests. That conversation, at the 2005 PME conference in Melbourne, Australia, led to a series of collaborations that helped shape my research endeavours over subsequent years. In this paper I will sketch out how I moved ‘from there to here to where?’ by first presenting a theoretical map of my research program on the learning and development of mathematics teachers and mathematics teacher educators, then outlining the chronology of my professional relationship with Laurinda, and finally weaving these two strands together to show Laurinda’s influence on my thinking—past, present and future.

Mapping a research program

A few years ago, I started to create a schematic representation (shown in Figure 1) of the ways in which I was thinking about two questions in mathematics education: how are opportunities to learn created and who has opportunities to learn (Goos, 2012)? At that time, I had investigated the learning of both students and teachers of mathematics (represented in the top half of Figure 1), from two perspectives drawing on community of practice and zone theories. I was also starting to think about future research that would extend these theoretical ideas into new contexts involving mathematics teacher educators, including university mathematicians who taught future teachers in initial teacher education programs (represented in the bottom half of Figure 1).

I now refer to these two theoretical perspectives as the *practice perspective* and the *change perspective*. The practice perspective draws on Wenger’s (1998) ideas about learning within communities of practice as well as at the boundaries between communities. I am interested in boundary practices that permit members of different communities to coordinate their differing perspectives and possibly to create new knowledge and new identities from negotiating the discontinuities between their communities (as suggested by Akkerman & Bakker, 2011). The change perspective, on the other hand, draws on Vygotsky’s notion of the zone of proximal development (ZPD) as the symbolic space within which

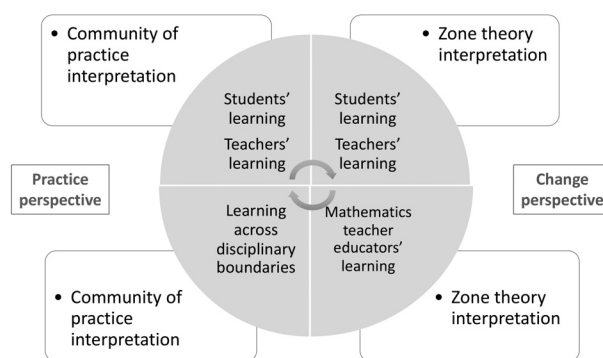


Figure 1. Theoretical map of a research program investigating opportunities to learn in mathematics.

learners’ minds are roused to life, and his advocacy for a genetic or developmental method that studies the processes of growth and change. I had also come across Valsiner’s (1997) zone theory of child development, which built on Vygotsky’s ZPD but seemed to offer new insights into learning as a process of change in which individuals negotiate relationships with their environment and the people in it.

I will use these theoretical ideas to reflect on my evolving professional relationship with Laurinda, and how she is located within this landscape.

Chronology of a professional relationship

I think about this chronology of my professional relationship with Laurinda in three stages, which I have labelled First Contact, Apprenticeship and Identity. I can see that these labels could also be applied to my relationship with my doctoral supervisors as I worked towards establishing an independent research program, although the specific details differ in the two cases. But the overall similarities suggest that my labels might be useful to other developing researchers.

First contact

In 2005 I attended my first PME conference as a relatively recent PhD graduate. This was one of the first papers I had

written using zone theory, and my research interests were shifting from students' learning of mathematics towards mathematics teachers' learning and development. Laurinda was already in the room where I was to present the paper—she had sought me out because she wanted to talk to me about a paper from my doctoral study, in which I analysed how a secondary school mathematics teacher created a classroom community of mathematical inquiry (Goos, 2004). In my conversation with Laurinda it was significant for me to be able to give this teacher his real name—Vince Geiger—and to recognise his accomplishments without feeling that I had compromised any ethical standards for the conduct of research. In this study I had worked within the practice perspective on opportunities to learn, so that student learning was conceptualised as increasing participation in the practices of a classroom community of inquiry. But my main focus was on what specific actions the *teacher* should take to foster student participation.

I explained to Laurinda how this researcher-teacher relationship had evolved over time, and what Vince and I had learned about ourselves as we negotiated our membership of the communities of researchers and teachers. My story resonated with Laurinda's own experience in working with teachers, especially Alf Coles, who at that time was a secondary school mathematics teacher in England. In her capacity as Editor of FLM, Laurinda invited me to write a conversation piece with Vince about our collaboration. We did so, drawing on a real conversation that we audio-recorded and analysed for this specific purpose (Goos & Geiger, 2006). In that paper, we wrote about how we were moving back and forth between two mathematics education research communities: my own world was made up of university academics "who do formal research defined by rigorous methodologies and well-articulated theory" (p. 39), and Vince's world comprised of school teachers "whose research is more like practical inquiry about what works with their students" (p. 39). Writing this piece shifted my thinking about learning as practice into a new domain—away from the school classroom, towards the broader community/ies of research inhabited by teachers and university academics.

My first contact with Laurinda thus sparked a new line of thinking for me, about how researchers and teachers could work together to create knowledge as a form of practical wisdom that could be shared between and used by both communities.

Apprenticeship

In 2006, my emerging interest in researcher-teacher collaboration was further cultivated by a PME Research Forum on teachers working with university academics. The following year, Jarmila Novotna invited me to join her in organising a PME Working Session on the same theme, with Laurinda as a participant. Together the three of us organised another two PME Working Sessions. The final Working Session led to a double special issue of the *Journal of Mathematics Teacher Education* (Volumes 13(5) and 13(6), published in 2010), guest edited by Laurinda, on the topic of mathematics teacher and mathematics teacher educator change. To create

this special issue Laurinda assembled an editorial group comprising three teacher/teacher educator 'pairs': herself and Alf, David Reid and Vicki Zack, and myself and Vince.

The experience of working with Laurinda and other long-standing PME participants introduced me to the various group activities of PME conferences and to other researchers who shared the same interests. I now think of these interactions as a series of generational encounters between old-timers like Laurinda and newcomers like myself. According to Wenger (1998), these encounters between generations are not only the mechanism by which communities of practice are maintained over time, but also "the aspect of practice that is most often understood as learning" (p. 99). My apprenticeship within this community had afforded me a modified form of participation, somewhat on the periphery because I was not in the role of Working Session leader or Special Issue editor, but still being granted enough legitimacy to be treated as someone who could become a competent member.

The series of PME activities led me to start thinking about and theorising researcher-teacher relationships and mathematics teacher educators' learning. The latter interest was partially stimulated by the difficulty that authors had experienced in meeting the *JMTE* special issue requirement that papers should include critical reflective accounts of the learning/development/change of the teacher educator/ researchers themselves as a consequence of researching with teachers.

Identity

In 2009 I visited Laurinda at the University of Bristol. We talked about my growing interest in extending my theoretical ideas using zone theory to explore the learning and development of mathematics teacher educator-researchers, and she suggested that we could propose a new PME Discussion Group on this topic. We wrote the proposal during my visit—and for the first time, I was the first-named organiser. We also invited Olive Chapman and Jarmila Novotna to join us, and this new collaboration led to a series of group activities at three successive PME conferences. It felt like I was moving from the periphery to the centre of this community of researchers.

I have labelled this phase 'Identity' for two reasons; I was forging a new research identity for myself, with Laurinda's encouragement, and I was also interested in using the practice and change perspectives on opportunities to learn to explore theories of identity formation in mathematics teachers and mathematics teacher educators. Since my 2009 visit with Laurinda, I have continued to elaborate on this theoretical work in the context of mathematics teacher educator learning and development represented by the bottom half of the diagram in Figure 1. From the practice perspective, I have worked with colleagues to develop an account of interdisciplinary boundary practices that stimulate collaboration between mathematicians and mathematics educators who teach in initial teacher education programs (Goos & Bennison, 2018a). From the change perspective, my colleagues and I have used zone theory to examine the extent to which mathematics teacher educators are able to exercise agency within their professional environments (Goos & Bennison, 2018b).

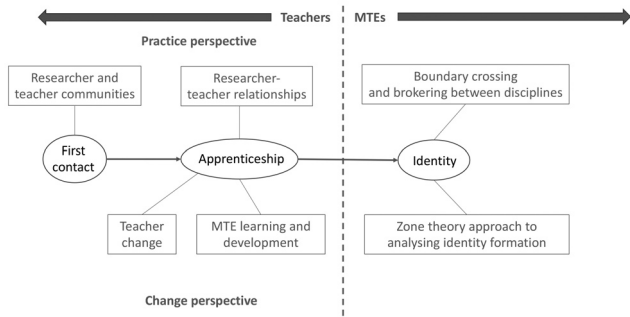


Figure 2. A web of collaborations.

Laurinda’s willingness to support me in investigating mathematics teacher educators’ learning opened up new spaces for collaboration as well as new roles. We have now worked together as PME group leaders, editors and authors in each other’s journal special issues and research volumes, and we have introduced other colleagues to the research on mathematics teacher and teacher educator learning/development/change. This rich web of collaboration has helped me to further my own theoretical interests, as the next section explains.

From there to here to where?

Figure 2 attempts to unite the previous sections to show how my collaborations with Laurinda generated ideas from both the practice and change theoretical perspectives. It also marks out my own shift in interest from teachers’ to teacher educators’ learning and development.

I now want to zoom in on the change perspective to help me think how Laurinda has influenced my own learning.

The change perspective is concerned with how to create relationships between individuals and their environments that foster learning. Over several years I adapted Valsiner’s (1997) zone theory of child development to investigate these relationships in the context of students’ and teachers’ learning. Valsiner regarded the zone of proximal development (ZPD) as a set of possibilities for development that are coming into being as individuals negotiate their relationships with the learning environment and the people in that environment. For a school student, the learning environment is the mathematics classroom and the people in the environment are the teacher and fellow students. Valsiner also proposed the existence of two other zones to explain development (Figure 3). The first of these additional zones he referred to as the ‘zone of free movement’ (ZFM), representing environmental constraints that may either hinder or enable access to particular areas or resources or ways of acting with resources. For a school student, the ZFM is equivalent to what the learning environment *allows*. The second additional zone is the ‘zone of promoted action’ (ZPA), which represents the activities, objects, or areas of the environment in respect of which an individual’s actions are promoted. For a school student, then, the ZPA is equivalent to what the teacher *promotes*, in terms of interactions with the environment or other learners. An interesting point to note is that the environment might not seem to allow what the teacher is promoting.

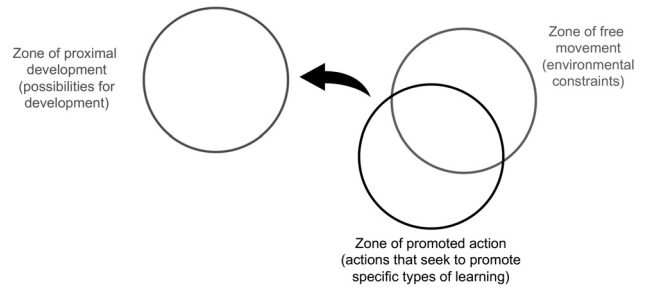


Figure 3. Zone theory interpretation of learning.

The ZFM and ZPA are inter-related and form a ZFM/ZPA complex that directs learners’ development along a set of possible pathways. An important feature of zone theory is that it allows for learners’ *agency* in changing their environments or their relationships with people in the environment in order to achieve their emerging goals.

Initially the literature on applying zone theory to understand opportunities to learn in mathematics education defined the ZPD from the student’s perspective, so the ZFM represents the classroom environment and the ZPA the actions of the teacher to promote the students’ learning. I call this the student-as-learner approach, or SasL (see Figure 4). However, in my own research I introduced the possibility of defining the ZPD from the perspective of the teacher-as-learner (or TasL, see Figure 4). Here, the ZFM represents the teacher’s professional context with all its constraints, and the ZPA can be provided by a teacher educator—so now the ZPD is defined from the teacher’s perspective. This has proven to be a fruitful approach to exploring how tensions between teachers’ beliefs, contexts, and goals can be a trigger for their learning.

In my most recent work I have imagined a third layer with the mathematics teacher educator as the learner (marked as TEasL in Figure 4). Of course, we would need to decide who is included within the definition of ‘mathematics teacher educator’—for example, it could mean a university-based education or mathematics academic, a school teacher who supervises a pre-service teacher’s practicum placement, a professional development consultant, or a teacher who offers workshops at CPD conferences. So far I have chosen to focus on university academics (both mathematicians and

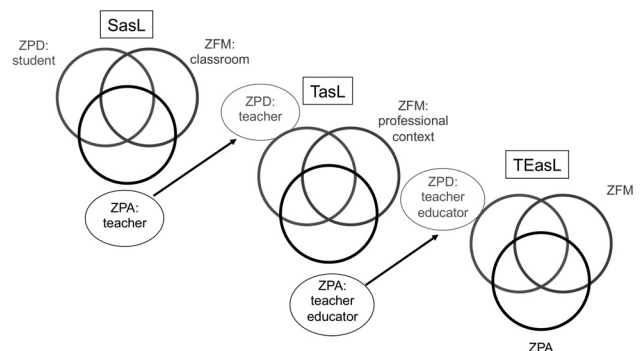


Figure 4. Zone theory in three layers: student, teacher, teacher educator.

mathematics educators) whose responsibilities include preparing future teachers of mathematics. The ZPD is now defined from the perspective of the teacher educator.

Instead of treating these three zone systems as separate entities, I see them as forming the nested layers shown in Figure 4. In each layer, the ZPD of the learner—whether that learner is a school student, a teacher, or a teacher educator—is shaped by what the environment allows (the ZFM) and the activities or objects in respect of which the learner’s actions are promoted (the ZPA). The links between the layers arise because individuals can be teachers in one context (providing a ZPA for their learners) and learners in another context (experiencing a ZPD shaping their own possibilities for development).

For a school student, the ZPD arises from what the classroom environment allows (ZFM) and the activities or objects promoted by the teacher in that environment (ZPA). For a teacher who is participating in a professional development course delivered by a teacher educator, the ZPD arises from what the course environment allows (ZFM) and the activities or objects promoted by the teacher educator (ZPA). By extending the nested zone system to a third layer, we could say that, for a teacher educator, the ZPD arises from what their learning environment allows (ZFM) and the activities or objects promoted by people within that environment (ZPA). The question then arises as to how we can interpret the meaning of the zones of proximal development, free movement and promoted action for mathematics teacher educators.

If we persist with the change perspective represented by zone theory, we must admit that we seem to know very little about the structure of mathematics teacher educators’ zones of free movement and how these enable or hinder innovative teacher education practices and professional growth of teacher educators. For example, what is the effect of local and national education policy environments on initial teacher education? How do such contextual factors differ across nations and cultures? There is also scope for systematically mapping out variations in the zones of promoted action available to mathematics teacher educators, beyond those created through reflection on one’s own practice or

research with teachers—which appear to be the most commonly discussed opportunities for learning (Beswick & Goos, 2018). What formal professional development opportunities are available to mathematics teacher educators in different countries? What assumptions about the mathematics teacher educator role and the preparation for this role underpin such opportunities? What are the different pathways into becoming a mathematics teacher educator, and how and why do these vary across contexts?

Zooming in ever further on the question of what ZPAs are available to mathematics teacher educators allows me to locate Laurinda in this theoretical landscape. She has been part of my zone of promoted action, creating opportunities for me to learn but also to exercise agency in deciding what opportunities I take up in forming my identity as a mathematics teacher educator-researcher. This research remains a work in progress, just as the work of identity formation is a never-ending process of becoming.

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