Social practice theory and mathematics teacher education:

A conversation between theory and practice[1]

Jill Adler

By way of introduction

In her presentation and paper, Jere Confrey articulated the agenda for the conference through three central questions.

- How do we (mathematics educators) currently understand and use our theory and what do we find compelling about it?

- How have we modified our theory as it is applied to an increasing number of sites of practice?

- How do we relate our theory to other theories, and how do these influence our own theory?

She presented a snapshot of the history of mathematics education research, which depicted a movement from questions and methods focused on mathematics, moving outward towards learning, teaching, and teacher education on the one hand, and from the classroom to the curriculum, the school, and the wider society on the other. We can describe this historical trajectory as moving from the micro out to the macro. Jere then interrogated "constructivism" as a theory, asking whether it continues to be a powerful tool in, for and across complex sites of mathematics education practice.

As a relative latecomer to the academy, having spent many years in anti-apartheid education outside of the University, my own work in mathematics education research has had an opposite trajectory to that described by Jere. My starting point was and remains a "problem in the world". In the late 1980s in South Africa, the overarching issue for me in

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mathematics education was the structural inequality produced in and through Apartheid education. Access to and success in mathematical learning in school was grossly unequal, predominantly along racial lines. Social structure, politics, ideology in education and the tension between the development of South African society on the one hand and its democratisation on the other were constant themes in my work. It is this history that accounts for my foregrounding social theories of knowing, and of learning and teaching, as key in mathematics education research. My concern has always been to be able to interpret what is happening in particular mathematics classrooms, or with particular learners, or teachers, in relation to the wider socio-political and economic context. As South Africa changes, and so too the work of mathematics education, the inter-relationship of the macro and micro in educational research becomes ever more important to understand and unravel. Hence the pertinence of the questions for this conference.

My purposes

My central purpose in this paper is to engage with 'social practice theory' and specifically Lave (1991) and Lave & Wenger's (1991) approach to learning as increasing participation in communities of practice[2]. I will do this primarily through reflection on a mathematics teacher education research project in South Africa and in this way bring theory and practice to bear on each other. In this process, I will raise for discussion a number of issues that persist for me when social practice theory becomes my focus of attention.

While engagement with social practice theory is my central purpose, and, as already hinted at, theory per se is never my starting point as I engage in my work in mathematics education research and teacher education, my starting points are rather "problems" in the world. Theories are necessary tools for interrogating, acting on and coming to understanding such problems. In Lave's terms, starting points or motivations for learning through participation in a community of practice reside in "central dilemmas" in the practice (1990). Herein resides my selected reflection on teacher education in this paper. The current

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[2] Since Lave & Wenger's seminal work published in 1991, Etienne Wenger has taken further a number of the issues I will raise in this paper. He has developed an extended theory of learning through social practice, and published this recently (1998) in a book entitled *Communities of practice: Learning, meaning and identity*. Cambridge: Cambridge University Press. I refer, where appropriate, to Wenger's work. My focus of attention in this paper remains within Lave's work, as it is her work that has already taken root in the mathematics education research community.

"problem" that drives my work in teacher education is describing and explaining teachers' knowledgeability: how it is constituted in and constitutive of moments of practice; how it changes over time; and how it shapes and is shaped by professional development programmes. I use the concept of "knowledgeability" to capture and produce a dynamic and situated notion of learning, of coming to know about teaching. I do this because of a deep concern ("central dilemma") with what I feel is a deficit discourse unintentionally produced within current teacher professional development research and practice. In the light of curriculum innovations and reform in mathematics education across contexts, and in the apartheid education aftermath, teachers are acknowledged as key to innovation and change, but somehow lacking. There is an inevitable pointing to what it is teachers currently in practice do not know or cannot do, and inevitable disappointment as implementation of reform takes its own shape, as it must, in the complex context of diverse school mathematics classrooms. Knowledgeability contains within it a sense of being knowledge-able. As a positive statement, I believe, it provides a conceptual tool that could assist us to shift away from a deficit discourse in teacher professional development.

I start my engagement with social practice theory from a point of view of learning as social, and of persons as constitutive of, and constituted by, their social, political, economic, cultural and historical contexts. Any interpretation of learning and knowing needs to take into account that *who* is learning, and *what* is being learnt are both always *situated* in a nexus of inter-related activities, processes and contexts – or what Wenger (1998) describes as a nexus of intersecting communities of practice. By way of a brief example, in my practice as a mathematics teacher educator, I attempt to be aware of how, in the teaching-learning process, teachers' interpretations of, and engagement with, a task that I present are never simply a function of some kind of decontextualised 'cognition'. Neither are they a simply a function of the (mathematical and/or educational) content and demands of the task. Teachers' engagement with the task and their productions are rather a function of a complex interplay of contingent conditions. These include the interests, values and goals each brings to the situation; how these interact with the context, content and demands of the particular task; what is or is not triggered for the teachers, and so what is challenged, extended and/or changed in relation to their (mathematical and other) learning histories; and the power relations between diverse teachers themselves and between the teachers and myself, their lecturer. Of course, it is impossible, in ongoing moments of practice, to be consciously attentive to, or indeed aware of, all these conditions and how they interact. As 'teacher' and

'assessor' of the teachers' learning, I nevertheless need to think carefully about what mathematical and/or mathematics education meanings are brought to bear on the task, why particular selections are made, and where and how the teaching-learning context is implicated. I also need to constantly reflect and act on the ways in which the teachers in any particular program themselves shape what it is that ultimately becomes the curriculum-in-use.

Situating my interest in social practice theory

The need to foreground the social and political in education was always obvious in the apartheid context of statutory inequality. Hence my attraction to Vygotsky's social theory of mind when I entered academic practice some ten years ago. In particular, Vygotsky's notion of speech as a key mediational means pushes us to consider carefully how mathematical meaning is shaped by talk (between teacher and learners and learners themselves) in the classroom. In particular, a Vygotskian perspective on learning and teaching in school made sense in the South African context where learners' mathematical histories were formed in apartheid education, and in multilingual settings. I will not discuss Vygotskian and socio-cultural theory further here – Stephen Lerman's paper does this in detail. Indeed, Steve's paper tells a story of how sociocultural theory has developed over time and in response to a deeper understanding of the social in learning and development. Sociocultural theory, as it is developing, continues to be a powerful means for interrogating mediation of mathematical learning in school.

I nevertheless started a romance with social practice theory during my study of teachers' knowledge of their practices in multilingual mathematics classrooms (Adler, 1996). I needed to work theoretically and empirically at two levels. I needed to 'observe' and theorise what teachers knew about their *teaching practices* in their multilingual classrooms. At the same time I needed to work theoretically and empirically with the object of that knowledge i.e. *mathematical learning in school*. As I have detailed elsewhere (Adler, 1998b), Lave & Wenger's theory of learning as increasing participation in a community of practice provided a set of conceptual tools that assisted me to interrogate 'knowing' about a practice like *mathematics teaching*. In relation to the mediation of mathematics, and how this took shape in multilingual classrooms, Lave & Wenger's conceptual framework, emerging as it does from apprenticing and not formal learning and teaching contexts, 'ran out'. I thus continued to draw on the powerful tools in Vygotskian theory, particularly his understanding of the nature and development of

scientific concepts and how these may be mediated in the school context. As I explained then:

> ... *[T]he notion of learning through participation in communities of practice appropriately and powerfully illuminates learning and knowledge about teaching. But a shift into school learning raises questions about what constitutes, in Lave and Wenger's terms, a community of practice and its resources, and hence about theorising the learning and knowing of mathematics in school within social practice theory. Social practice theory requires recontextualisation if it is to fully illuminate the complexity of learning and teaching school mathematics*
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> *(Adler, 1998b, 162-3)*

In my current work on teachers' take-up from formalised in-service professional development programmes, I continue to drawn on Lave and Lave & Wenger's work. In social practice theory, coming to know is never separate from becoming. Lave deals with knowledge and learning in a way that connects cognition and identity. How we act, our knowledgeability, in any situation is never simply a function of what is 'in' our heads at the time. Knowledgeability is a function of who we are with, where we are, what we are acting on and with and all the histories, emotions, social and power relations embedded in these inter-related aspects of being. What we call up and use in any situation is a complex interaction between previous learning experiences (including skills, information, values and ways of thinking) and how these may or may not be triggered and elaborated through a new situation and the social and power relations produced in it. This view of knowledgeability resonated with my many years of experience with mathematics teachers in professional development activity in South Africa. Lave & Wenger provide a network of concepts to elaborate participation in social practice. For example, in their terms, changing knowledgeability in a practice is a function of *talking within* (talking as part of doing), as well as *about* (reflecting on) the practice. Changing knowledgeability is further a function of the nature of the *resources* in the practice and the extent of their *transparency* - their simultaneous *visibility and invisibility* to participants. Together these concepts became pivotal tools for identifying, describing and explaining central dilemmas of teaching in the multilingual mathematics classroom (Adler, 1998a).

What I am pointing to here is that my turning to social practice theory was a function of my increasing involvement in *mathematics teacher education*. In social practice theory I found conceptual tools for working with teachers' learning about mathematics teaching, and so mathematics in relation to teaching. In the section that follows, I outline Lave and

Wenger's theory of learning as participation in social practice with my eye on teacher education. I am not claiming here a universalised theory that explains all learning. Lave & Wenger's theory of learning as participation was developed in and through contexts of apprenticeship. As I have already discussed, it does not easily and unproblematically apply to all learning contexts. In particular, their project of understanding learning by moving out of the school pushes them to dichotomise teaching and learning. Lave and Wenger argue for a learning as opposed to a teaching curriculum. Many in the field of education would now agree that teaching does not equal learning, that much of what teachers in school intend learners to learn is not learnt. Nevertheless, and I have argued this in more detail elsewhere, by splitting off learning from teaching, their conception of learning cannot easily extend to the complex teaching-learning situations constituted in schools (Adler, 1998b). I will return to this point later in the paper.

Learning as participation in social practice

Lave's conception of learning as deeply interwoven with becoming is captured in the quote below. She argues that learning should be regarded as

> *a social phenomenon constituted in the experienced, lived-in world, through legitimate peripheral participation in ongoing social practice; the process of changing knowledgeable skill is subsumed in processes of changing identity in and through membership in a community of practitioners; and mastery is an organizational, relational characteristic of communities of practice.*
> *(In Resnick, L., Levine, J. & Teasley, S., 1991, p. 64)*

It is through this elaborated and complex conception of learning that Lave & Wenger (1991) and Lave (1990, 1993, 1996) have had a significant impact on widening acceptance of learning as situated and fundamentally shaped by the social situations and the activities in which the learning occurs. Social practice theory has been instrumental in revealing the interdependence of activity, concept, culture and social relations. From this perspective, learning is not located in an isolated way in individual learners' heads. Nor is learning simply a result of intentional teaching, and restricted to interactions between teachers and learners. Learning is a function of learner histories and their changing identities on the one hand, and of participation in the practice through access to its resources, both material and social. Learning is bound into social relations and relations of power, in particular social practices. In contrast to dominant psychological views of learning, Lave's approach brings in the contextual and the historical.

Lave & Wenger, 1991	Lave, 1990, 1996
Learning is a function of **increasing participation** in **communities of practice** **Newcomers** enter the practice, engage with old-timers and resources in the practice and eventually themselves become **old-timers,** as they achieve **mastery** of the practice, and **fashion an identity** related to the practice	**Central dilemmas** in the practice **drive the learning curriculum**, and so too learning and identity e.g. a central dilemma for teachers in school is between teaching for 'results' and teaching for 'meaning'. In Lave's terms here, what teachers ultimately do in school mathematics classrooms is a function of how they deal with this dilemma.
Participation is constituted by • A **learning curriculum** (that which learners come to do). This is in contrast to a teaching curriculum (that which teachers intend learners to do). **Participation and becoming** involves • **learning to talk** in the manner of the practice, through **talking within and talking about** the practice • **access to resources** in the practice (its artifacts and social relations) is through their **transparency** - **the dual visibility and invisibility** of the resources in the practice When participation is blocked, and access denied, newcomers can be **sequestered** i.e. alienated from the practice	While a learning curriculum is distinguished from a teaching curriculum, Lave nevertheless identifies in the apprenticeship context, a **sequence of activities (and hence curriculum).** This sequence includes: • **observation by old-timers** • **practice by the apprentice, and** • **ongoing supervision.**

Table 1: A network of inter-connected concepts

I have argued more formally elsewhere (Adler, 1996; 1998b) that social practice theory, through its network of inter-related concepts, offers a powerful analytic framework for understanding 'learning to teach'. In other words, learning to teach is usefully understood as a process of

increasing participation in the practice of teaching, and through this participation, a process of becoming knowledgeable in and about teaching. I want to bring this approach to learning to bear on a research project focussed on 'teachers' learning to teach'. In an attempt to not do damage to the overall coherence of social practice theory it is important to keep a hold on key interacting concepts in Lave's and Lave & Wenger's work. I have listed these in Table 1, separating those that emerge in Lave & Wenger's *Situated learning: Legitimate peripheral participation* (1991), from others in Lave's earlier (1990) and subsequent work (1996).

Researching formalised in-service

In 1996, the University of the Witwatersrand introduced an in-service teacher development programme: the Further Diploma in Education (FDE) in Mathematics, Science and English Language Teaching. The FDE is a formalised in-service programme for teachers who have a three year post secondary school teaching diploma (what in South Africa is abbreviated as an "M + 3") and who wish to upgrade to an M + 4 qualification in one of three subject areas: Mathematics Teaching, Science Teaching or English Language Teaching. Under apartheid rule, most black teachers in South Africa qualified with an M + 3 through studies in segregated Colleges of Education. Most white teachers, particularly secondary teachers, completed a three-year degree followed by a one-year post-graduate diploma, and thus have an M + 4 qualification. Underscored here is the strong redress motivation in the FDE programme and its broader goals of quality and equity. More specifically, the goals of the programme are:

- to broaden and deepen teachers' subject knowledge, pedagogic subject knowledge and educational knowledge;

- to extend teachers' reflective capabilities;

- to facilitate professional growth (increasing participation and membership in professional activities, networking, associations, workshops, curriculum discussions);

- to enable access to further education.

These intentions were implemented through doing and reflecting, through opportunities for talking within and about the practice of teaching; and through access to a wide range of resources in the practice of teaching (other teachers, texts, teacher educators; teacher educators; policy makers etc.)

The FDE programme can be considered innovative in a number of ways. Firstly, it is a school-focussed, formal, in-service programme, leading to recognised certification. While it is run and accredited at a distance from schools and from teachers' classrooms, teachers' activity in the programme is focussed on school and classroom practice. Secondly, the programme and courses are built on three inter-related 'pillars' of teacher knowledge: subject knowledge, pedagogic subject knowledge and educational knowledge. Thirdly, it works across three subject areas (mathematics, science and English language), as well as across senior primary and secondary teachers, and teachers from rural and urban school settings. Finally, and this innovation separates the Wits FDE programme from a number of other FDE programme in South Africa, it is offered in mixed-mode: a combination of carefully produced distance learning materials and quarterly residential workshops. As Ellerton argues, teacher education through flexible and distance delivery modes offers potential advantages in addition to accessing 'remote' students. There are greater possibilities for a programme to link directly into teachers' professional practice, as they engage in the programme's activities 'on site'. Also, contrary to common sense assumptions, distance from the institution offering the programme enables the responsibility for professional growth to transfer to the teachers themselves (1999, p. 59). The team responsible for the development of the programme was excited by its innovative dimensions, and simultaneously determined from the outset to develop the programme through research. In 1996, a research project was launched with the aim of investigating teachers' 'take-up' from the FDE programme.

An underlying assumption in the programme and the research is an understanding of what we have called "the teacher in context". This is an assumption that teachers' changing knowledgeability (their participation in and take-up from the programme) needed to be located in a conception of knowing as tied to becoming in context. Data were collected in ten rural and urban, primary and secondary schools in which a selection of teachers from the 1996 cohort of FDE teachers was working. Each of the teachers in the sample was visited for one week in each of three successive years (25 teachers in 1996, 23 in 1997 and 18 in 1998, with the numbers changing as a few t eachers were transferred or dropped out of the programme or were working in contexts where schooling was disrupted. Nine of these were mathematics teachers). By 1998 most of the teachers had graduated from the programme. The data include transcribed interviews with each teacher for each of the three years, teacher narratives and responses to questionnaires, observation schedules

and notes from the lessons observed, videotapes of some of the lessons, examples of learners' work and selected testing of learners. Methodologically, while the research project has 'project evaluation' elements to it, it is more appropriately described as a practice-based (Lampert & Ball, 1998), case study of cases (Bassey, 1999). The FDE is the overall case, with the teachers constituting a collection of particular cases. The research aimed to learn from teachers' classroom practices (knowing-in-practice) about their practice, with the focus on the relationship between this practice and the practices in the FDE programme (Adler & Reed, 2000; Adler, Lelliott & Slonimsky et al 1997; Adler, Lelliott & Reed et al, 1998). We have attempted to see beyond the classroom in the classroom. In the language introduced at the beginning of the paper, we have attempted see the macro in the micro.

In our analysis we have focussed on key themes that emerged through the study and that have a particular significance in the changing education, curriculum and language policy context in South Africa, including:
- the nature, availability and use of material and cultural resources as a function of programme take-up and the context of teachers' work;

- the critical issue of the relationship between teachers' knowledge-in-practice and the nature of the cognitive demand on learners;

- the challenge of language-in-education policy and practice, particularly code-switching as a teaching and learning resource, across contexts where English language infrastructure varies;

- teachers' take -up of the forms and substance of learner centred practice

Each of these foci takes as crucial, the integral nature of persons acting and the social world, and so how take-up, or changing knowledgeability, would be reflected in knowing-in-practice.

So far so good. But as I move to using Lave's notion of learning as socially and culturally constituted, I need to work on, and develop further, two key difficulties. The mechanism for learning in social practice theory is increasing participation in communities of practice. What is/was the 'community of practice' or the social practice in which teachers in the FDE programme were engaged? What is meant by 'increasing or ongoing participation' in this community?

What constitutes the practice of teaching? Where is it? In Lave & Wenger's terms, teaching as a practice is constituted by old-timers (experienced teachers in the school - supposed masters of the practice) in interaction and relation with newcomers (novice, less experienced younger teachers); by specific ways of talking and acting; by material resources like textbooks and social resources like colleagues, parents, learners themselves; and by wider social and political relations. In most common sense terms, the practice of teaching is located in schools and classrooms. However, the widespread move towards systemic reform is a clear signal that the practice of teaching is not bounded by the school gates and classroom door. The practice of teaching spreads beyond the school into curriculum development units and their text production, government departments, policy makers, professional associations.

As an in-service programme the FDE teachers were each already participants in the practice of teaching in their own particular school, context and community. They thus entered the social practice of the programme with a history in the practice of teaching. The 'site' of their participation in the practice of teaching through the programme extended beyond their school to include the distanced site of the University and its provision of residential workshops on the one hand, and learning materials on the other. The course materials for the mathematics teachers in the programme engaged with pedagogy and mathematics and their inter-relation. In regular quarterly residential workshops at the University, the teachers had access to and experience with other textual and material resources in the practice of teaching (videotext of 'master' teachers; easily produced 'aids' e.g. tangrams), and immersion in mathematics teaching-related activity. They had access to colleagues (both older, younger and more and less experienced, and who were also programme participants and from different school contexts) and to lecturers in the course that brought to bear ranging schooling experiences and expertise in the practice of teaching themselves. In short, participating teachers were offered opportunities for increasing participation in the practice of teaching, and so for changing knowledgeability.

What is signalled here is that learning about teaching cannot be understood through some bounded notion of a community of practice. Resources 'in' the practice of teaching inevitably cross over from other practices. The FDE teachers were participating in a network of intersecting communities and practices which are constitutive, together

with what the teachers themselves bring, of the practice in any moment in time. In short, and such is the case with any theoretical framework as interpretive tool, there will need to be work done through the research as this framework is brought to bear on a particular empirical field.

Knowing in the practice of teacher education research

It is not possible to do full justice to the richness of the data that emerged in this research project. I select from it, first in rather generalised and then in more specific ways, to illuminate social practice theory and how its concepts offer tools of description and analysis of teachers' changing knowledgeability, and how, in working it in to interpreting teachers' knowledgeability, there remains work to be done.

Both commonality and diversity emerged through the analysis of data. All the teachers articulated a belief in their personal growth and learning through the programme. Across most of the teachers was a clearly articulated feeling of greater confidence in themselves as teachers and in the mathematics they were required to teach. Most recruited new material resources or used existing resources in new ways. For example, the primary mathematics teachers brought in a newly designed worksheet and/or some 'apparatus' (e.g. home-made tangram) to demonstrate a concept. Most of the secondary mathematics teachers used their chalkboards in new ways: instead of using these themselves to demonstrate a new procedure or problem solution, they had learners come to the board to write up their own solutions and share these with the rest of the class. In this way, many of the teachers also began to elicit more and diverse learner productions. In other words, they encouraged learners, through different kinds of tasks, to offer ranging task interpretations and problem solutions. However, only a few engaged with these and then in rather abbreviated ways. Typically, they focussed on producing a correct solution. Only a few primary teachers ventured to change the nature of their tasks. In general, mathematics remained fragmented and algorithmic despite other changes, like increased learner participation through group work and spoken language through harnessing of learners' main language. All the mathematics teachers struggled with content/syllabus coverage and ongoing poor learner performance, both a function of longterm neglect and the breakdown of a culture of learning and teaching in many schools in the aftermath of the 1976 Soweto Revolt.

In relation to the foci identified *above*, primary teachers were far more flexible than the secondary teachers in recruiting new resources. Teachers' knowledge-in-practice was associated with low order task

demands on learners' mathematics, irrespective of the teacher's own mathematical sophistication. Teachers in rural areas, where English language infrastructure is more akin to a foreign rather than an additional language-learning environment, made convincing arguments for their own and their learners' use of English in ways that ran against policy for multilingual practice. While all demonstrated some attempt at forming learner-centred practice, none mounted the challenge of actually working with learner conceptions.

And within this commonality, in-depth analysis of each teacher-in-practice over time revealed an overarching diversity of changing knowledgeability. Take-up of ideas and practices from the FDE programme was uneven, partial and diverse.

Let's take Mrs Sara Sethole (pseudonym). Sara teaches secondary mathematics in a school in the Northern Province. Sara was personally motivated throughout the programme and was the only student to qualify with an overall distinction for all her coursework in 1998, and particularly in the mathematics focussed courses. (Note, this overall result was exclusive of any assessment of classroom practice – i.e. only school-focussed, not school-based[3] tasks were assessed). In fact, in the first year of the research project - at a time when she had only been in the programme for a few months - her take-up of ideas and practices in the programme was evident. For example, she drew directly from course materials where investigative teaching and learning practices were developed. Sara adopted an approach to sequences and series in her Grade 11 class where she worked enthusiastically to developing a formula for the sum of terms of an Arithmetic Progression through investigation of, and then generalising from, particular sequences.

She was, however, increasingly demoralised in her school where social relations in the school and between the school and the surrounding community deteriorated significantly between 1996 and 1998 together with learner performance in the external Grade 12 National Examinations. She focussed her learning efforts - her participation in the FDE programme - on her mathematics, believing that somewhere, deeper engagement with calculus, for example, would be useful to her in her teaching. As a result of the deteriorating conditions in her school, instead

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[3]   The distinction used here is to differentiate between in-service programmes where a great deal of the activity between teachers and teacher educators takes place in the school classroom (these are "school-based"), and programmes where activities are "focussed" on and in the classroom, but teacher educators do not work alongside teachers in their school classrooms.

of collaboration with colleagues in relation to teaching, time spent in the staff room for the science and mathematics teachers was used to support each other in their individual study pursuits. At the same time, however, Sara involved herself in an action research project with the lecturer of the course, taking her work and thinking to a mathematics teacher conference. She furthermore chose in 1998 to teach lower down in the school (Grade 8) in an attempt to influence a mathematical learning culture in this first year of the secondary school. In 1998 we observed her struggle to work with pedagogic content knowledge appropriate to Grade 8 learners within a wider context of demoralisation in the school.

How do we talk about Sara's development, her changing knowledge-ability, as a function of her participation in the FDE programme? Should we? In her course work she successfully demonstrated a range of knowledges. How do we talk about her 'use' of this knowledge in classroom practice over time in a deteriorating context? Should we? What happens if we split these, i.e. split performance on mathematical and pedagogic content knowledge tasks say, from the use of this mathematical knowing in classroom practice? How do we do justice to Sara if we don't? How do we account for in-service programme effects if we do? Does it help to distinguish between *inert* knowledge and *external obstacles to using knowledge*? Does social practice theory help provide a coherent and robust lens to engage these questions? At the broadest and most significant level it does, since Sara's changing knowledgeability, her knowing-in-practice over time is clearly not located in her head in some static or isolated way, nor is it directly located in her involvement in the FDE programme. It is rather a function of her participation at one and the same time in multiple, contradictory (and all constitutive) communities or contexts of practice, including the FDE programme, her school, the changing curriculum context underway in the country. While the school context increased Sara's alienation and despondency in her teaching, she continued to enjoy and learn from the FDE programme, as well as her action research with the course lecturer. At the same time, she repositioned herself in her school as a teacher of 'junior' classes so as to "influence the learning lower down". Sara's take-up from the FDE programme is thus uneven and in some ways contradictory, but can be understood as her increasing participation in the practice of mathematics teaching within the constraints of her particular school context.

The other mathematics teachers in the research project were in different school conditions and faced different possibilities and constraints in their schools to those faced by Sara. Teachers from the same school did not necessarily benefit from the programme in the same way. Teachers in

different schools enjoyed different parts of the programme and were stimulated in different ways to broaden and deepen their teaching. For example, other secondary mathematics teachers in both poorer and more established schools than Sara's focussed their attention on trying out new pedagogical strategies. Two, in particular, succeeded in developing their mediational strategies. Both were more successful in eliciting and then working with what it was that learners offered. In contrast, Sara's colleague in her school (a science teacher in the FDE programme) was less affected than her by the deteriorating conditions in the school. At the same time, he demonstrated far less take-up and exploration of ideas from the programme, as did Sara, particularly in her first year. Perhaps in this way, he protected himself from disappointment in investing in any new practices.

It is beyond the scope of this paper to provide more detail here. Such is available across various publications related to the research project, some of which include case studies of particular teachers (e.g. Adler, 2000). Overall, diversity was apparent in the nature of the material and cultural resources recruited into teachers' practices; in the way mathematical knowledge was selected, organised, approached and mediated. Teachers are different. They brought diverse histories (mathematically, pedagogically, professionally) into the programme, and they worked in diverse school contexts. Diversity of take-up from the programme makes sense from the perspective of social practice theory where knowing is tied to becoming, and changing knowledge-ability is a function of participation, resources, changing identity and social relations in the practice.

Yet numerous issues remain as diversity in teachers' changing knowledge about their practice' pushes us to reconsider social practices, and how these are constitutive of and constituted by intersecting communities of practice, with ranging and sometimes competing forms of participation. In the remainder of this paper I will discuss those areas where more work is needed for social practice theory to be a comprehensive and robust framework and set of tools for research in mathematics teacher education

Issues in mathematics teacher education

Who judges changing knowledgeability?

This is a question for research and practice in mathematics teacher education. In an apprenticeship context, the master is judge and jury (though not in uncontested ways). There is also the produced artifact, which can be judged by outsiders. Judgement of changing knowledge-

ability in teaching (about knowing how to teach and being a teacher) is less clear, a function, in part, of the relatively low status of the profession. Unlike professionals in law and medicine, South African teachers do not regulate their profession themselves. Many of the key functions in teaching, like assessment, are removed from the teacher. If we go back to the teachers in the FDE programme, from their own perspective they were "empowered" by their participation in the programme. They "learned a lot". They experienced and expressed knowledge growth and enrichment. They believed, or most of them did, that they were being "better" teachers, whatever that might mean. They felt more "confident", particularly in dealing with specific areas of mathematics. They were increasingly knowledgeable.

If we shift the evaluation to the researchers and lecturers in the programme, then the teachers' changing knowledgeability was uneven, partial and sometimes even a reversal. Like Sara, many teachers increased their participation in aspects of the practice outside of their classrooms e.g. the activities of the national mathematics teachers' association. Yet we saw significant epistemic constraints on the way most of the teachers worked with mathematics. This was evident in the mathematics they selected, how they organised this into task and activity, how they sequenced and graded mathematical work with learners. And the language used to describe this, as is clear in my description of general research findings above does not escape a language that finds teacher 'lacking'. Moreover, in the most impoverished of the rural schools in which we worked, teachers' uptake produced reversals in their knowing-in-practice, undoing a functionality perhaps peculiar to the specificities of teaching and learning under complex constrained conditions - a functionality in contradiction with practices valued and enacted in the ranging intersecting communities producing teaching and learning in post apartheid South Africa.

I will side-track briefly here with an example. In the first year of observation, 1996, Regina, who worked in one such impoverished rural primary school, was confident and lively about her teaching in her Grade 7. During that visit she was consolidating the operations on fractions. In whole class teaching she engaged learners in distinguishing the rules for addition and multiplication, and then in carrying out various operations. Learners were confident to express procedural steps publicly and in English, and were able to complete the classwork set. In 1997 Regina and her colleague tried to introduce what for them were 'new' tasks, for example, practical activity in measurement tasks. There were

neither enough rulers nor even paper for each learner. Both teachers struggled to re-interpret the tasks in such a way as to meet the needs of their learners and their context. In 1998, Regina in particular had become defensive and demoralised, convinced at everything but her own agency and capabilities. Observations in her classrooms in 1998 were of a lifeless and limited practice, and a far cry from those observed in 1996. Yet, Regina's story is incomplete if it does not include discussion and analysis of the wider context of the school. The head teacher was ineffectual, and indeed undermining of teachers who set out to further their education; there was a confusing implementation of curriculum change across the country; and Regina herself carried personal resentments and anger at events in her domestic life.

Returning to the consideration of who evaluates changing knowledgeability, if we shift the evaluation further away from the classroom and the teaching learning context out to parents, the wider community, government departments, policy makers and programme funders, the most powerful determinant of evaluation is the continuing widespread poor learner performance, despite teachers' experiences of learning. Whatever claims there might be to changing and increasing knowledgeability of the teacher, these are undermined by unchanging wider-spread poor learner performance, particularly in the National Grade 12 examinations. As we shift judgement away from the teacher to the profession and then to wider interests, we find ourselves in a context that produces individual teachers and the profession at large as deficient in some or other way.

Who should judge changing knowledgeability? What criteria need to be used? In effect, as a public good, school education, and teachers within this social institution, will inevitably be judged by others, and with criteria drawn from other practices and interests. In a context of fiscal constraint, we are under serious pressure in the wider political economy of South Africa to demonstrate that in-service teacher education fulfils its promise of improved quality in the teaching-learning context. The significant challenge is how we might push at the notion of changing knowledgeability (build on what social practice theory has offered) in ways that embrace all three positions above (the judgements of teachers themselves, that is from within the profession; judgements of teacher educators and their criteria for good practice; and judgements in the wider public, based on learner performance) without at the same time producing a discourse of deficit in teachers.

Is changing knowledgeability an unproblematic 'positive' outcome of participation?

There is a sense in Lave's work in which learning by immersion in social practice is always and everywhere successful. Not all street kids do street math with the same fervour and success. Some 'survive' over others. Does more participation lead to 'more' knowing and a 'better' becoming? How do we ask questions about, and interrogate and expect a deeper knowing from ongoing experience? I am left uneasy with a framework of apprenticeship learning, where **more** participation in practices (be these well organised and structured) becomes unproblematically conflated with **better** learning - quantity becomes quality. We need to push on the notion of participation – to understand the relationship between different kinds of participation and ranging learning outcomes. Boaler's analysis of two different mathematical practices in two different schools in the UK (Boaler, 1997) goes some way to push on the notion of participation and show that different kinds of participation result in different kinds of knowledge. In both schools, learners participated in 'increasing' ways in mathematical practices as they moved from Grade 9 through to Grade 11 in their school and finally to taking their GCSE examinations. The nature of their participation, however, differed substantively, leading to different kinds of mathematical practices.

Where, actually, is history in social practice theory?

History is under-developed in this perspective. Personal history in particular does not get sufficient attention. The wider practice in some bounded way is produced as over-determining. We know that while we participate in one practice, we do bring to bear knowledge and being from other practices. In the FDE programme, and in our other teacher education activity in the university, the most powerful constraint on take-up or what more formally we could name as 'appropriations', is teachers' history and deeply embodied mathematics in school practice. And the same point can then be extended to histories in the wider participants in the intersecting communities in the practice. Significant personal and collective histories in teaching and teachers are challenges to our theory and practice, and not simply obstacles. We need to push on the theory in our research and practice, so as to embrace this challenge.

There isn't sufficient cognisance of distance in time and space in Lave's concept of communities of practice. Community of practice is too bounded a notion.

> *... [T]heories of learning-in-practice assume that processes of learning and understanding are socially and culturally constituted, and that what is to be learned is integrally implicated in the forms in which it is appropriated, so that, for example,* how math *is learned depends on it being* math *that is learned, and how math is learned in school depends on its being learned* there *... knowing, thinking and understanding are generated in practice, in situations whose specific characteristics are part of the practice as it unfolds.*
>
> *(Lave, 1990, pp.18-19)*

What is still unresolved is how we look beyond the classroom in the classroom; how we look in and through the classroom to social and power relations distanced from but constitutive of classroom processes - the macro/micro problem. This is part of a developing critique of Lave's perspective on learning through participation in communities of practice:

> *The problem is that these (human) communities are treated as bounded, strictly local settings, seemingly unconnected and unconnectable to other spaces and times. People move in and out of Lave and Wenger's circumscribed version of the 'social world' in terms of participation (although no attention is given to the trajectories that bring people to the peripheries of particular communities in the first place), but the question of how such communities are structured, maintained and connected to one another across space and time cannot be asked within the assumptions of the framework. (They remain locked in an individualised, bounded conception of community, in the particular and hence decontextualised ... despatialised).*
>
> *(Nespar, 1994, p.12)*

What Nespar helps illuminate is that the classroom, for example, while constituting a kind of community, is never sealed off from other communities of practice. Learners come in to the mathematics class with all kinds of histories and identities, and so belongings, and these shape and are shaped by mathematical classroom practices.

What about transfer?

Lave's has provided the most sustained and effective critique of 'learning as transfer'. She has challenged the widespread assumption, particularly in mathematics, that we acquire knowledge in one setting (say the school) and then move around and use it at will in ranging circumstances. The debate on transfer on knowledge continues[4]. Lave's strong attack on 'transfer' as an explanatory tool in learning can be interpreted with respect to her bounded concept of community, and her limited concept of history in learning. 'Transfer' might well be an inappropriate description of how it is we do use knowledge acquired in one setting in another. But we still need to explain why it is that knowledge acquired in one setting is or is not triggered, used and useful in another. Immersion in one practice is and can be generative of, and related to, ways of knowing and being in other practices. There are many attempts to deal with knowing and being across sites, discourses, practices e.g. Billet's (1998) distinction between near and far transfer; Walkerdine's chains of signification (1988).

In teacher education currently, the debate on transfer is focussed on where teacher education takes place. For many, the only effective site for learning to teach is 'in' the school (i.e. school-based) and so 'in' the practice. Research and practice in teacher education, and particularly in-service, tells us that changing knowing-in-action is also not easily produced on site, in school-based programmes. Immersion in a practice can sometimes prevent seeing. How do we move beyond dichotomous conceptions of site and activity as either directly 'in' or completely 'out of' the practice? (The swinging we are seeing in teacher preparation between University and school as site, and between subject and pedagogy as activity).

What about teaching?

In the emphasis on participation in a learning curriculum in social practice theory, lies an important recognition that intentional teaching does not equate with learning. There is, nevertheless, a recognition of sequence in the curriculum, constituted by observation, practice and supervision. Such description renders teaching invisible. Is this appropriate, particularly in the context of learning mathematics and learning in school? One of the major issues for social practice theory is that while it has done a great deal to unpack learning, its way of dealing with 'teaching' is to remove it rather than unpack it. There is no attempt

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[4]   See for example, the 1999 issues of Educational Researcher; as well as the 1999 American Education Research Association yearbook #24.

to understand what teaching is and how it is taking place in apprenticeship contexts, where by her own admission (Lave, 1990) there is a sequenced curriculum. As a result, there is a continuing difficulty of interpreting social practice theory in social contexts like the school, where teaching and learning are intertwined.

Wenger (1998) takes social practice theory further and elaborates in great detail what is meant by learning. And the problem created around teaching remains. Indeed, for Wenger, maximising learning entails 'minimising' teaching (p. 267). As a teacher educator, thinking about ongoing learning about teaching, and teaching as a social practice, there is something quite strange about learning to teach (as we must) when the ultimate goal is its minimisation.

What about mathematics, particularly mathematics in teaching-learning in school?

And this leads me to the most pressing issue for me now in South Africa - what we can loosely call teachers' content or subject knowledge and whether and how this could be deepened. The more we learn about what could be possible in school mathematics learning under idealised conditions, the more I think we are moving away from harsh on the ground realities. We are expecting more and more mathematical sophistication from teachers at a time when those entering mathematics teaching and those who find themselves in it, do not have strong mathematical histories. If we are talking about knowing-and-being a school **mathematics** teacher, we need to work on how 'participation' can work as metaphor and/or mechanism for *mathematics learning in school and in in-service teacher education.*

By way of conclusion

There is no concluding argument to this presentation and paper - it was never the intention to reach some kind of closure on social practice theory. It was my purpose to articulate its central ideas and concepts, relate these to practice and from there engage with where it assists in interpreting and explaining our work in mathematics teacher education, and where it runs out. I nevertheless close, as we were asked to do, with additional questions to focus further discussion. Firstly, where is power? where is history? in social practice theory, for without these, our explanations of Sara's changing knowledgeability remains inadequate. Secondly, if knowledge does not transfer unproblematically across situations, what then of the boundary around everyday, school and disciplinary mathematical knowledge? How hard is it? And finally, as I

have posed elsewhere before (Adler, 1998b), what happens (or needs to happen) as we tear social practice theory from its roots in learning through apprenticeship and professional practice, and recontextualise it as a theory for learning to teach mathematics in school, and learning mathematics in school? What needs to be done to expand or change the network of concepts so as to be able to describe and explain mathematical learning in school and mathematics teacher education?

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Research interests
Language and mathematical learning in multilingual contexts: in particular, how do teachers and learners negotiate the journey from exploratory or informal mathematical talk in the learners' main languages to to discourse specific talk in English, the Language of Learning and Teaching.

Mathematics teacher education: in particular how does social practice theory provide the concepts, tools and practices that can enhance how we theorise, research and practice mathematics professional development.

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